GovTech Connect

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DRAFT REPORT
European GovTech Technology Scanning

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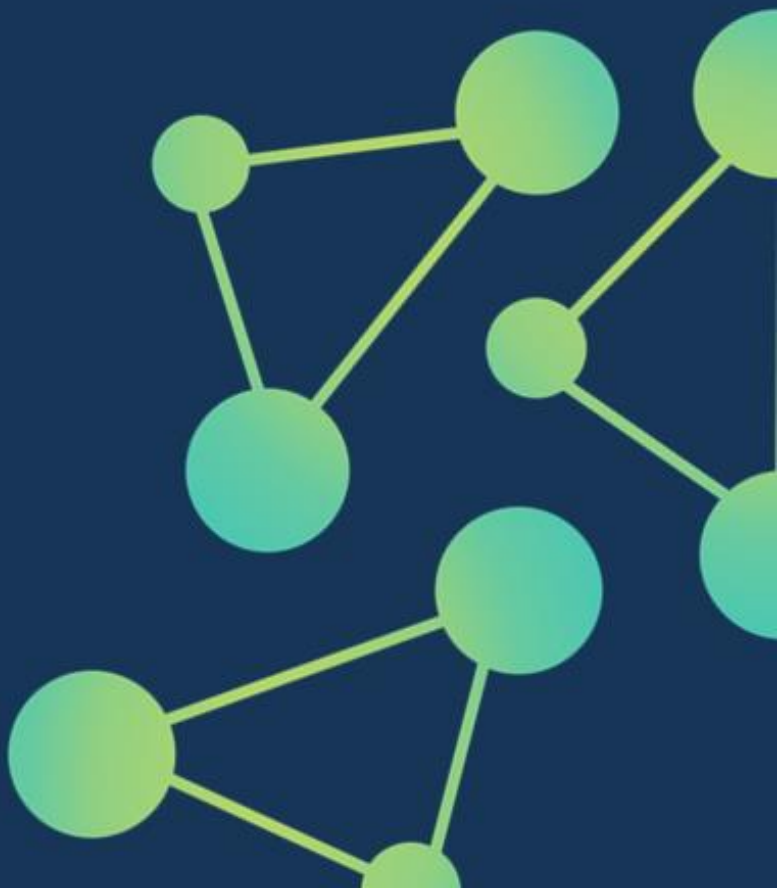

Technology Scanning Study to support the development of a Foresight Study within the GovTech Connect Pilot Project

DRAFT Report

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ABSTRACT

In this study we conducted a technology scanning, aimed at discerning the different technologies utilized within the European public sector, thereby assessing their potential impact on the European GovTech ecosystem.

The exploration delved into eight categories of technologies—Artificial Intelligence, Communication Technologies, Computing Infrastructures, Distributed Ledger Technologies, Digital Identity and Security, Immersive Technologies, Internet of Things and Smart Devices, and Software and Service Technologies—based on the framework provided by Bruno et al. (2020) to ensure continuity with existing literature of the European Commission.

The aim of this analysis is to consider ways in which we can boost technologies that already provide successful use cases for the public sector.

TABLE OF CONTENTS

1 INTRODUCTION

In our technology scanning research, we ventured into an exploration of the European public sector's technological landscape, focusing on its integration with the rapidly evolving GovTech ecosystem.

This investigation categorised and evaluated eight pivotal technology domains: Artificial Intelligence, Communication Technologies, Computing Infrastructures, Distributed Ledger Technologies, Digital Identity and Security, Immersive Technologies, the Internet of Things and Smart Devices, and Software and Service Technologies.

Our approach was informed and guided by the established framework of Bruno et al. (2020), ensuring that our study aligned with and expanded upon the foundational research conducted by the European Commission. To address the lack of data in this landscape we have extrapolated the use of these technologies throughout the 50 most successful startups presented at the market scanning. This to form a somewhat representative sample of the most successful use cases and distribution of technologies thus far.

This analysis serves as the foundation for future developments, highlighting opportunities for innovation and improvement in public sector services across Europe.

2 ARTIFICIAL INTELLIGENCE

The definition of Artificial Intelligence is yet subject to considerable debate. According to the expert group appointed by the European Commission and retaken for the AI Watch, "Artificial intelligence (AI) refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals. AI-based systems can be purely software-based, acting in the virtual world (e.g., voice assistants, image analysis software, search engines, speech, and face recognition systems), or AI can be embedded in hardware devices (e.g., advanced robots, autonomous cars, drones, or Internet of Things applications)"[1].

For the technology scanning in the GovTech Connect project, the definition of AI was broadened and defined by type of technology based on Bruno et al (2020). Hence, Artificial Intelligence (AI) refers to technologies that apply advanced analysis and logic-based techniques to interpret events, support automated decisions, and take actions. AI simulates human intelligence processes by machines, which include learning, reasoning, and self-correction. It encompasses Machine Learning, Deep Learning, Natural Language Processing, Text Mining, Computer Vision, Cognitive Computing and Predictive Analytics, and Expert and Rule-Based Systems to interpret, support and automate decisions and act.

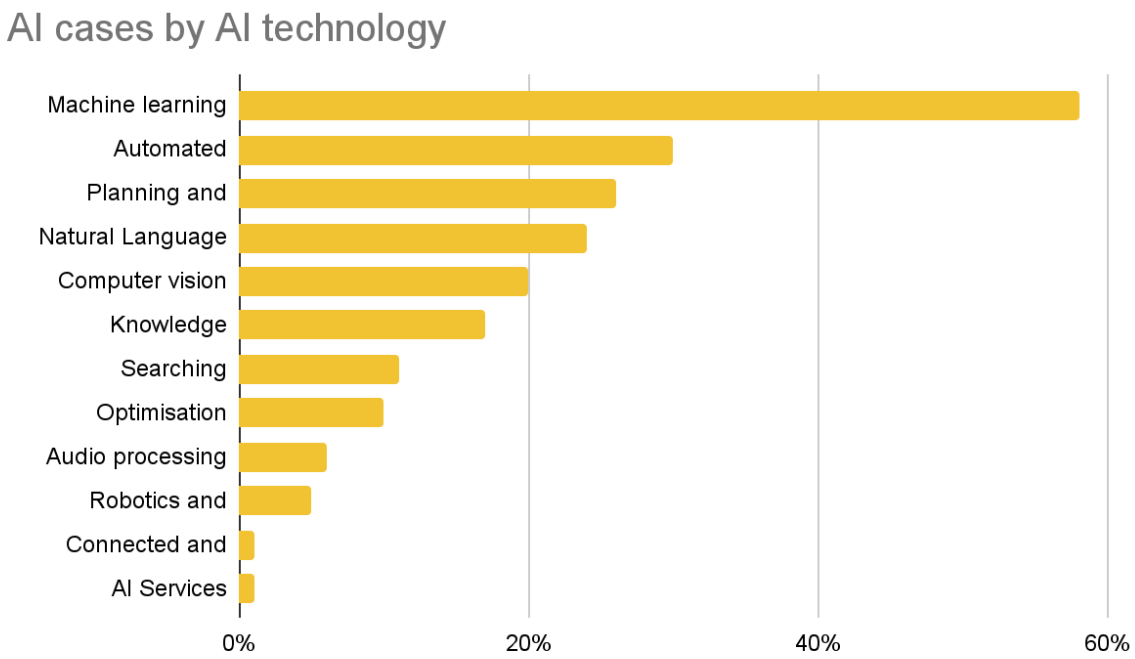
Artificial Intelligence uses in the public sector

Using AI in the public sector allows for more capabilities, and it expands the opportunities for the improvement of services. First, AI can be implemented in information processing, the perception of the environment, decision-making, and achieving specific goals and task management in the public sector; we identified three main areas: (1) improving the internal efficiency of public administration, (2) improving public administration decision-making, and (3) improving citizen/government interaction, including better and more inclusive service provision and enhance citizen participation in the activities of the public sector .

According to the AI Watch report published in 2022, most of the identified cases of AI use in the public sector are categorised as Machine Learning, followed by Automated Reasoning Techniques. Chart 13 indicates the main types of AI technology used in the public sector:

[1] Tangi, L., Van Noordt, C., Combetto, M., Gattwinkel, D. and Pignatelli, F., AI Watch. European landscape on the use of Artificial Intelligence by the Public Sector, Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/39336, JRC129301.

Chart 1. AI cases by AI technology (Tangi et al, 2022)

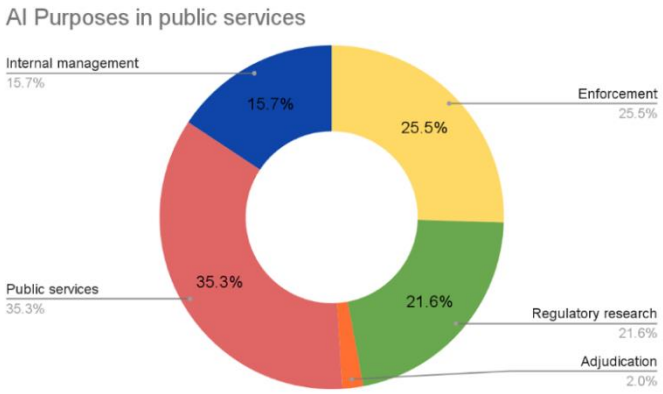


The different application purposes of AI in the public sector are:

- Enforcement: enforcing the existing regulation.
- Regulatory research, analysis, and monitoring: to assist policy-making processes.
- Adjudication: to help or conduct the granting of benefits of entitled rights to citizens.
- Public services and engagement: to support providing services to citizens and businesses, facilitating communication with the public.
- Internal management: to assist in the management of the internal organisation.

Chart 2 explores further the weight of each purpose:

Chart 2. AI purposes in public services (Adapted from Tangi et al, 2022)



The more significant part of AI application in the public sector is directed at **public services and engagement**, hence related to public service delivery and

communication activities with external actors. Most of the cases refer to their use for service personalisation (13%), engagement management (10%), service integration (9%) and data sharing and management (2%).

The second largest use is for **enforcement.** Most of the AI use is directed at smart recognition processes (9%) and predictive enforcement processes (9%), followed by supporting inspection processes (2%) and management of auditing and logging (2%).

In terms of **regulatory research, analysis and monitoring,** the technology is most used for prediction and planning (10%), information analysis processes (7%), and monitoring policy implementation (6%). For internal management, it is used for internal support processes (9%) and internal primary processes (8%). Adjudication is a minor purpose regarding AI applications, directed at making decisions on benefits (2%).

Artificial Intelligence use in GovTech solutions

Through the market scanning, we identified fifty-nine (59) leading GovTech startups and SMEs in three European geographical areas: Southern, Northern, and Western. The startups and SMEs providing AI-based solutions sum up to 15 (some of them using AI and other technologies at the same time), mainly for the "Environment" market segment (6), followed by "Well-being" (3), "Inclusion" (3) and "Transparency" (2). Most startups using AI are in Southern Europe (7) and Northern Europe (6), followed by Western Europe (2). Table 8 presents leading which startups use AI:

Table 1. Leading European startups and SMEs using AI for GovTech solutions

Name of the organisation	Region	Market segment
TeknTrash	Southern	Environment
Unbabel	Southern	Inclusion
Biometrid	Southern	Inclusion
Inbenta	Southern	Transparency
Gestoos	Southern	Transparency
Tucuvi	Southern	Well-being
Savana	Southern	Well-being
Eneryield	Northern	Environment
InfoTiles	Northern	Environment
Skenario Labs	Northern	Environment
Findable	Northern	Environment
Bintel	Northern	Environment
CortiAI	Northern	Well-being
Vialytics	Western	Environment
Viind	Western	Inclusion

We have selected Govwise as an example of how AI is being used by a startup in GovTech. Table 2 describes their solutions:

Table 2. GovWise use AI in their solutions

Govwise
GovWise is a startup based in Lisbon, which has expanded its market in Portugal, and Spain and is currently being developed in Italy. It seeks to simplify public procurement to generate value savings, profitability, and return on investment for public organisations and companies working with the public sector. Their solutions are AI-based, including: • GovAI Research engine: it is a search engine for public procurement that facilitates the process of finding any public information or document. • Smart information organiser: an AI-based tool that helps professionals working with public procurement monitor opportunities in the public sector. • Interactive AI reports on GovWise platform: a real-time data generation and filter. • CRM Plug-in.

3 COMMUNICATION TECHNOLOGIES

Communication Technologies refers to the equipment and programs that process and communicate information. It encompasses 5G Networks and Handheld Devices, as well as Software Defined Networks (SDN). The first refers to a wireless technology that allows individuals to connect handheld devices, such as smartphones and tablets, to a broadband internet connection through a mobile phone network since the 5G Network is three times faster than its predecessors. The second refers to an approach to network management for dynamic, flexible, and programmatically efficient network configuration to improve network performance.

Communication technologies use in the public sector

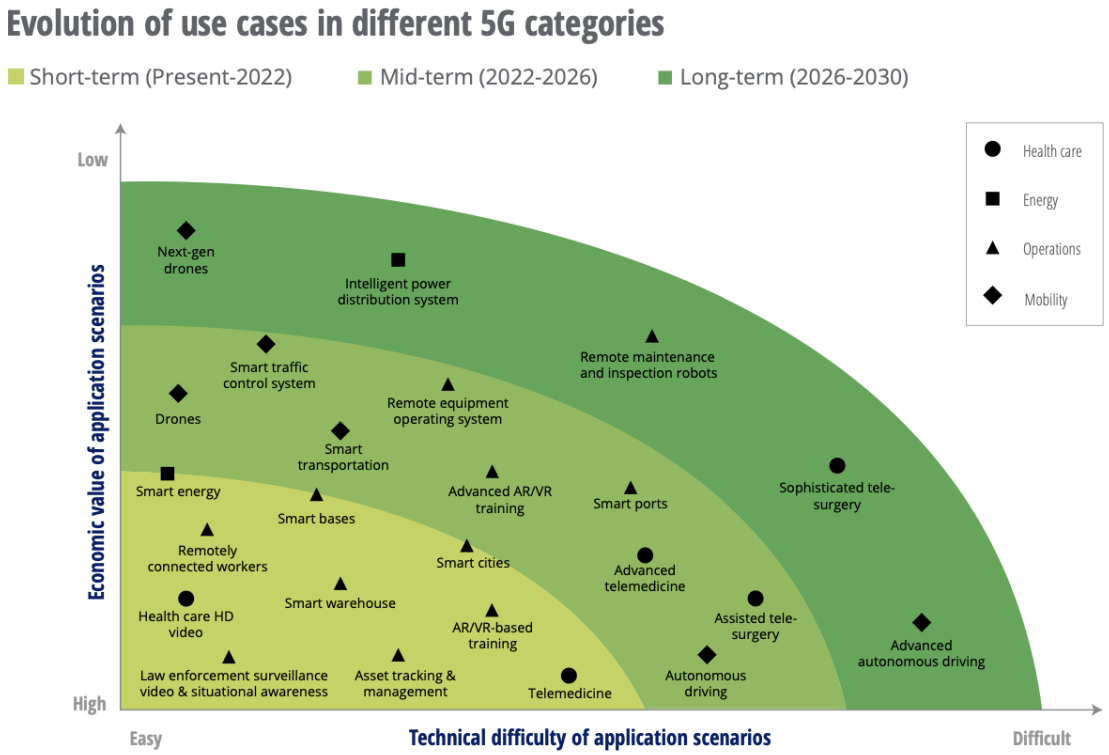
Communication technologies in the public sector are not new, but their use is the first technological breakthrough. Whilst each generation of wireless connectivity has brought more efficiency to this type of network, the role that 5G has been playing has led to better visual experience, enabling better-augmented reality and virtual reality), a better multi-user experience, hyperconnected cities (Internet of Things), and autonomous applications and software[2].

Using communication technologies in the public sector can bring many opportunities, especially by complementing other technologies. The use of 5G networks can allow for government operations transformation, as it supports access to high levels of real-time information from any device, which is particularly important for field workers such as first responders, law enforcement officials, and food inspectors. Technology can also improve public infrastructure by creating intelligent and hyper-connected communities and act as a force multiplier for other technologies, such as AI, cloud computing, and multi-access edge computing.

The use of 5G can impact different areas of the government. Figure 1 describes its benefits:

[2] Greenberg, Brian et al. 2020. "5G in government the future of hyperconnected public services". Deloitte Insights.

Figure 1. Evolution of case studies in different 5G categories (Greenberg et al. 2020)[3]



On the policy side, the European Commission (EC) has bet on the power of 5G for digital transformation. Since 2013, the EC has established public-private partnerships to accelerate research and innovation in 5G technology. Through the Horizon 2020 programme, the EC has committed public funding of more than €700 million. In 2016, the EC adopted a 5G action plan to ensure the deployment of the technology across Europe, which sought to launch 5G services in all EU Member States by 2020.

According to the latest report published by the European 5G Observatory (2022), 5G has been deployed in 81% of European populated areas, with the highest coverage in the Netherlands (100%), Italy (99,7%), Denmark (97,8%), Finland (94,7%) Germany (93,2%), Austria (91,7%), and Lithuania (90,1%). Conversely, the weakest coverage is in Belgium (29,6%), Romania (26,8%) and Sweden (20,5%)[4].

Considering the rapid evolution of connectivity technologies, the European digital transformation also benefited from establishing "Smart Networks and Services Joint

[3] Greenberg, B., Bajpai, R., O´Leary, J., Kelkar, M. "5G in government the future of hyperconnected public services". Deloitte Insights. 2020.

[4] "5G Scoreboard – 5G Observatory." n.d. 5G Observatory – Tracking 5G Developments

Undertaking" as a legal finding agent that set out an EU budget for €900 million between 2021-2027, to be matched by the industry, focused on 6G[5].

Regarding the use of SDN, we have outlined four benefits. Given that it is a network architecture that is dynamic, manageable, cost-effective, and adaptable, it can contribute to:

1. The standardisation of siloed IT systems used in government agencies' infrastructure has led to an incomplete view of data and hampers service delivery.
2. This leads to cost savings, given that SDNs do not require proprietary hardware to run.
3. Streamline operations, as SDN centralises controls for better management of the entire network.
4. Improve security, as the technology not only centralises network management but also centralises security[6].

Communication Technologies use in GovTech solutions

Considering the leading 59 startups and SMEs identified during the market scanning, none works specifically with communication technologies (such as providing or improving 5G networks and SDN). However, most of them rely on fast and secure networks to operate. As presented in the previous subsection, 5G networks are intrinsically connected to the advancement of immersive technologies, the Internet of Things and AI (considering the automation of processes). Table 3 provides an example of how startups using communication technologies that could benefit the public sector based on the experience from Maven Wireless:

Table 3 Wireless use Communication Tehnologies in their GovTech solutions

Maven Wireless
Maven Wireless is a Swedish startup working with a next generation 5G Distributed Antenna System (DAS). Its solution for 5G DAS has been implemented in the Austrian railway for safety-critical and cellular networks by applying a modern, energy-efficient radio coverage that reduces power consumption up to 60%. Its solution supports critical frequency running from VHF to UHF/TETRA to GSM-R and offers Austrian cellular MNO frequencies from 2G to 5G in one platform.

[5] "5G | Shaping Europe's Digital Future." n.d. Shaping Europe's Digital Future

[6] Comcast Business. SDN: *Powering the Next Generation of Government Networks*.

4 COMPUTING INFRASTRUCTURE

Computing Infrastructure is a collection of servers, networks, physical and cloud data centres, and related equipment that provide a specific level of aggregate computing capacity. It includes High-Performance Computing, Cloud Computing and Edge Computing.

Computing Infrastructure use in the public sector

Cloud computing is considered an essential tool for supporting digital transformation in the public sector. It can adjust to the needs for data storage, it is a shared space for technology resources, its cost varies according to what is used, it is secure for storing data, and it contributes to developing new products and services. In this sense, cloud computing can help the public sector as follows:

- Flexibility, as the cloud facilitates flexible and immediate use of resources, hence being demand-oriented and better using other advanced technologies.
- Efficiency, as the cloud reduces the need for procurement, installation, configuration and maintenance of hardware and software.
- Resilience, as the cloud protects against business disruptions caused by hazards.
- Cost-effectiveness, as the costs associated with investing in IT infrastructure are reduced.
- Agility and scalability, as cloud resources are available anytime.
- Sustainability, as the cloud uses low or zero-emission data centres.
- Customer experience and skills development, as the cloud improves customer experience by reducing response time, speeding product development, and enhancing decision-making[7].

European policies have addressed the use of cloud computing both for European Businesses and public authorities, seeking to provide access to secure, sustainable, and interoperable cloud infrastructures and services. Whilst today, most of the large data centres are in centralised computing facilities, trends have shown that by 2025, 80% of all data will be processed by smart devices closer to users (edge computing).

The ambition for broad Cloud and Edge computing is embedded in two objectives of the EU´s Digital Decade: to have 75% of European businesses using could-edge technology for their activities and the deployment of 10,000 climate-neutral and highly secure edge nodes for rapid data transfer and connectivity provision.

Cloud computing is also included in the **European Data strategy**, which proposes developing interoperable cloud and edge services to support the common European data spaces. Furthermore, cloud-computing uptake can benefit the European Green Deal by underpinning digital solutions and the Digital Decade concerning the Important

[7] Deloitte. Digital Government_ how the EU cannot miss the cloud opportunity (2021).

Project of Common European Interest (IPCEI) on Next Generation Cloud and Edge Computing Services[8].

Computing Infrastructure use in GovTech solutions

Amongst the leading startups identified in the market scanning, the ones using computing infrastructures are mostly related to the ones using IoT. Amongst the startups presented in Table 4, only Cloudguide, Element software, and Polyteia did not share the use of IoT in their solutions, along with computing infrastructure.

Most of them are located in Southern Europe (5) and Western Europe (5), followed by Northern Europe (2), focusing on the "environmental" market segment.

Table 4. Leading European startups and SMEs using Computing Infrastructures for GovTech solutions

Name of the organisation	Region	Market segment
Farmcloud	Southern	Environment
Artys	Southern	Environment
Cloudguide	Southern	Inclusion
Hopu	Southern	Transparency
Novoville	Southern	Transparency
Clean Sea Solutions	Northern	Environment
Nordsense	Northern	Environment
GoUrban	Western	Environment
Greencity solutions	Western	Environment
Smartends	Western	Environment
Element software	Western	Transparency
Polyteia	Western	Transparency

[8] *Cloud computing*. (2023, October 16). Shaping Europe's Digital Future. https://digital-strategy.ec.europa.eu/en/policies/cloud-computing.

One interesting example encompassed by the selected leading startups working with Computing Infrastructure is Cloudguide. Table 5 presents a more in-depth description of this case:

Table 5. CloudGUIDE uses Computing Infrastructure technology in their GovTech solutions

CLOUDGUIDE **CloudGUIDE**
Cloudguide is an app that provides tourists and culture lovers with a new way to experience sightseeing. It supports users in planning their visits, accessing multimedia tours and audio guides, taking notes, and sending postcards. The app includes content from over 1000 websites from 26 countries, being consolidated as the leading global sightseeing app for interactive experiences in museums and cultural heritage sites. It also provides data for participating institutions that allows them to understand the behaviour of their audience whilst providing tools for closer communication with users.

5 DIGITAL IDENTITY AND SECURITY

Digital Identity and Security refers to the technologies related to ICT security and physical security through technological tools. It encompasses Firewall and Protocols, Antivirus and Vulnerability scanners, Advanced user analytics, Biometric Screening, Cloud-Oriented Cybersecurity, Mobile ID, and Digital Identity Frameworks.

Digital Identity and Security technologies use in the public sector

The use of digital identity and security technologies in the public sector is an important asset for the digital transformation in the public sector as it enables the delivery of more digitally oriented services. It can enhance the relationship between governments and individuals by minimising potential travel costs and waiting times citizens may have for requiring a service, as well as reduce paperwork in public administrations and the risk of identity fraud. Governments can also use digital identity to streamline their relationship with business, as digital identity can be incorporated into registration, taxes, authorisations and other processes[9].

For instance, the implementation of European Digital Identity expects to provide digitised identification documents that are valid throughout the European territory, and it gives the opportunity to citizens to safely control how much of their information is shared with different services. It equally facilitates citizen identification online and offline. Practical examples of the use of the European Digital Identity include the identification for public services, opening bank accounts, filing tax returns, applying for a university abroad, renting a car, and checking in in a hotel.

One of the key enablers to digital identity in Europe is the Regulation on electronic identification and trusted services (eIDAS Regulation), which ensure that citizens and businesses can use national electronic identification schemes to access public services that are available online. It also creates a European internal market for trust services. Nowadays, around 60% of European citizens in 14 Member States can use their digital identification cross-border, which is still a low number, whilst only 14% of key public service providers in Member States allow cross-border identification with an e-identity system[10].

Digital Identity and Security technologies use in GovTech solutions

Only three out of the 59 leading startups identified in the market scanning use digital identity and security technologies: one in Southern Europe for "inclusion", one in Northern Europe for "Transparency" and one in Western Europe for "Transparency". Table 6 presents the cases:

[9] Domeyer, A., McCarthy, M., Pfeiffer, S., & Scherf, G. (2020).

[10] European Digital Identity, European Commission.

Table 6. Leading European startups and SMEs using Digital Identity and Security technologies for GovTech solutions

Name of the organisation	Region	Market segment
Biometrid	Southern	Inclusion
Veriff	Northern	Transparency
Element software	Western	Transparency

Table 7 explores deeper how Biometrid uses this type of technology:

Table 7. Case study: Biometrid

Biometrid
Biometrid is a Portuguese company funded in 2015 that provides AI-based solutions and APIs combined for a no-code identity verification biometric solution. It provides support for the whole compliance journey for opening accounts, preventing fraud, age verification, KYC/AML compliance, and proof of liveness. The solution is embedded into a platform that can integrate the different technologies created by the company into one single process.

6 DISTRIBUTED LEDGER TECHNOLOGIES (DLT)

Distributed Ledger Technology (DLT) is a digital system that records the transaction of assets in which the transactions and their details are stored in multiple places simultaneously. They have the potential to speed transactions as they decentralise authority or middleman, which depends on large networks with a series of participants, and each participant manages a node in this network. It encompasses two categories: Blockchain and other DLTs. Blockchain is one of the consensus management applications used to apply DLT. It organises data into blocks that are chained together, and hence, information cannot be cancelled out.

Distributed Ledger Technology use in the public sector

DLT has been considered, along with others, as one of the technologies with the most significant potential for disruption in public administrations. It has the potential to streamline processes, increase trust and accountability in government operations and reduce the cost of the processes whilst increasing efficiency, transparency and security.

More specifically, DLT technology can be applied for:

- Streamlined collaboration: when multiple organisations need to collaborate, but each may only act in a way that all others consent to, such as for benefits and grant approvals and disbursement.
- Security and resilience: DLT technology is more cyber-resilient as it functions through encryption and integrity by default.
- Privacy and confidentiality: DLT technology reduces the need to keep multiple copies of sensitive information, reducing the risks of compromised data. It can be used, for instance, for identity verification and sharing medical records.
- Compliance and oversight: DLT can track the origin of all data during a process by demonstrating a "chain of custody". It can be used for tracing logistics and procurement supply chains, for example.
- Registration and recording: DLT can produce permanent digital records, which can be used for land registry traceability of food supply-chain[11].

According to the "European Landscape on the Use of Blockchain Technology by the Public Sector" (2022)[12], in addition to the mentioned benefits, blockchain technology can support:

- The credibility of digital academic credentials by using blockchain to create a permanently time-stamped electronic version of a document.
- The use of identity management for authentication and login for e-government services.
- The enhancement of asylum process management.

[11] *Distributed Ledger Technologies in Public Services*. (2018, October 26). The Scottish Government.

[12] Bosch, J.M., Tangi, L. and Burian, P., European Landscape on the Use of Blockchain Technology by the Public Sector, EUR 31332 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-60172-2, doi:10.2760/18007, JRC131202.

Since 2016, there have been examples of how DLT technologies have been used in the public sector. In that year, Estonia became the first country to use blockchain for healthcare on a national level. In 2016, the Estonian E-Health Foundation launched a project for safely storing patient health records using blockchain technology in archiving related activity logs. In this case, a private digital ledger was integrated into the ledger at the E-Health Foundation to record and track patient medical data, which allowed for the possibility of having a real-time awareness of the integrity of the data stored.

Other examples include:

- In 2016, the UK Department for Work and Pensions did a pilot using a blockchain-based app for granting disbursements to 30 participants.
- In 2017, the Swedish Land Registry developed a blockchain-based platform for property transactions[13].
- In 2021, the Open Government of Catalonia, in collaboration with Howest University, deployed a pilot for students using their digital identity based on a college student ID card for granting discounts on municipal utilities.
- Since 2021, the German Federal Office of Migration and Refugees has been migrating the asylum process to a blockchain-based system, expected to reduce the error rate or the asylum process.
- In 2022, the European Blockchain Services Infrastructure (EBSI) developed cross-border pilots tackling different challenges from students studying and working abroad. It included graduated citizens applying for a job with a degree in a foreign country with the participation of universities in Cyprus and Greece; PhD students applying for specific courses in a foreign country with the participation of universities in Finland and Lithuania; Students getting a master diploma after validating a transcript of records by Erasmus, with the participation of universities in Belgium, Spain and Italy; Students applying for a PhD with a bachelor or master degree from a foreign country, with the participation of universities in Belgium, France and Greece; and Refugees presenting an EQPR to apply for a European university or finding a job in Europe, with the participation of CIMEA in Italy and GovPart GmbH in Germany[14].

The "European Landscape on the Use of Blockchain Technology by the Public Sector" reported a mapping exercise for blockchain-based case studies in the public sector in Europe using 167 case studies from 23 countries. The mapping showed that most of the cases are in Italy (31), the Netherlands (26) and the UK (13), whereas countries such as Andorra (1), Finland (1), and Poland (1) are at the bottom of the list[15].

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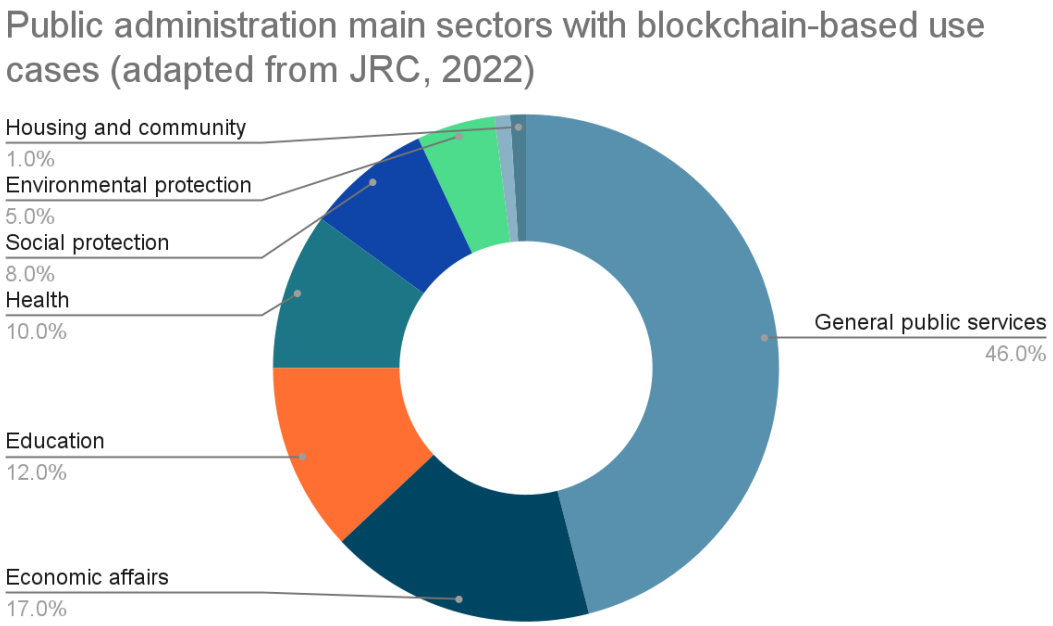
[13] *Distributed Ledger Technologies in Public Services*. (2018, October 26). The Scottish Government.

[14] *Verifiable Credentials Success Stories - EBSI*

[15] The mapping included: Andorra, Austria, Belgium, Cyprius, Estonia, Finland, France, Germany, Greece, Italy, Luxembourg, Malta, Moldova, Netherlands, Poland, Portugal, Russia, San Marino, Spain, Sweden, Switzerland, Ukraine, and the UK.

The mapping shows that most of the services are directed to general public services and economic affairs, and the less well-served sectors are for public order and safety and housing and community amenities. Chart 3 presents the distribution of blockchain-based:

Chart 3. Public administration main sectors with blockchain-based case studies (adapted from JRC, 2022)16



As for their maturity, 54% of the blockchain applications in the public sector are pilots, 19% are in development stages, 16% were implemented, 10% are no longer in use, and 2% are planned to be developed.

Distributed Ledger Technologies use in GovTech solutions

Out of the 59 leading startups identified in the market scanning, none openly deploy DLT technology in their solutions. Although most of the technologies and solutions they provide could be related to the use of DLT, they do not mention the use of DLT in their descriptions. As the shift from web3 moves to web4 and after the recent scandal related to blockchain technology (see FTX), companies have stopped visibly marketing themselves as blockchain solutions. Furthermore, the top 59 solutions are just a sample out of 1000 startups we have mapped for the market scanning; as such we can deduce that even though the representative sample of the most widespread solution does not include blockchain, the technology is still in an upward trend. For exemplification, Table 8 presents how ChromaWay is using DLT technology for GovTech:

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[16] Bosch, J.M., Tangi, L. and Burian, P., European Landscape on the Use of Blockchain Technology by the Public Sector, EUR 31332 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-60172-2, doi:10.2760/18007, JRC131202.

Table 8. Case study: ChromaWay

ChromaWay
Chromaway is a blockchain technology company in Stockholm that created "relational blockchain". Their technology supports land administration, real estate, finance, token & cryptocurrency by combining traditional databases with the distributional power of blockchains. It has partnered with the Swedish government to develop the Land registry pilot.

7 IMMERSIVE TECHNOLOGIES

Immersive technologies digitally simulate the natural world and create a sense of immersion. It encompasses Augmented Reality and Virtual Reality.

Immersive Technologies Use in the Public Sector

The Public sector's inclusion of virtual worlds can create a new channel for delivering digital public services in a more personalised way based on behavioural data that provide tailored experiences.

Immersive technologies can enhance productivity, as they can be used by users dealing with large amounts of data to interact with digital data in the real world. Users can interact with each other and see and understand the data, leading to better training and improved government services. Immersive technologies also unlock the potential for accessing the correct information at the right time, telepresence, and reduce costs.

Against this backdrop, governments can use immersive technologies to simulate environments, create immersive experiences, visualise and interact with data, facilitate the maintenance of machines, platforms and infrastructure, and improve education, public health and security[17].

The European Commission has been financing projects that contribute to the development of Citiverse, a citizen-centric metaverse that facilitates policymaking using AR and VR technologies. The Citiverse is expected to be multilevel, bring citizens closer to decision-making and increase their participation. Another example is Guichet.lu, an immersive application in the Luxembourg Megaverse related to national administrative services[18].

Immersive Technologies use in GovTech solutions

Amongst the leading startups identified in the market scanning, only Attensi uses immersive technologies specifically for the "inclusion" segment of the market.

Table 9 provides an additional case study for the use of immersive technologies as a GovTech solution:

Table 9. Case study: OneBonsai

ONEBONSAI	OneBonsai
OneBonsai is a company situated in Belgium that provides ready-to-use and tailor made XR applications. It has delivered a set of applications for sectors such as healthcare, industry, safety, military, marketing and virtual tours.	

[17] *Digital reality in government*. (n.d.). Deloitte Insights

[18] *Next generation virtual worlds: opportunities, challenges, and policy implications*. (2023, July 3). EU Science Hub.

The company's products span from a VR platform and solutions for VR training, VR hardware, and VR for safety.

8 INTERNET OF THINGS AND SMART DEVICES

The Internet of Things (IoT) relates to the physical objects embedded with sensors or actuators and connected to a network. An IoT platform allows for the development, deployment, and management of solutions that connect and capture data from the IoT endpoints. It includes Mobile Devices, Wearables, Sensors, and IoT Platforms.

Semantically, it refers to a "worldwide network of interconnected objects uniquely addressable, based on standard communication protocols", and is expected to increase the potential of the Internet through the integration of every object for interaction via embedded systems, leading to a highly distributed network that communicates with humans and other devices.

Internet of Things and Smart Devices use in the public sector

The use of IoT and Smart Devices in the public sector can create value for citizens and support public entities to enhance the efficiency and effectiveness of government services. Its application spans the health sector, education, transportation, and decision-making.

IoT can be important in connecting the e-health system with the cyber world, providing new services and interconnection between devices. It can also enhance healthcare systems by enabling preventive care and improving the quality of the healthcare system by diminishing the risk of human error. For *the education system*, IoT can benefit from the greater use of connected devices to make knowledge resources readily available to students through QR reading, automate attendance procedures using students' ID cards, and track equipment usage and monitor lighting and security systems. In the transportation sector, it can provide real-time traffic information and path optimisation, facilitating the everyday life of citizens, as well as providing real-time traffic data for better decision-making for public transportation.

Overall, IoT can be used for cities that wish to become "smart cities", using the technology for better city management that impacts the health, education, transportation, public safety and public service delivery[19].

Through a study developed in 2019 based on interviews led by Umea University in the Northern European region (Finland, Norway, Denmark, Estonia and Sweden), out of 355 municipalities contacted, 219 indicated they had already implemented one or several IoT solutions. The biggest number of municipalities using IoT were in Estonia (59),

[19] Ibid.

Sweden (50) and Denmark (41), whilst the lowest numbers were in Finland (37) and Norway (32)[20].

Europe has integrated an Internet of Things policy as the rollout of IoT technologies is projected to increase from around 40 billion connected devices in 2023 to 49 billion by 2026. The European Commission, through the Horizon Europe programme, has launched calls on "World Leading Data and Computing Technologies", through which the European Investment in IoT has reached around €100 million between 2021 and 2022[21].

Internet of Things and Smart Devices use in GovTech solutions

The definition of which startups are using IoT amongst the 59 leading ones identified in the market scanning was led by the ones openly stating that IoT was one of their solutions as well as the ones whose technology uses sensors and satellites. The total number of IoT startups was 17: 7 in Southern Europe, 6 in Northern Europe, and 4 in Western Europe. The majority of the solutions targeted the "environment" segment (13), followed by only 3 in "transparency" and 1 in "well-being".

Table 10. Leading startups in Europe using IoT

Name of the organisation	Region	Market segment
Farmcloud	Southern	Environment
Artys	Southern	Environment
Green Urban Data	Southern	Environment
TeknTrash	Southern	Environment
Novoville	Southern	Transparency
Hopu	Southern	Transparency
Sword Health	Southern	Well-being
InfoTiles	Northern	Environment
Clean Sea Solutions	Northern	Environment
Cordulus	Northern	Environment

[20] Westergren, U., Katrin, J., Velsberg, O. (2019). "Internet of Things in the Public Sector: Perspectives from Northern Europe".

[21] *Europe's Internet of Things Policy*. (2023, October 27). Shaping Europe's Digital Future.

Drypdata	Northern	Environment
Nordsense	Northern	Environment
Trafi	Northern	Environment
GoUrban	Western	Environment
Greencity solutions	Western	Environment
Smartends	Southern	Environment
Vianova	Southern	Transparency

We have identified an interesting case study in Sweden for the use of IoT as GovTech solution:

Table 11. Case study: Dryad

Dryad
Dryad is a Swedish startup that focuses on ultra-early forest fire detection as well as health and growth monitoring solutions. Amongst their many solutions, the Silvanet Wildfire sensor exemplifies how they use IoT technology: with a solar-powered wildfire sensor that provides wireless data transmission, the sensor detects the levels of hydrogen, carbon monoxide, and other gases at the ppm level to detect fire and aoid false positives.

9 SOFTWARE AND SERVICE TECHNOLOGIES

Software and Service Technologies encompasses everything related to software. It includes APIs, Web Services and Micro-services, Enterprise Service Bus Technologies, and Government Service Utilities.

Software and Service Technologies use in the public sector

The use of software and services technologies in the public sector strongly collaborates to the digital transformation European policies have been encouraging. Nowadays, digital connections are mostly deployed using application programming interface (API) services, which ensures fairness and robustness of European digital ecosystems given that APIs facilitate the creation of ecosystems and monitor their stability[22].

Software and Service Technologies use in GovTech solutions

Most leading startups in GovTech identified during the market scanning use Software and Services Technologies. Of the 59 startups, 29 use this type of technology, gy, six use it along IoT technologies and one use it along computing infrastructure technologies. Nine of them are directed to the "environment" segment of the market, nine for "transparency", six for "well-being", and five for "inclusion".

Table 12. Leading startups using Software and Service Technologies

Name of the organisation	Region	Market segment
MuniDigital	Southern	Environment
Green Urban Data	Southern	Environment
Bonus X	Southern	Inclusion
Comuni-chiamo	Southern	Inclusion
Ufirst	Southern	Inclusion
Novoville	Southern	Transparency
Kuorum	Southern	Transparency
MyPolis	Southern	Transparency
DoctorsHello	Southern	Well-being

[22] European Commission. Joint Research Centre. 2022. *API Strategy Essentials for Public Sector Innovation.* LU: Publications Office. https://data.europa.eu/doi/10.2760/203781.

Sword Health	Southern	Well-being
Climateview	Northern	Environment
Ignite Procurement	Northern	Environment
Measure & Change	Northern	Environment
Trafi	Northtern	Environment
GoUrban	Western	Environment
MyCleanCity	Western	Environment
SmartEnds	Western	Environment
Discuto	Western	Inclusion
CitizenLab	Western	Inclusion
&effect	Western	Transparency
Cap-Collectif	Western	Transparency
Fluicity	Western	Transparency
Manty	Western	Transparency
Polyteia	Western	Transparency
VotreAppli.fr	Western	Transparency
Ambler Health	Western	Well-being
Clinishift	Western	Well-being
Patient21	Western	Well-being
Padoa	Western	Well-being

We have identified an interesting case study based on the French startup Onhys, which is using software technology to improve decision-making in terms of urban planning. Table 20 further described the case:

Table 13. Case study: Onhys

Onhys
Onhys is a French startup whose solutions focus on urban planning according to pedestrian behaviour. It provides simulations of pedestrian flows that impact mobility, security, urban planning, marketing and services delivery. They use a realistic 3D simulation of pedestrian flows in public avenues for better safety planning as well as pedestrian flows and alerts in a 3D digital twin real-time visualisation.

10 CONCLUSION AND POLICY RECOMMENDATIONS

The technology scanning across the European public sector with a special focus on startups has revealed a dynamic GovTech ecosystem filled with potential. The technologies in question, including Artificial Intelligence, Communication Technologies, Computing Infrastructures, Distributed Ledger Technologies, Digital Identity and Security, Immersive Technologies, the Internet of Things and Smart Devices, as well as Software and Service Technologies, are not only enhancing the efficiency of public administration but also revolutionising the interaction between citizens and government entities.

AI has emerged as a pivotal force, driving advancements in public service personalisation, decision-making, and citizen engagement. Nonetheless, there are risks associated with the use of AI, and how to mitigate those risks when engaging with small suppliers remains an important aspect. Simultaneously, the integration of 5G networks is transforming government operations by facilitating real-time access to information and supporting a constellation of other technologies. Computing infrastructures like cloud computing are enabling flexibility, resilience, and cost savings, while Distributed Ledger Technologies promise enhanced transparency and trust in public operations. In the sphere of Digital Identity and Security, advancements are streamlining government-citizen interactions, with initiatives like the European Digital Identity pushing the boundaries of accessibility and interoperability across member states. Meanwhile, Immersive Technologies are opening new avenues for public service delivery, and the Internet of Things is catalysing the development of smart city initiatives, reflecting a growing trend towards a more interconnected public service framework. Lastly, Software and Service Technologies continue to underpin digital transformation, facilitating robust digital ecosystems across the continent. It is necessary to understand how much of these needs are addressed by startups, but unfortunately, the current threshold for procurement data is too high and it hasn't captured the size of the market yet. Nonetheless, small innovative suppliers, such as SMEs and startups should be at the receiving end of most of the facilitations needed to enter the public.

Policy Recommendations

- **AI Integration and Ethical Frameworks**: The EU should continue to foster AI's growth within the public sector while developing robust ethical frameworks to ensure AI is used responsibly, particularly when it comes to data management and citizen interaction. The EU should also consider a regulatory framework that doesn't hinder the innovation of new and small companies like startups.
- **5G Deployment and Digital Divide**: Intensify efforts to roll out 5G infrastructure, ensuring equitable access across regions and promoting the interoperability of networks at a pan-European level. This will help address the severe regional digital divide in Europe.
- **Incentivising Cloud and Edge Computing**: Invest in understanding the relationship between the use of cloud and edge computing adoption across the public sector, and cybersecurity and data sovereignty. Incentives testbeds and regulatory sandboxes as safe environments to understand the technology's risks and benefits.
- **Blockchain for Transparency**: Cautiously study the application of Distributed Ledger Technologies to enhance transparency in public services, particularly in

supply chain management and public records. Frame regulatory ex-ante policies that can incentivise startups to be players in the market.

- **Universal Digital Identity**: Consider the universal adoption and standardisation of digital identity frameworks to streamline public service delivery and foster a digital single market.
- **Smart City Investments**: Support IoT initiatives in urban and rural development projects, emphasising the creation of smart cities that can enhance living standards through better resource management.
- **Augmented and Virtual Reality Applications**: Invest in and support AR and VR technologies for training, education, and citizen engagement purposes, aligning with the broader vision of a digitally inclusive society. Incentivise the education of marginalised and
- **Data Security and Privacy**: Strengthen the focus on cybersecurity across all technology implementations, ensuring citizens' data privacy and security through stringent policies and the deployment of advanced security solutions.
- **Cross-sector Collaboration**: Encourage cross-sector collaboration and the sharing of best practices among EU member states, leveraging joint research initiatives and pilot projects to test and scale effective GovTech solutions. Doing so also promotes interoperability.

By adopting these policy recommendations, the European Union can not only lead in public sector innovation but also create a more efficient, transparent, and citizen-centered governance model for the digital age.

In the next phase of the project, we will conduct a Delphi analysis, part of our horizon scanning, where we are going to understand the maturity of these technologies and of the market itself, by categorising them into three levels: short-term, medium term and long-term strategic areas.

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