European Commission

Adopt AI Study

Final study report

Written by

EUROPEAN COMMISSION

Directorate-General for Communications Networks, Content and Technology (CNECT)

Unit: Artificial Intelligence Policy Development and Coordination (CNECT.A.2)

Contact: Martin Ulbrich

E-mail: martin.ulbrich@ec.europa.eu

European Commission

B-1049 Brussels

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Executive summary

Artificial Intelligence (AI) is developing fast and the benefits of adopting AI are widely recognized. AI applications can contribute to better public services, e.g. by improving citizen-government interaction, enabling smarter analytical capabilities or improving efficiency across public-sector domains and supporting democratic processes. The use of AI systems can bring benefits across all key public-sector activities. Through early adoption of AI, the public sector can be the first mover in adopting AI that is secure, trustworthy and sustainable. Public procurement is one of the key measures that have a strong potential to facilitate AI adoption and help stimulate demand and offer trustworthy and secure AI technologies in Europe.

AI applications can contribute to better public services for example by improving citizen-government interaction, enabling smarter analytical capabilities, delivering shorter feedback loops or improving efficiency. However, the available evidence suggests that there is still considerable untapped potential for the uptake and public procurement of AI. Therefore, one of the focus areas for the European Commission is to develop and support European actions to accelerate the process of AI uptake and strategic, sustainable and ethical public procurement of AI systems by the public sector in the EU and thus maximise the impact and benefits of human-centric and trustworthy AI.

Against this background, DG CNECT commissioned a study on how best to support public procurement of AI systems in the European Union and help to transform public procurement processes themselves. The main purpose and objective of the commissioned study are to support the European Commission with evidence and operational recommendations on how public procurement of AI systems can be facilitated.

The study includes the State of play/scoping report (presented in chapter 1), the Assessment of the key sectors (presented in chapter 2), Consultation and assessment of the results of the consultation of stakeholders (presented in chapter 3) and the Assessment of policy options and recommendations (presented in chapter 4).

Chapter 1: State of play/ Scoping report

The study opens with a scoping section, which aims to identify the state of play on the uptake and public procurement of AI technologies by the public sector in the EU and to select four priority key sectors that are most ready for large-scale deployment of AI technologies. This is achieved by analysing available literature, evidence, and data and is presented through four main sections. The first section (State of play of the public procurement of AI) provides an overview of the political and legislative initiatives on AI at the European level as well as a focus on the AI strategies put in place at the national level throughout the EU. The second section (Challenges and benefits in public procurement of AI) identifies the main challenges and benefits faced by Member States' governments when considering the public procurement of AI technologies. The third section (Economic analysis) analyses the economic potential of further investments in AI based on existing quantitative data on public procurement, market trends and maturity of AI technologies. Finally, the selection of the four key sectors that are most ready for large-scale deployment of AI technologies is provided in the fourth and final section and is based on the information gathered and analysis conducted throughout the three other sections of the scoping activities.

More specifically, the final selection of the sectors is based on three research questions, further detailed in the methodological note, on identifying (1) the main gaps and obstacles that hinder public procurement and uptake of AI, as well as (2) the benefits and added value that can be generated by a wider uptake and procurement of AI systems in the EU and the main sectors/areas, and (3) AI technologies with high economic potential (e.g. technological readiness, high growth performance) where accelerated public procurement could bring the highest EU added value. The approach taken to tackle the research questions consists of four main steps. Firstly, providing a state of play focused on public procurement by mapping and analysing, both qualitatively and quantitatively, national initiatives on AI. Secondly, conducting a challenges and benefits analysis in public procurement by analysing and mapping identified challenges and benefits for the public procurement of AI and complementing it with findings of the private sector. Thirdly, performing an economic analysis by quantitatively mapping current investments in AI projects and future national projections as well as analysing innovation indicators in selected economic sectors and market indicators of AI typologies. Lastly, selecting the four priority areas based on the above steps and triangulating the findings based on the specific criteria of identified trends in governmental initiatives, projects, and the market, maturity of AI technologies, and the economic potential of the sectors that will create European added value for the public procurement of AI.

The scoping concludes that the four key sectors that are ready for the large-scale deployment of AI are: Health, Mobility, E-Government and Education. This is based on the findings of the qualitative and quantitative analyses of governmental AI initiatives and the economic analysis. The former provides, on the one hand, an overview of governments' priority policy areas for the adoption of AI, and on the other hand, the current state of play of adopted AI policy areas and technologies. The economic analysis evaluates the digital maturity levels of sectors by looking at the following indicators: AI adoption levels, digital intensity, and R&D intensity of different sectors. Along the same line, the economic potential of AI technologies was also assessed based on four key indicators: market growth, adoption rates, labour productivity impact, and employment generation.

Chapter 2: Qualitative and quantitative analysis of key sectors

This chapter analyses the dynamics of the adoption and use of Artificial Intelligence (AI) in four key public sectors in the European Union: eGovernment, mobility, healthcare and education. Leading the way in terms of AI maturity, these central sectors are already undergoing significant change as a result of the introduction of this paradigm-changing technology. Using the insights from these policy areas, acquired through a multi-method research design, this chapter aims to increase the understanding of the uptake of AI by public organisations. This is paramount if the European Union is to reach its goal of becoming a global leader in the field of AI and other policy goals such as the twin-transition.

In eGovernment and general public services, AI´s potential to considerably improve operational efficiency, and public services and allow more open government has seen many administrations begin to fund, develop and use AI solutions. In addition to a burgeoning GovTech space, chatbots and virtual assistants are now commonplace in many member states at both the national and regional levels. While much of the innovation thus far has focused mostly on upgrading established governmental practices, a continued investment could see AI radically redesign existing vertical and hierarchical-oriented administrative structures for the benefit of everyone. This is contingent on well-informed public sector actors with expertise in AI adoption and the mitigation of risks such as a lack of trust and understanding of the technology and its effects.

In the mobility and transport sector, one of the most profoundly affected by the COVID-19 pandemic, AI is perhaps the most pervasive in the public consciousness. AI has the potential to greatly increase efficiency and safety as well as transform everyday transportation with autonomous vehicles (AV) and smart traffic systems. The sector has a considerable political imperative for governments given the centrality of transport in everyday life and the fight against climate change but a lack of harmonized rules across Europe and siloed focus on data and regulation has meant that the majority of innovation and use of AI has taken place in the private sector. With a proven economic track record from the success of the AV market and the environmental benefits of improved transport systems and urban space, mobility will continue to be at the forefront of AI development provided concerns around safety remain central.

In the health sector, government-funded research of AI is still the dominant paradigm of public sector support although the use of AI solutions in healthcare system management and frontline applications is growing. AI has myriad potential uses in the health sector at every step in the value chain from R&D in the field of pharmaceuticals to managing hospitals and healthcare systems and delivering care to the patients themselves. Harnessing AI in health will assist governments in tackling the long-term structural problems of ageing populations and protect against rising costs, especially through automating administrative tasks, currently a common focus area for AI health policy. As with other sectors, effective implementation will increase the quality and accessibility of healthcare though it is vital to guarantee thorough security and protection of data and that the human side of the provision of healthcare is not lost.

Finally, in education, AI has emerged as both a subject of learning and an instrument to improve its delivery. AIEd and EdTech promise to transform education through student-facing AI, enhancing teaching and improving the operation of education systems. However, AI use cases in education are not yet widespread as a result of a lack of tried and tested solutions and reticence from educators to adopt the technology. Nevertheless, the current focus of most public policy throughout Europe focuses on educating citizens on the use and potential of AI. Not limited to technical higher education, the key link between employment and education has seen many governments invest in teaching programmes on AI from early years to adult learning.

Chapter 3: Consultation of stakeholders' analytical, comparative report

This chapter presents a comparative analysis of stakeholder consultations undertaken as part of this study. The consultations included four sectoral workshops, dedicated to exploring the challenges and measures in the uptake of AI by the public sector in the health, e-government, mobility/transport and education sectors, and an online survey, dedicated to assessing the challenges and recommendations in the uptake of AI in the public sector.

The stakeholder consultations undertaken as part of this study show that the main challenges in the uptake of AI centres on the procurement process, data, AI technology and organisation.

The most significant procurement process challenges are related to burdensome administrative requirements, lack of clarity from the public sector regarding their needs/demands, an emphasis on price/cost-savings over service quality and non-financial benefits, unclear regulatory requirements, and the complexity of writing technical specifications.

The most significant data challenges are related to unsatisfactory sharing of data across organisational boundaries, insufficient access to large volumes of high-quality data, lack of data to understand where AI is needed/ best suited, underdeveloped data governance, and lack of clear "data ownership/ data sovereignty".

The most significant AI technology challenges are lack of transparency in AI systems' decision support/making processes, difficulty to inspect and assess an AI solution before their actual deployment, the potential for biases/discrimination within the systems, difficulty in establishing liability and responsibility for the AI system, lack of limited regulatory spaces ("sandboxes") for experimenting with AI solutions and monitoring their impacts, and high requirements for the explainability of AI solutions.

The most significant organisational challenges are a lack of human resources for managing the system, lack of political support, lack of understanding of the capabilities/benefits of AI solutions, lack of human resources for procuring the system, system complexity and lack of single-entry point, and lack of system interoperability.

The comparative analysis shows that these challenges are not significant across the sectors. These challenges were raised and discussed by participants in all the workshops, irrespective of the sector. In addition, the differences between the sectors in the online survey were minor and cannot be considered significant.

Chapter 4: Policy recommendations on the uptake of AI in the public sector

This chapter explores the recommendations to increase the uptake and public procurement of AI. It includes the results from the policy workshop dedicated to identifying and exploring policy solutions and recommendations for the uptake of AI in the public sector, and an online survey, dedicated to assessing recommendations for the uptake of AI in the public sector.

The chapter also provides a comparative assessment of the recommendations. It provides an assessment of the most important recommendations on a scale of low/medium/high based on the criteria of Effectiveness (the extent to which recommendations achieve their goals and the level of benefits they provide), Feasibility (the extent to which recommendations can be implemented and whether they have significant limits), Efficiency (the extent to which recommendations provide value for money and if they require significant resources), and EU added value (the extent to which recommendations provide benefits at a European level and the Single Market and which level of implementation, European or Member State, is the most appropriate, keeping in mind the principle of subsidiarity).

The chapter triangulates the recommendations from the policy workshop and the online survey to arrive at the combined ranking. The recommendations are:

1. Increase funding and resources for AI in the public sector.
2. Reduce bias within AI and data sources.
3. Encourage coordination of AI procurement strategies.
4. Increase clarity and harmonization around cross-border data flows.
5. Promote alignment between industry and public sector expectations.
6. Establish a clear AI regulatory framework.
7. Promote the integration of new AI technologies and services into existing systems in education, health and transport.
8. Promote interoperability, open data and data sharing.
9. Build trust in AI solutions through transparency and accountability.
10. Harmonize EU regulations to promote human-centric and trustworthy AI-enabled public services.
11. Focus on long-term implementation in the use of AI in the public sector.
12. Develop dedicated AI-enabled solutions based on co-creation approaches.
13. Create a European marketplace for GovTech solutions in support of public sector digital transformation.
14. Strengthen the role of the EU Artificial Intelligence Observatory.
15. Promote the development of sustainable AI.

The report concludes with a brief discussion of each recommendation, noting the current EU initiatives and the potential policy actions that the European Commission can take to address them.

Introduction

ICF, Carsa and Wavestone were awarded by DG CNCT to conduct the "Study for the Adopt AI Programme". The main purpose and objective of the commissioned study are to support the European Commission with evidence and operational recommendations on how public procurement of AI systems can be facilitated

This final report presents the results of the study. It consists of the following chapters:

- **Chapter 1: State of play/ Scoping report**. This chapter provides an analysis of the state of play of the public procurement on AI, barriers to and benefits of the adoption of AI in the public and private sectors, economic analysis of and the selection of the four sectors for further analysis: e-government, mobility, health and education.
- **Chapter 2: Qualitative and quantitative analysis of key sectors**. This chapter provides a deep analysis of the four selected sectors (e-government, mobility, health and education), consisting of challenges and solutions for AI in the sectors, digital value chains, main drivers and barriers to the uptake of AI in the sectors, case studies of selected projects, and economic analysis of the impacts of AI on the sectors.
- **Chapter 3: Consultation of stakeholders' analytical, comparative report**. This chapter provides the results and the comparative analysis of four dedicated sectoral workshops (e-government, mobility, health and education) and an online survey conducted as part of this study.
- **Chapter 4: Policy recommendations on the uptake of AI in the public sector**. This chapter presents the results of a dedicated policy workshop and an online survey on policy recommendations conducted as part of this study. The chapter provides a comparative assessment of policy recommendations, considering effectiveness, efficiency, feasibility and EU-added value. It concludes with a brief discussion of each recommendation, noting the current EU initiatives and the potential policy actions that the European Commission can take to address them.

The annexes include detailed methodologies for each chapter, outlining the data collection efforts, approaches to data analysis, definitions, lists of projects and initiatives, and references.

1 Chapter 1: State of play/ Scoping report

1.1 Introduction

The chapter aims to provide a review and analysis of available qualitative and quantitative data on the public procurement of AI technologies in the EU, further complemented by market research on priority economic sectors and AI typology uptake.

The chapter consists of the following four sections, further detailed in the Methodological note:

1. State of play of the public procurement of AI
2. Challenges and benefits in public procurement of AI
3. Economic analysis
4. Final selection of four priority public sector policy areas

1.2 State of play of the public procurement on AI

This section provides a brief contextual overview of political and legislative initiatives on AI at the EU level; after which the focus will turn to the national level and the AI strategies put forth throughout the Member States.

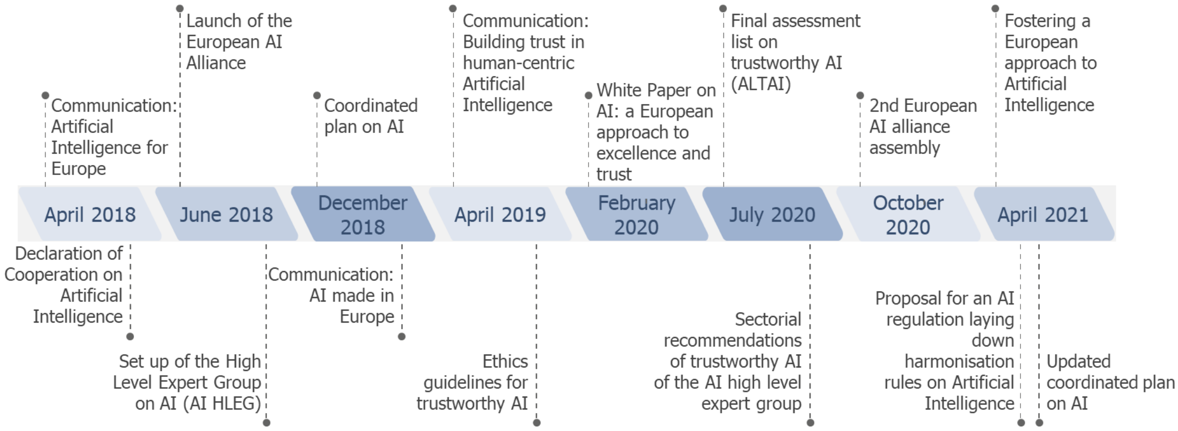
It must be noted that the information available through desk research does not cover all countries to the same depth, therefore we will showcase the countries with the highest level of information available.

1.2.1 Artificial Intelligence initiatives at the European Union level

The European Union aims to heavily invest in Artificial Intelligence (AI) to allow all industries to benefit from it. In the period 2014-2017, around EUR 1.1 billion was invested in AI-related research and innovation. The aim is to reach EUR 20 billion per year in the decade following 2020.[1] The EU's role in AI is to facilitate and enhance cooperation across the Union. The timeline, Figure 1 below, shows the EU AI initiatives since 2018 when the Communication on Artificial Intelligence for Europe was published.

[1] Communication from The Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions on Artificial Intelligence for Europe. 25 April 2018. URL: https://ec.europa.eu/digital-single-market/en/news/communication-artificial-intelligence-europe

Figure 1 Timeline of EU AI initiatives



Source: Authors' elaboration based on A European approach to Artificial Intelligence[2].

The key goals of a number of the above-pictured initiatives are explained in Table 1 below.

Table 1 European Union initiatives on AI

Document title (hyperlinked)	**Date**	**Key goals**
Communication on Artificial Intelligence for Europe	April 2018	The Communication set out to: • Boost the EU's technological and industrial capacity and AI uptake across the economy, both by the private and public sectors; • Prepare for socio-economic changes brought about by AI by encouraging the modernisation of education and training systems, nurturing talent, anticipating changes in the labour market, supporting labour market transitions and adaptation of social protection systems; • Ensure an appropriate ethical and legal framework, based on the Union's values and in line with the Charter of Fundamental Rights of the EU.
Declaration of cooperation on Artificial Intelligence	April 2018	The participating Member States agree to cooperate on: • Boosting Europe's technology and industrial capacity in AI and its uptake, including better access to public sector data; are essential conditions to influence AI development, fuelling innovative business models and creating economic growth and new qualified jobs; • Addressing socio-economic challenges, such as the transformation of the labour markets and modernising Europe's education and training systems, including upskilling & reskilling EU citizens;

[2] https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence

Document title (hyperlinked)	Date	Key goals
		• Ensuring an adequate legal and ethical framework, building on EU fundamental rights and values, including privacy and protection of personal data, as well as principles such as transparency and accountability.
Coordinated plan on Artificial Intelligence and its Review	December 2018 and April 2021	Actions of the 2018 Coordinated plan: • Member States are encouraged to develop their national AI strategies, building on the work done at the European level; • In the Union, public and private investments in AI must be scaled up to reach the target of EUR 20 billion per year over the next decade; • Under the next programming period 2021-2027, the Union invests in AI at least EUR 1 billion per year from Horizon Europe and the Digital Europe programmes; • Member States and the Commission will engage in peer learning and discuss areas for joint procurement of AI solutions, including cybersecurity, as well as specific challenges for the public sector. Actions of 2021 reviewed Coordinated plan: • Accelerate investments in AI technologies to drive resilient economic and social recovery aided by the uptake of new digital solutions; • Act on AI strategies and programmes by fully and timely implementing them to ensure that the EU fully benefits from first-mover adopter advantages; • Align AI policy to remove fragmentation and address global challenges.
Ethics guidelines for a Trustworthy AI	April 2019	According to the Guidelines, trustworthy AI should be: • Lawful - respecting all applicable laws and regulations • Ethical - respecting ethical principles and values • Robust - both from a technical perspective while considering its social environment
White Paper on Artificial Intelligence – A European approach to excellence and trust	February 2020	The main building blocks of the White Paper are: • The policy framework sets out measures to align efforts at the European, national and regional levels. In a partnership between the private and the public sector, the framework aims to mobilise resources to achieve an 'ecosystem of excellence' along the entire value chain, starting with research and innovation, and to create the right incentives to accelerate the adoption of solutions based on AI, including by small and medium-sized enterprises (SMEs). • The key elements of a future regulatory framework for AI in Europe will create a unique

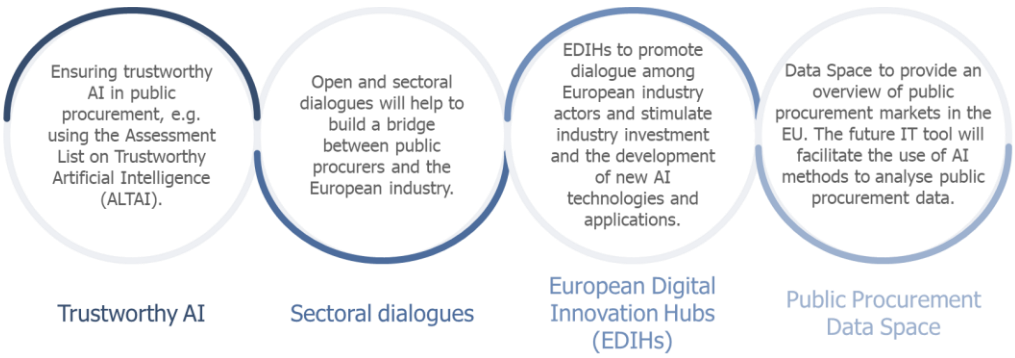
Document title (hyperlinked)	Date	Key goals
		'ecosystem of trust'. To do so, it must ensure compliance with EU rules, including the rules protecting fundamental rights and consumers' rights, in particular for AI systems operated in the EU that pose a high risk.

Source: Authors' elaboration based on European Commission AI documents, hyperlinked in the 'Document title' column.

The European Commission in its 2018 Communication on Artificial Intelligence for Europe recognised that public procurement is one of the key measures that have a strong potential to facilitate AI adoption and help to stimulate demand and offer of AI technologies in Europe.

In the European Commission's Coordinated Plan on AI (2018; 2021), the Commission and the Member States set the goal to support public administrations in procuring trustworthy AI by developing a set of minimal capabilities for algorithms to be used in contract conditions. The specific actions relevant to public procurement are presented in Figure 2 below.

Figure 2 Actions of the Coordinated Plan on AI (2021) relevant to public procurement



Source: Authors' elaboration based on Coordinated Plan on AI (2021).

The AI Watch report on the Overview of the use and impact of AI in public services in the EU[3] recommends the use of innovative public procurement to stimulate and speed up AI adoption, which is likely to further extend the appropriateness and cost-effectiveness of AI take-up in government, meeting the expectations of increasingly proactive service providers and policy designers to the changing global landscape, made more complicated by the Covid-19 crisis.

Finally, the need to support public procurement of AI systems was presented in the White Paper on AI (2020). As presented in the Coordinated Plan on AI (2021), the programme aims to help transform public procurement processes via open and transparent sectoral dialogues to build a bridge between public procurers (who want to know what solutions are available to address their needs) and European industry (which wants to supply products/services to public administrations, and which needs to know more about their plans). This will be organised on a European scale, allowing the Member States to learn from each other. European Digital Innovation Hubs (EDIHs) will be used to promote dialogue among industry actors throughout Europe. The programme will thus stimulate industry investment in AI and the development of

[3] European Commission. 2020. AI Watch Artificial Intelligence in public services – Overview of the use and impact of AI in public services in the EU. URL: https://publications.jrc.ec.europa.eu/repository/handle/JRC120399

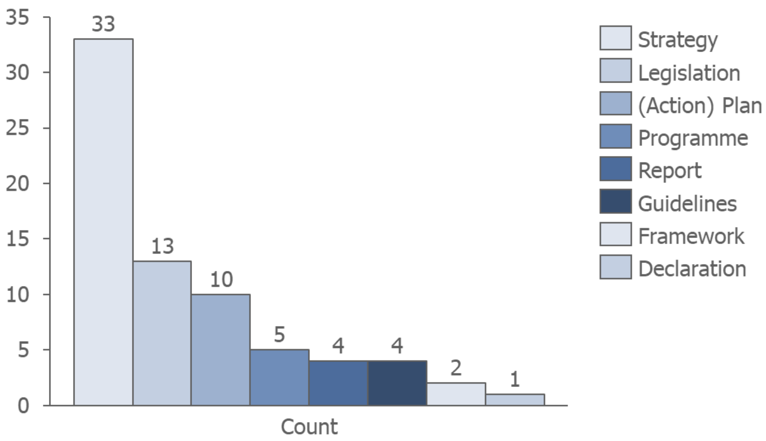
new AI technologies and applications. Furthermore, the European Commission aims to design a public procurement data space that will provide a comprehensive overview of public procurement markets in the EU. A future IT tool will facilitate the use of AI methods to analyse public procurement data. Available data combined with updated, powerful analysis tools will be central to improving the governance of public procurement.

1.2.2 Artificial Intelligence initiatives at the national level

This section presents the findings of the political and legal initiatives throughout the 27 EU Member States. These initiatives were researched based on the criteria of whether Artificial Intelligence is a point mentioned within (Figure 3), and further refined according to whether AI is the main subject matter (Figure 4), and how the procurement of AI is envisaged within. The data collected and studied refers to non-fixed periods, which include initiatives published between 2014 and 2020. The findings are based on desk research of OECD data[4], EU data[5], and national-level data[6].

As for the total overview of initiatives that include AI, a total of 72 initiatives were found. Several initiatives foresee to be effective for multiple years. Figure 3 below shows the breakdown by type of initiative for the total initiatives found. As can be seen, most of the initiatives including AI are strategies (33 out of 72), legislation (13 out of 72) and Action plans (10 out of 72).

Figure 3 Types of national initiatives that include AI



Source: Authors' elaboration.

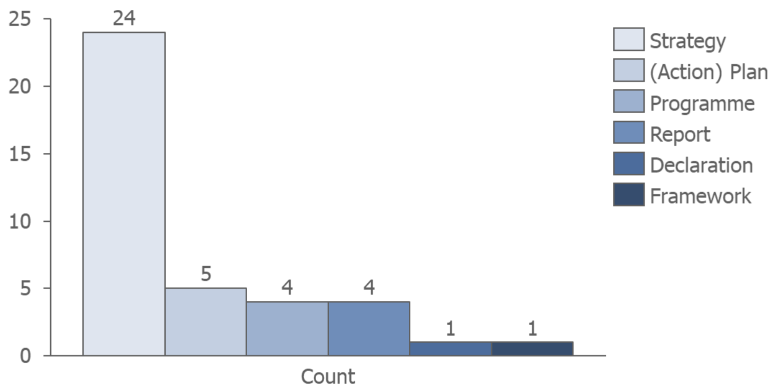
The initiatives that include an AI point of view can be further broken into various categories of focus. The most prominent ones include, for example, initiatives for automated driving and vehicles[7], touching upon, for instance, governmental guidelines on testing on public roads and safety considerations. AI is also mentioned in digitalisation[8] plans, often from the data protection and human rights point of view. Some countries have also published initiatives touching upon AI, specifically focusing

[4] https://oecd.ai/en/dashboards
[5] https://knowledge4policy.ec.europa.eu/home_en
[6] Research in all Member State languages to identify and analyse AI initiatives.
[7] For example: Austrian Automated Driving Regulation (2019); Belgian Autonomous vehicles code of practice for testing (2016).
[8] For example: Dutch Digitalisation Strategy (2021); Spanish Digital Rights Charter (2021).

on potential discrimination, human rights, and data disclosure.[9] Legislations are only present in the category of initiatives that are not all-encompassing about AI and include types of initiatives as mentioned, on driving regulations and data ethics.

Of the total 72 initiatives, Figure 4 below shows the types of initiatives that focus specifically on AI, adding up to a total of 38. These 38 initiatives on AI were published between 2018 and 2020. They also include initiatives that have a long period of validity, with the longest AI strategies from 2020 until 2030, namely in Hungary and Poland.

Figure 4 Types of national initiatives that focus on AI



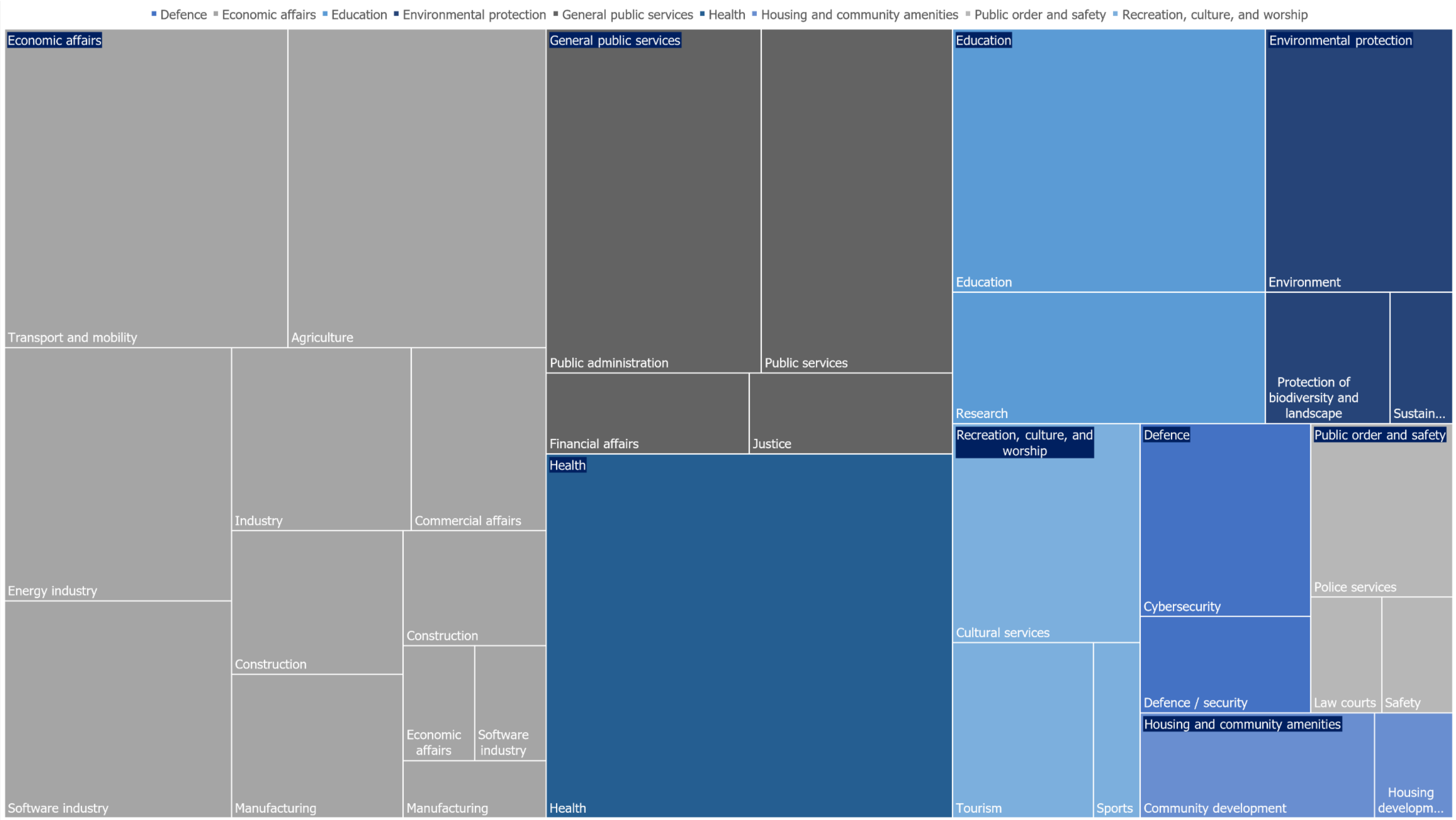
Source: Authors' elaboration.

The large majority of initiatives are AI strategies. It emerges from the data analysed that every Member State has a national AI-focusing initiative, except for Croatia (in development), Romania (in development), and Slovakia (includes its AI priorities in the general action plan for digital transformation). Conversely, there are no legislations (yet) at the national level that focus particularly on AI. Furthermore, it has been found that only Belgium has additional strategies/action plans in place for AI at the sub-national level (more precisely, in both Wallonia and Flanders in addition to the federal strategy).

The following Figure 5 provides an overview of the quantification of priority areas as mentioned in the national AI initiatives, based on an analysis of the AI-focusing initiatives and mentioned priorities within, carried out by the authors. The sizes of the boxes depict the number of instances the policy sectors were mentioned within national governmental AI programmes, categorised according to the COFOG classification with added sub-categories as relevant.

[9] For example: Danish Law on the disclosure of Data ethics Policy (2020); French Framework addressing human rights concerns arising from facial recognition technology (2019).

Figure 5 Classification of public sector priority areas for AI



Source: Author's elaboration.

The figure depicts the COFOG classifications and a breakdown of specific public sector policy areas that Member State governmental AI initiatives have pointed out as a priority for adopting AI. Given the high-level COFOG taxonomy, it is recommended that the sub-categories within (as depicted in Figure 73) are used as takeaways to identify the public sector policy areas which are most prioritised in national AI initiatives. That is, according to COFOG, the government's broad objective (division) is the 10 main categories, e.g., Economic affairs, which can be broken down into sub-items (groups), e.g. agriculture, transport, and manufacturing within Economic affairs. Therefore, the four most prioritised public sector policy areas are Health; General Public Services (public administration and public services combined); Economic affairs (transport and mobility); and Education.[10]

When it comes to the procurement of AI, it was found that among the Member States, there are varying strategies and goals, and therefore lack of common denominators in all countries' approaches to public procurement of AI. We can extract three main national approaches around AI procurement, focusing on i) internal development, ii) R&D, and iii) the private sector, as depicted in Figure 6.

Figure 6 AI procurement national approaches

Source: Authors' elaboration.

Under the **internal development category**, in Estonia, public sector civil servants have access to guidelines and tools for better understanding and carrying out procurements that may involve AI. These include a verification questionnaire; instructional material; guidance material for data annotation; data protection impact assessment; and explanation of technological concepts among other things.

For the **R&D category**, to exemplify, Hungary's AI strategy has set a dedicated R&D and innovation procurement fund through the Artificial Intelligence National Laboratory[11], for the various policy sectors that it prioritises (manufacturing, healthcare, agriculture, public administration, transportation, logistics and energy). In Slovenia, AI R&D and innovation projects have been funded in priority policy areas (health, industry 4.0, language technologies, and public administration).

Finally for **the private sector-focus** procurement of AI technologies mentions in national AI initiatives, in Wallonia (Belgium) for instance, public funds are available to

[10] Detailed information is not available on the selected public sector priority areas given that these are usually listed in the initiatives without further context.
[11] https://mi.nemzetilabor.hu/about-us

start AI projects since 2021, of which some projects supported public organisations in their digital transformation into AI, thanks to the Start IA[12] / Tremplin IA[13] plans. In Ireland, the government aims to lead the way and drive growth in AI by purchasing and developing ethical and trustworthy AI applications, and by using public procurement policies to stimulate and encourage the industry to provide AI-based products and services to the government.

Main findings/implications

- ➔ The four most prioritised public sector policy areas in national initiatives for AI are Health; General Public Services (public administration and public services combined); Economic affairs (transport and mobility); and Education.

1.2.3 Overview of AI projects in the public sector

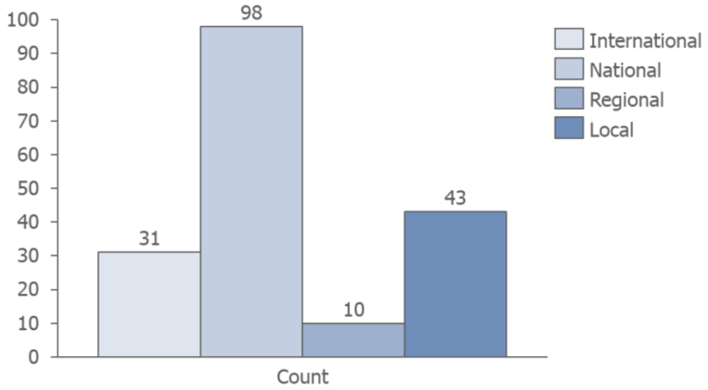
This section provides an overview of the identified projects in which AI technology is used. The collection of information is based on desk research from AI Watch[14], OECD[15], and CORDIS[16]. The projects are categorised by the following characteristics:

- Administrative level,
- Public sector policy area,
- AI typology.

Our research found a total of 182 projects that use AI as a technology.

The breakdown of the administrative levels of the AI projects in the public sector is depicted in Figure 7 below.

Figure 7 Administrative levels of AI projects



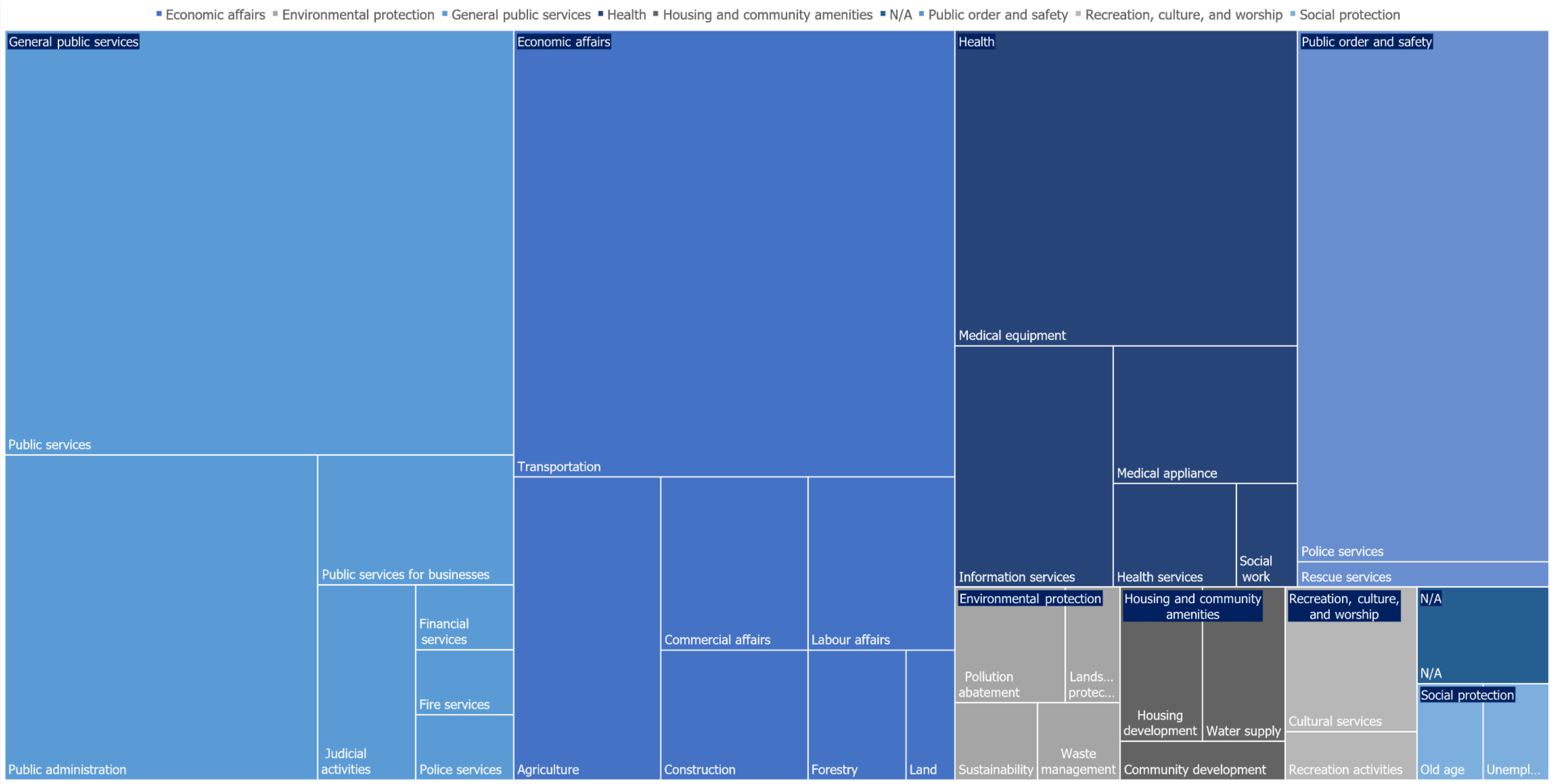
Source: Authors' elaboration.

[12] https://www.digitalwallonia.be/fr/publications/appel-start-ia-05
The Start IA plan helps companies to exploit data thanks to Artificial Intelligence, with the help of expert companies in the field.
[13] https://www.digitalwallonia.be/fr/publications/dw4ai-tremplin-ia
The Tremplin IA plan is aimed at Walloon companies wishing to do a feasibility study or a Proof Of Concept (POC) involving Artificial Intelligence technologies.
[14] https://ai-watch.github.io/AI-watch-T6-X/catalog/10009.html
[15] https://oecd.ai/en/dashboards
[16] https://cordis.europa.eu/

It can be seen that most projects are implemented at the national level (98 projects out of 182), for the whole government. Projects at this level may include, for instance, chatbots on ministerial websites, automated classification of files, automated analysis of water quality, etc. The local level projects closely follow in number (43 out of 182). At this level, AI tools are mostly implemented to be tested out in a particular city, such as for citizen opinion analysis and automated parking control. As for regional projects using AI, these are few (10 out of 182) and concentrated in countries where regions have high political power, which are Belgium, Germany, and Italy. Projects include, for instance, agricultural subsidy monitoring, automated audio processing, and regional mobility forecasting. The international level projects (31 out of 182) represent the projects that were identified where multiple countries and stakeholders were involved, that is, through Horizon 2020 funding. These projects may fall into the category of general health appliances and automated vehicles, which can be adopted at any other level.

The public sector policy areas in which the AI projects are implemented were also classified according to the COFOG taxonomy and where relevant, these were further broken down as done above for the national AI initiatives. Below in Figure 8 is a classification of the public sector areas within which AI projects are implemented, to be read in the same manner as for Figure 5 above (i.e. the size of the boxes represents the quantification of instances projects fell into a category).

Figure 8 Classification of public sector areas of AI projects

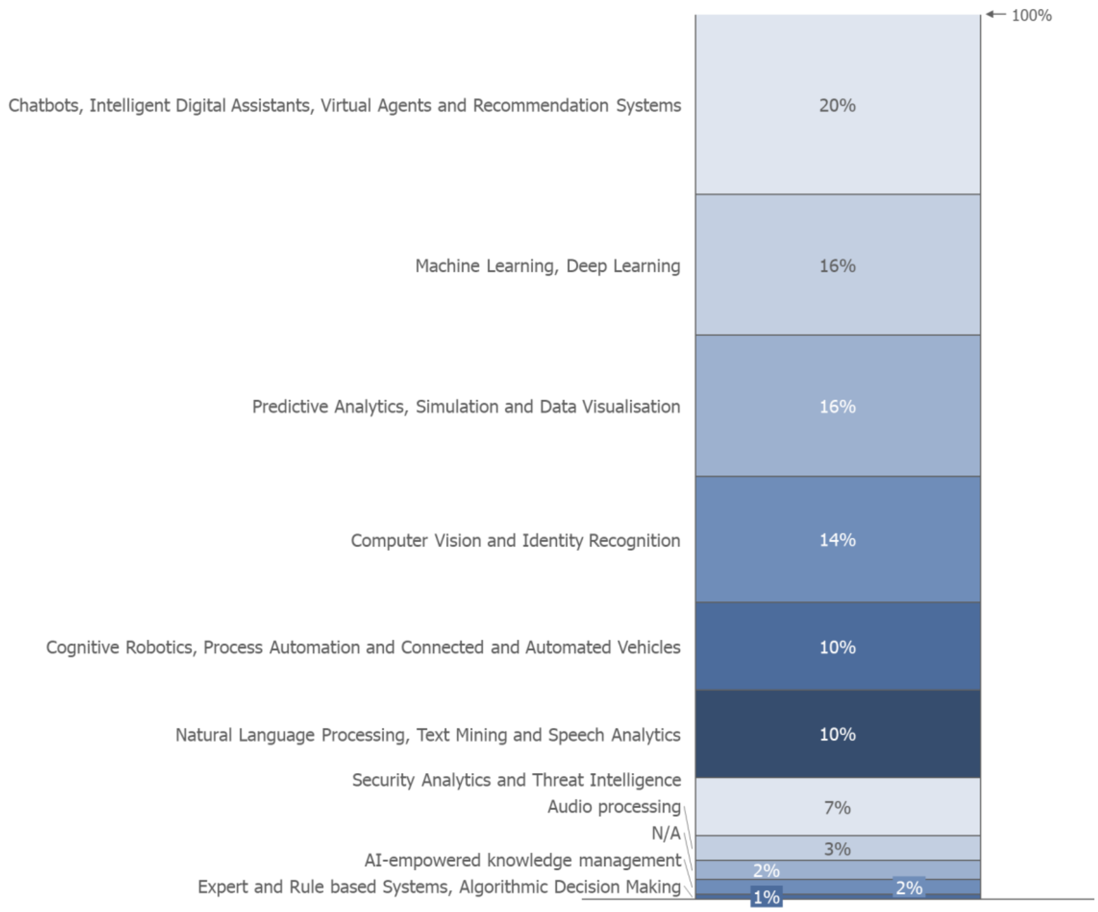


Source: Authors' elaboration.

According to the quantification depicted in the figure above, the COFOG public sector policy areas in which projects are most implemented are General public services (public administration and public services combined); Economic affairs (transportation); Public order and safety (police services); and Health (medical equipment). AI projects under the public services category include technologies that contribute to providing digitalised services to citizens such as chatbots, intelligent digital assistants, and virtual agents. The transportation category includes projects that may help traffic flow with predictive analytics. Police services, in turn, include AI technologies, more specifically computer vision and security analytics that support ensuring regulations e.g. mobile phone detection while driving, or identifying fraud. Finally, medical equipment is defined as technologies that are needed for health purposes and also include predictive analytics for diagnostics.

The breakdown of AI typologies is based on the AI Watch[17] AI typology (see Figure 76). The categorisation and amount of projects falling into each category are shown in Figure 9 below.

Figure 9 AI projects' typologies



Source: Authors' elaboration.

The four types of AI technologies that are currently most used in the Member States' AI projects are Chatbots, Intelligent Digital Assistants, Virtual Agents and

[17] European Commission. 2020. AI Watch Artificial Intelligence in public services – Overview of the use and impact of AI in public services in the EU. URL: https://publications.jrc.ec.europa.eu/repository/handle/JRC120399

Recommendation Systems; Machine Learning, Deep Learning; Predictive Analytics, Simulation and Data Visualisation; Computer Vision and Identity Recognition.

Main findings/implications

- ➔ The four public sector policy areas in which AI projects are currently most implemented are General public services (public administration and public services combined); Economic affairs (transportation); Public order and safety (police services); and Health (medical equipment).
- ➔ The four AI typologies that the projects used are chatbots, computer vision, machine learning and predictive analytics.

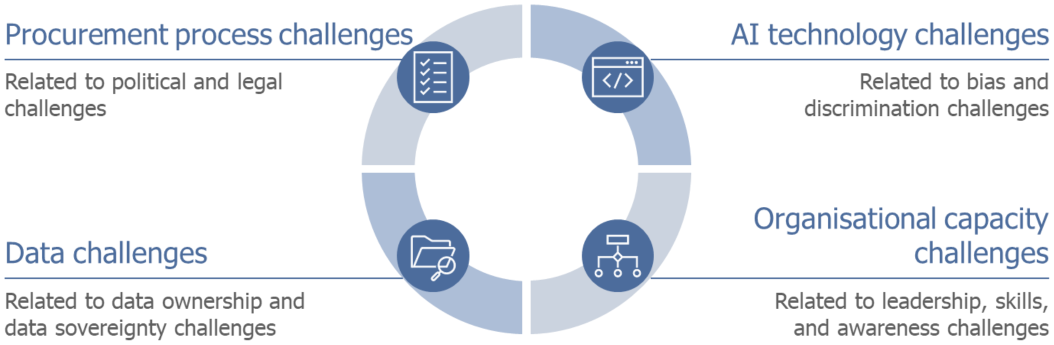
1.3 Barriers to and benefits of the adoption of AI in the public and private sectors

Based on the findings of the desk research, this section identifies the main challenges (issues/obstacles) and benefits that the Member States' governments face when considering the public procurement of AI technologies. Specific cases will be mentioned, as well as general discussions as found in the literature.

1.3.1 Challenges

Four main axes of challenges have been identified through desk research that may pose a barrier to the public procurement and adoption of AI technologies in the public sector (and private sector when relevant), as shown in Figure 10 below and further explored in the following sub-sections.

Figure 10 Macro categories of challenges



Source: Authors' elaboration.

1.3.1.1 Procurement process challenges

Procurement process challenges are caused by internal organisational obstacles and are mostly related to political and legal challenges. Furthermore, the procurement process challenge also relates to public organisations deciding whether an AI tool is necessary to procure for the needs at hand.[18]

[18] McBride, K., van Noordt, C., Misuraca, G. and Hammerschmid, G., 2021. Towards a Systematic Understanding on the Challenges of Procuring Artificial Intelligence in the Public Sector. (Final version not yet published)

According to the World Bank[19], there are currently inadequate policies, legislation, and incentives for AI. Indeed, at the moment, there is a lack of legal clarity over the use of AI technologies which causes an obstacle underlined by national governments, such as written in the Austrian Research and Technology Report[20]. The French Mission Villani report[21] dedicates a section on leveraging public procurement for AI. To do so, it emerges from the report that innovative procurement is not yet sufficiently utilised due to a lack of information on the appropriate procedures, as well as the legal and operational risks involved with these types of purchases such as liability on the public purchaser. The Danish strategy[22] also points to the lack of guidelines and an ethical framework for AI as a challenge.

These challenges are also confirmed when looking at the private sector's point of view. Legislation-related challenges are considered as stemming from external hindrances, and the lack of laws or regulations poses an obstacle for 69% of the surveyed private sector enterprises by the European Commission[23].

It emerges a need for alignment between the public and private sectors to understand the market functioning and ensure that public procurement is aligned with what the private sector may be able to offer. One of the points made by the Austrian government[24] is that to create a suitable framework for using AI in public administration is "making use of public procurement (promoting innovation), i.e. so that public administration can generate demand for ethical AI or applications in certain industries such as healthcare or similar, enabling it to define markets and set standards".

The European Commission is undertaking several initiatives in this regard. One is a community of practice for public buyers and the e-competence centre[25], aiming to spread good practices on the procurement of innovation, and tools and information to help public buyers. Additionally, the Commission is developing a specific Community of Practice on the development and testing of EU-wide AI procurement Clauses[26].

1.3.1.2 Data challenges

There are multiple data-related challenges to the public procurement of AI relating to data "availability, governance, ownership, and infrastructure"[27].

[19] World Bank. 2020. Artificial Intelligence in the Public Sector : Maximizing Opportunities, Managing Risks. URL: https://openknowledge.worldbank.org/handle/10986/35317
[20] Austrian Federal Ministry of Education, Science and Research. 2021. Austrian Research and Technology Report. URL : https://www.bmbwf.gv.at/en/Topics/Research/Research-in-Austria/Services/FTB.html
[21] AI for Humanity. 2018. For a meaningful Artificial Intelligence (Mission Villani Report). URL: https://www.aiforhumanity.fr/pdfs/MissionVillani_Report_ENG-VF.pdf
[22] The Danish Government. 2019. National Strategy for Artificial Intelligence. URL: https://eng.em.dk/media/13081/305755-gb-version_4k.pdf
[23] European Commission, Directorate-General for Communications Networks, Content and Technology. 2020. European enterprise survey on the use of technologies based on artificial intelligence : final report. URL: https://data.europa.eu/doi/10.2759/759368
[24] Austrian Federal Ministry of Education, Science and Research. 2021. Austrian Research and Technology Report. URL : https://www.bmbwf.gv.at/en/Topics/Research/Research-in-Austria/Services/FTB.html
[25] https://commission.europa.eu/funding-tenders/tools-public-buyers_en
[26] https://ec.europa.eu/newsroom/growth/items/746858/en
[27] McBride, K., van Noordt, C., Misuraca, G. and Hammerschmid, G., 2021. Towards a Systematic Understanding on the Challenges of Procuring Artificial Intelligence in the Public Sector. (Final version not yet published)

In the public sector, the lack of clear "**data ownership"** can create an issue of sovereignty, as pointed out by the French Mission Villani report[28]: for AI, a certain dependency may arise on foreign technologies, therefore causing an issue of sovereignty. Indeed, there is a challenge related to "data ownership" and "data sovereignty", i.e., where is the data collected and who is it sold to with or without complete ownership.

The insufficient **availability of high-quality digital data and digital infrastructure** in the public sector was also pointed out as a challenge by the World Bank[29] as well as the Danish National Strategy for AI[30]. Low data quality may lead to poor performance of the AI, thereby not being able to fully automatise the selected processes. A well-developed digital infrastructure is also more ready for AI adoption, as it will lead to interoperable, successful and sustainable AI solutions. Public administrations that lack this are unlikely to benefit from AI technologies.

1.3.1.3 AI technology challenges

AI technology challenges concern its "quality, transparency, and bias"[31]. These relate to the necessary commitment that governments must make in their public procurement processes, to overcome challenges associated with ethics and potentially biased AI.

The European Parliament[32] reports the following risks/challenges related to AI technology adoption in the public sector:

- Discrimination due to data bias and hard coding of presumptions.
- Transparency and explicability. Good governance principles and the right to an explanation of a decision become more difficult when the use of AI and 'black-box' algorithms for decision support or algorithmic decision-making is increasing.
- The dehumanisation of public services. Due to the hard coding of governmental processes and decision-making, there is less and less leeway for exceptions or case-by-case circumstances (automation in general and AI specifically do not deal well with exceptions or boundary cases).

In the public sector especially, when procuring a technology, the potential for bias and discrimination in AI, i.e., who bears responsibility and liability for the actions due to the algorithm, is an important factor to address during the procurement/development process.[33] The question of understanding who bears responsibility and liability for AI

[28] AI for Humanity. 2018. For a meaningful Artificial Intelligence (Mission Villani Report). URL: https://www.aiforhumanity.fr/pdfs/MissionVillani_Report_ENG-VF.pdf
[29] World Bank. 2020. Artificial Intelligence in the Public Sector : Maximizing Opportunities, Managing Risks. URL: https://openknowledge.worldbank.org/handle/10986/35317
[30] The Danish Government. 2019. National Strategy for Artificial Intelligence. URL: https://eng.em.dk/media/13081/305755-gb-version_4k.pdf
[31] McBride, K., van Noordt, C., Misuraca, G. and Hammerschmid, G., 2021. Towards a Systematic Understanding on the Challenges of Procuring Artificial Intelligence in the Public Sector. (Final version not yet published)
[32] European Parliament. 2021. Artificial Intelligence and public services. URL : https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/662936/IPOL_BRI(2021)662936_EN.pdf
[33] McBride, K., van Noordt, C., Misuraca, G. and Hammerschmid, G., 2021. Towards a Systematic Understanding on the Challenges of Procuring Artificial Intelligence in the Public Sector. (Final version not yet published)

technology, as found by a European Commission study, is also raised by 59% of enterprises in the EU, from a private sector point of view.[34]

The Austrian Research and Technology Report[35] for example raises the challenge of understanding how to create a non-discriminatory AI decision-making tool while ensuring traceability and transparency. On the other side, the Swedish National Approach to AI[36] aims to ensure that the country can manage the challenges associated with AI, especially when it comes to the unintended consequences that may arise from biased data, lack of transparency, and misuse. The priority of the Swedish government in this respect is to avoid any discrimination, loss of trust, financial damage and consequences on democracy. In the analysis of AI projects, it was also found that privacy protection is a challenge faced when implementing the projects. The transparency and explicability challenge seems to be fully confirmed also when looking at the point of view of the private sector, which is considered a barrier that 61% of those surveyed by the European Commission (2020).[37]

1.3.1.4 Organisational capacity challenges

Organisational capacity challenges relate to barriers at managerial, technical, and human capital levels stemming internally and similarly, from both public and private sector organisations.[38]

At the managerial level, leaders play an important role in the transition to AI, and there may be a lack of leadership and awareness[39] of AI's possible uses that may benefit organisational processes. Furthermore, communication with all involved parties is necessary (i.e. all levels of government as well as outside stakeholders) who will contribute to the development and/or running of the AI solution in the public sector.[40]

At the technical level, building up AI expertise is also a challenge.[41] If there is no proper understanding of what AI entails that is context-specific (i.e. country-level, public sector area-level), issues may arise, and non-appropriate strategies may be adopted to deal with those issues.[42] For instance, for the public sector, ensuring the

[34] European Commission, Directorate-General for Communications Networks, Content and Technology. 2020. European enterprise survey on the use of technologies based on artificial intelligence : final report. URL: https://data.europa.eu/doi/10.2759/759368
[35] Austrian Federal Ministry of Education, Science and Research. 2021. Austrian Research and Technology Report. URL : https://www.bmbwf.gv.at/en/Topics/Research/Research-in-Austria/Services/FTB.html
[36] Government Offices of Sweden. 2018. National Approach to Artificial Intelligence. URL: https://www.government.se/4a7451/contentassets/fe2ba005fb49433587574c513a837fac/national-approach-to-artificial-intelligence.pdf
[37] European Commission, Directorate-General for Communications Networks, Content and Technology. 2020. European enterprise survey on the use of technologies based on artificial intelligence : final report. URL: https://data.europa.eu/doi/10.2759/759368
[38] McBride, K., van Noordt, C., Misuraca, G. and Hammerschmid, G., 2021. Towards a Systematic Understanding on the Challenges of Procuring Artificial Intelligence in the Public Sector. (Final version not yet published)
[39] World Bank. 2020. Artificial Intelligence in the Public Sector : Maximizing Opportunities, Managing Risks. URL: https://openknowledge.worldbank.org/handle/10986/35317
[40] Campion, A., Gasco-Hernandez, M., Jankin Mikhaylov, S. and Esteve, M., 2020. Overcoming the challenges of collaboratively adopting artificial intelligence in the public sector. *Social Science Computer Review*, p.0894439320979953.
[41] Austrian Federal Ministry of Education, Science and Research. 2021. Austrian Research and Technology Report. URL : https://www.bmbwf.gv.at/en/Topics/Research/Research-in-Austria/Services/FTB.html
[42] World Bank. 2020. Artificial Intelligence in the Public Sector : Maximizing Opportunities, Managing Risks. URL: https://openknowledge.worldbank.org/handle/10986/35317

interoperability of an AI system with other government applications is an important necessity.[43]

The human capital level relates to the lack of digital skills.[44,45] "Public agencies find themselves without core AI skills, which hinders their ability to deploy and operate AI solutions."[46] However, once the AI experts with the required skills are hired, they expect higher salaries, which is identified as a variable behind the high cost of adopting AI solutions in the public sector.[47] In the private sector, the difficulty to hire new staff with the right skills to handle AI, as well as the lack of skills among existing staff, together pose very high barriers to the adoption of AI (85% and 81% of companies respectively consider so).

1.3.1.5 Sectoral and AI technologies-related challenges

In a research carried out on European enterprises by the European Commission in 2020[48], several challenges, i.e. lack of public or external funding, strict standards for data exchange and liability for damage caused by AI, were measured in light of their impact on the economic sectors. Observing these impacts can shed light on contributing factors that hinder the uptake of AI within the public sector sphere.

Figure 11 shows that the three types of obstacles do not vary greatly on average across sectors. Lack of public or external funding is considered an obstacle throughout the sectors in 36% of the cases on average; strict standards for data exchange at 34%; and liability for damage caused by AI at 33%.

[43] Kankanhalli, A., Charalabidis, Y., & Mellouli, S. (2019). IoT and AI for smart government: A research agenda. *Government Information Quarterly*, 36(2), 304–309.
[44] World Bank. 2020. Artificial Intelligence in the Public Sector : Maximizing Opportunities, Managing Risks. URL: https://openknowledge.worldbank.org/handle/10986/35317
[45] The Danish Government. 2019. National Strategy for Artificial Intelligence. URL: https://eng.em.dk/media/13081/305755-gb-version_4k.pdf
[46] World Economic Forum. 2019. 5 challenges for government adoption of AI. URL: https://www.weforum.org/agenda/2019/08/artificial-intelligence-government-public-sector/
[47] European Commission Joint Research Centre. Unpublished. AI Watch: Road to the adoption of Artificial Intelligence by the Public Sector.
[48] European Commission, Directorate-General for Communications Networks, Content and Technology. 2020. European enterprise survey on the use of technologies based on artificial intelligence : final report. URL: https://data.europa.eu/doi/10.2759/759368

Figure 11 External obstacles to the adoption of AI

Sector	Lack of public or external funding	Strict standards for data exchange	Liability for damage caused by AI
Agriculture, forestry and/or fishing	34%	29%	28%
Manufacturing	38%	32%	31%
Construction	34%	30%	32%
Oil and gas	21%	41%	23%
Waste management	39%	33%	37%
Water and electricity supply	33%	29%	27%
Trade, retail	36%	35%	32%
Transport	31%	31%	39%
Food	43%	38%	34%
Accommodation	36%	29%	37%
Recreation activities	32%	35%	33%
IT	33%	34%	32%
Finance, insurance	31%	40%	32%
Real estate	35%	36%	24%
Other technical and/or scientific sectors	36%	32%	36%
Education	45%	37%	34%
Human health	41%	40%	43%
Social work	51%	32%	27%

Base question Q3: I will name potential EXTERNAL obstacles to the use of artificial intelligence. Please indicate all that your company has experienced as a challenge or a barrier. Base size: EU27, N= 8661. (Base size represents only EU27 Member States, excluding the UK, Iceland and Norway).

Source: Figure 21, European Commission, Directorate-General for Communications Networks, Content and Technology. 2020. European enterprise survey on the use of technologies based on artificial intelligence: final report.

The same survey also looked into internal obstacles to the adoption of AI, as shown in Figure 12. On average across sectors it was found that the difficulty to hire new staff was considered the most important obstacle (57%) followed by the cost of adoption (53%); and the cost of adapting operational processes (50%).

Figure 12 Internal obstacles to the adoption of AI

Sector	Difficult to hire new staff with the right skills	Cost of adoption	Cost of adapting operational processes
Agriculture, forestry and/or fishing	60%	51%	44%
Manufacturing	59%	54%	50%
Construction	57%	50%	48%
Oil and gas	69%	64%	49%
Waste management	48%	54%	66%
Water and electricity supply	62%	52%	48%
Trade, retail	56%	53%	48%
Transport	57%	51%	47%
Food	59%	55%	52%
Accommodation	60%	52%	52%
Recreation activities	43%	55%	54%
IT	59%	45%	45%
Finance, insurance	52%	44%	49%
Real estate	48%	41%	41%
Other technical and/or scientific sectors	59%	53%	50%
Education	52%	54%	55%
Human health	55%	60%	54%
Social work	55%	57%	46%

Base question Q4: I will now name potential INTERNAL obstacles to the use of artificial intelligence. Please indicate all that you see as a challenge or a barrier for your company.; Base size: EU27, N8661, excluding 'does not apply to my firm'.

Source: Figure 25, European Commission, Directorate-General for Communications Networks, Content and Technology. 2020. European enterprise survey on the use of technologies based on artificial intelligence: final report.

1.3.1.6 AI technological considerations of the challenges

Focusing on AI technologies, in a research carried out on European enterprises by the European Commission in 2020[49], a number of the above-discussed challenges were measured by looking at barriers to the adoption of AI by specific technologies (Figure 13)[50]. Interestingly, this perspective confirms the takeaways from the previous analysis of the challenges, with i) liability considerations for damage, ii) poor skills availability, iii) high costs of adoption, iv) (lack of) digital infrastructure and v) difficulty to understand algorithms, being the most important barriers reported to diffusion and use of AI, across different AI technologies.

Figure 13 Barriers to the adoption of AI by technology

	External barriers								Internal barriers						
	Need for new laws	Data standards	Reputation risks	Access to private data	Access to public data	Lack of public/ external funding	Lack of citizens' trust	Liability for damage	Hiring staff with right skills[47]	Cost of adoption	Lack of skills internally	Lack of internal data	IT infra-structure	Cost of adapting processes	Difficulty to under-stand algorithms
Natural language processing	-0.1065***	-0.0565	-0.027	-0.018	-0.0288	-0.0307	-0.0601	-0.1547***	-0.0435	-0.1287***	-0.1657***	-0.0862**	-0.1534***	-0.1003**	-0.1221***
Computer vision	-0.0262	-0.0836	-0.1055***	-0.0321	-0.0964	-0.0514	-0.0983**	-0.1017**	-0.0191	-0.1541***	-0.2703***	-0.1038***	-0.1058***	-0.1566***	-0.1155***
Anomaly detection	-0.0608	-0.1133***	-0.1171***	-0.1570***	-0.1663***	-0.1238***	-0.0954***	-0.1406***	-0.074	-0.1908***	-0.2116***	-0.2093***	-0.2549***	-0.1109***	-0.1434***
Sentiment analysis	-0.0595	-0.0334	-0.2175***	0.0405	-0.09	-0.1374	-0.1624**	-0.1269	-0.1959***	-0.1159	-0.2597***	-0.2694***	-0.0824	-0.0403	-0.1065
Forecasting	0.007	-0.0496	0.0057	-0.0624	-0.0107	-0.1079***	-0.0295	-0.1499***	-0.0762**	-0.1542***	-0.2364***	-0.0733**	-0.2012***	-0.1225***	-0.112***
Process optimisation	-0.0363	-0.1197***	-0.1464***	-0.0894***	-0.0975***	-0.1457***	-0.0633	-0.1976***	-0.118***	-0.1396***	-0.235***	-0.0782***	-0.1542***	-0.154***	-0.0988***
Recommendation engines	-0.0968**	-0.1497***	-0.0984***	-0.1052***	-0.191***	-0.1553***	-0.2118***	-0.2067***	-0.0849**	-0.1429***	-0.3125***	-0.1367***	-0.2011***	-0.1654***	-0.1997***
Process automation	-0.0137	-0.014	-0.0221	-0.0497	-0.1161***	-0.1018***	-0.0189	-0.0716**	-0.0248	-0.1001***	-0.2046***	-0.0844***	-0.1342***	-0.1072***	-0.1203***
Autonomous machines	-0.2115***	-0.163***	-0.0921**	-0.1586***	-0.1185***	-0.1276***	-0.1781***	-0.1675***	-0.047	-0.2793***	-0.3019***	-0.0655	-0.1122***	-0.1869***	-0.1915***
Creative activities	-0.0644	-0.0533	-0.0791	-0.2053***	-0.0746	0.0014	-0.1255**	-0.1117**	-0.007	-0.115**	-0.2556***	-0.1627***	-0.1772***	-0.184***	-0.068

**: resampling p-value < 0.05
***: resampling p-value < 0.01

Source: Table 7, European Commission, Directorate-General for Communications Networks, Content and Technology. 2020. European enterprise survey on the use of technologies based on artificial intelligence: final report.

Main findings/implications

➔ The barriers to the public procurement and adoption of AI technologies, as found in the general literature and as identified at sectoral and technological levels can be categorised as below:

- Procurement process challenges
- Data challenges
- AI technology challenges
- Organisational capacity challenges

Many of these challenges are also confirmed when looking at similar sources of information for the private sector.

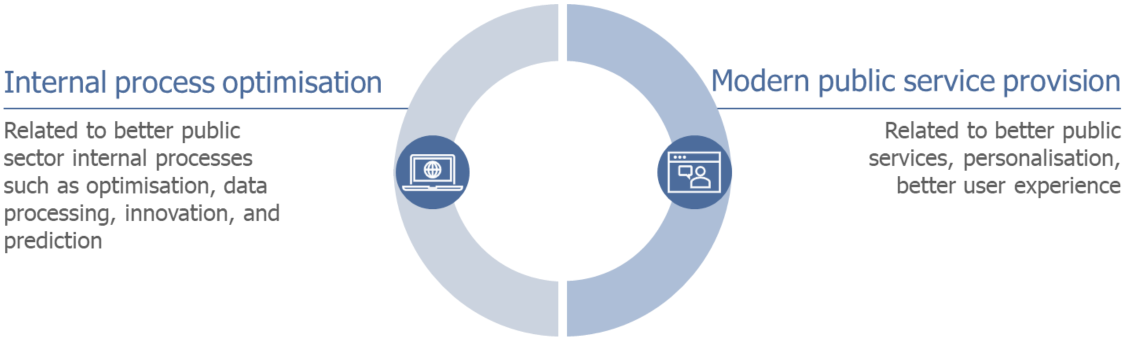
1.3.2 Benefits

Governments aim to use AI to provide **better public services to citizens**. This in turn can translate into virtuous spillovers across different public sectors, such as

[49] European Commission, Directorate-General for Communications Networks, Content and Technology. 2020. European enterprise survey on the use of technologies based on artificial intelligence : final report. URL: https://data.europa.eu/doi/10.2759/759368
[50] Please note that the AI typologies are not fully aligned with the classification made by AI Watch.

higher transportation safety, more varied cultural services, and improved healthcare services, among others. The adoption of AI technologies may also support governments' internal processes, by **digitalising and modernising public administrations**. This may take the form of a document, audio, and speech analysis which speeds up proceedings and provide more time for the provision of other services. These two main axes are depicted in Figure 14 below.

Figure 14 Macro categories of benefits



Source: Authors' elaboration

The use of public procurement is hence a strategic and beneficial activity for AI adoption, as it takes advantage of economies of scale in the public sector, and sets up networks to learn from other use cases (be they best practices or issues). According to the World Economic Forum, by "utilising public procurement, governments could not only support AI innovation and economic growth but also set standards, with a signalling effect on the market."[51]

The European Parliament[52] points out several generic benefits of AI in public services, such as process optimisation, economic growth, increase in jobs, efficiency, time and cost savings, service improvement, and improved accessibility and inclusion of services. Certain benefits may only be perceived in the long term, such as the eventual better allocation of public resources as a consequence of improved digital services. The report summarises the main benefits of AI to be:

- Efficiency gains and internal **process optimisation**.
- **Less human error and fraud**, both internally and in services to businesses and citizens.
- Possibility to deliver more accessible and inclusive services: **personalisation.**
- Increase of anticipatory governance and policy: more **accurate predictions**.

This is confirmed by the analysis carried out in this study on governmental AI initiatives and projects. Looking at the **positive outcomes of the AI projects** analysed in this study, **enhanced data processing capabilities**, **better user experience** and **less work for humans** are the most important cited positive

[51] World Economic Forum. 2020. How governments can use public procurement to shape the future of AI regulation – and boost innovation and growth. URL: https://www.weforum.org/agenda/2020/06/artificial-intelligence-ai-government-procurement-standards-regulation-economic-growth-covid-19-response/
[52] European Parliament. 2021. Artificial Intelligence and public services. URL : https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/662936/IPOL_BRI(2021)662936_EN.pdf

outcomes. Other notable mentions of positive project outcomes that utilise AI as technology are: **innovation, prediction, and optimisation** among others.[53]

The use of AI in governments comes with a multitude of benefits and challenges. As for the procurement of AI, governments must ensure that the technology is safe and that ethical concerns may be solved. There are also benefits to the deployment of AI in governments, which provides better decision-making, better public services to the citizens, and better operations within. AI may even be used for public procurement itself, thereby resulting in cost and employee working time savings. Furthermore, a majority of governments do not develop AI solutions in-house[54], for which reason there is a dependency on public procurement and the private sector to deliver AI solutions for public services. "Today, national governments should move beyond talking about AI in principle, and put into action practical solutions to foster the adoption of AI while mitigating its risks."[55]

1.3.2.1 Tools and ways to support the achievement of the benefits

Research has pointed out that to overcome the barriers and challenges, and to support the achievement of the benefits of AI adoption**, guidelines** may be put in place for the public sector specifically to better carry out public procurement for AI technologies. Such guidelines could encompass **standard templates, policies and legal frameworks, as well as ethical considerations**.

The World Economic Forum recommends that AI-specific tender templates, among others, could boost innovation and economic growth. Public procurement processes should also include young and small companies, including start-ups, which could learn how to tender correctly. For the procurement of AI, accountability and ethics should be embedded in the purchasing cycle. In fact, in general, the traditional approaches to public procurement should be rethought. To support governments in doing so, the World Economic Forum published two documents that support governments for the procurement of AI: AI Government Procurement Guidelines[56] and Project Overview[57].

Two country-specific examples can better illustrate the role of guidelines and templates to better capitalise on the potential benefits of AI. The **United Kingdom**[58] has published two relevant documents on AI, a Guide to using Artificial Intelligence in

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[53] A full list of keywords identified for the positive outcomes/objectives of an AI project is the following, in alphabetic order: accuracy; adaptation to new information; analysis; automated detection; automation; better analysis; better collaboration; better data processing; better decision making; better user experience; building a service with citizen input; cost and time savings; cost efficiency; created by real life needs; customer service; customer service around the clock; data processing; digitisation; efficiency; faster service; high level of detail; high quality ; innovation ; knowledge development; low labour costs; optimisation; prediction; real-time monitoring; reduced costs; reduced human labour; reduction of paper; reliability; scalability; security; speed; transparency.

[54] European Parliament. 2021. Artificial Intelligence and public services. URL : https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/662936/IPOL_BRI(2021)662936_EN.pdf

[55] World Economic Forum. 2020. How governments can use public procurement to shape the future of AI regulation – and boost innovation and growth. URL: https://www.weforum.org/agenda/2020/06/artificial-intelligence-ai-government-procurement-standards-regulation-economic-growth-covid-19-response/

[56] World Economic Forum. 2020. AI Procurement in a Box: AI Government Procurement guidelines. URL: https://www2.deloitte.com/content/dam/Deloitte/global/Documents/About-Deloitte/gx-wef-ai-government-procurement-guidelines-2020.pdf

[57] World Economic forum. 2020. AI Procurement in a Box : Project overview. URL: https://www3.weforum.org/docs/WEF_AI_Procurement_in_a_Box_Project_Overview_2020.pdf

[58] The United Kingdom is not a country included in the main analysis as it is not part of the EU-27. However, it is showcased given the relevance of the governmental AI initiatives.

the public sector[59] and Guidelines for AI procurement[60]. The Guide outlines that there are several considerations to take into account when procuring AI, such as understanding the needs, the maturity of commercially available products that meet those needs, and how to integrate the AI solution with the existing infrastructure. It is also pointed out that a data assessment should be carried out and ethical concerns must always be considered from the start of the procurement process. **In Ireland**[61], the governmental public procurement of AI is governed by trustworthiness and safety. Built upon the EU AI HLEG Ethics Guidelines, an Assessment List for Trustworthy AI (ALTAI) has been put in place, which is a checklist of questions that both public and private sector organisations may refer to. The AI strategy of Ireland aims to use public procurement "as a catalyst for ethical and innovative AI". Furthermore, "instruments such as dialogues, hackathons and pre-commercial procurement of innovative solutions will enable suppliers to respond better to public procurement requests, and also assist public authorities to understand the market better and formulate targeted procurements".

Main findings/implications

- ➔ The benefits to the public procurement and adoption of AI technologies, as depicted in the literature can be summarised below:
  - Through public procurement, governments support AI innovation and the economic growth of the market.
  - AI technologies modernise public administrations' internal processes as well as governmental public services.
  - By creating and/or following existing guidelines, European governments ensure the continued adoption of ethical and trustworthy AI.

1.4 Economic analysis

This section of the scoping report revolves around economic analysis. It provides an analysis of the economic potential of further investments in AI by looking at existing quantitative data on public procurement as well as market trends and maturity of AI technologies, including their use in the private sector, to complement data available on budgets dedicated to AI at the public procurement level. The latter is unfortunately too scattered to conclude about the economic potential of investments in AI. The following tasks of this study will work towards closing this gap by exploring four sectors more in detail and by performing primary data collection on the subject of public procurement of AI.

The main underlying concept of this economic analysis is that some AI technologies are more ready than others for large-scale deployment and are used more intensively in specific sectors, henceforth, using those technologies in certain public sector areas would provide greater added value than not yet ready AI technologies. This section

[59] UK Government Digital Service. 2020. A guide to using artificial intelligence in the public sector. URL: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/979892/A_guide_to_using_AI_in_the_public_sector__Print_version_.pdf

[60] UK Government Digital Service. 2020. Guidelines for AI procurement. URL: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/990469/Guidelines_for_AI_procurement.pdf

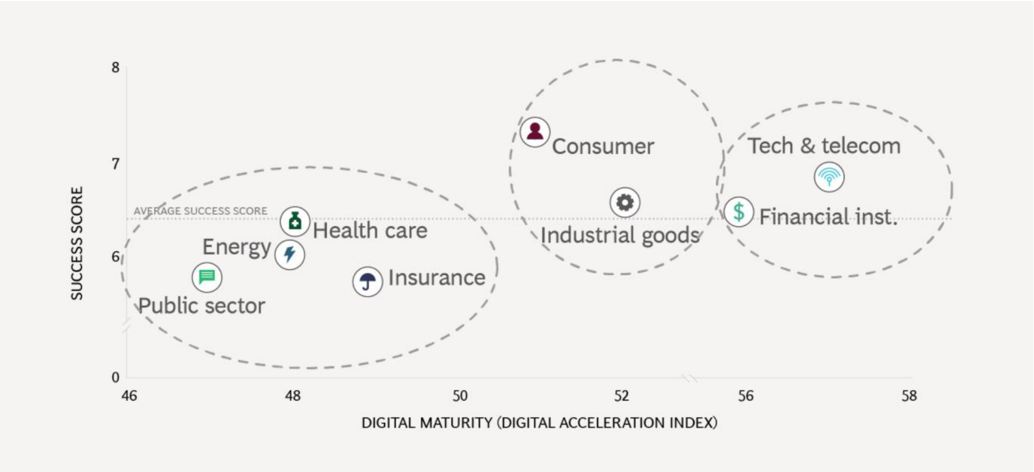
[61] Government of Ireland. 2021. AI – Here for Good. A National Artificial Intelligence Strategy for Ireland. URL: https://assets.gov.ie/152580/b8ad2fa0-9ef2-44da-bab6-aaf8bb03c898.pdf

thus serves to provide an understanding of the market as it stands, and the potential for the adoption of AI technologies in the different sectors.

Understanding the performance of the private sector and the overall market will allow us to extract considerations for the public sector: adopting AI requires a high level of digital readiness and digital transformation.

The private sector can be considered a leading actor in the uptake and development of AI while the public sector is currently at low digital maturity as compared to other sectors, as further detailed in Figure 15. According to the BCG (2021), the top four sectors in terms of digital maturity are Tech and telecommunications, financial institutions, the Consumer sector, and Industrial goods.

Figure 15 Likelihood of digital transformation success, 2021



Source: Boston Consulting Group. 2021. Which Sectors Perform Best in Digital Transformation?[62]

The importance of looking at the public sector adoption of AI in parallel with the market dimensions of sectoral digital readiness and AI technologies maturity is motivated by the fact that collaboration of the public and private sectors is key to increasing knowledge and know-how on the procurement of innovative technologies. For instance, as mentioned by the AI Watch[63], the GovTech ecosystem may be stimulated to develop AI for public sector use. According to Accenture[64], AI innovation for the public sector will emerge if the GovTech[65] ecosystem works together to achieve so. This passes from streamlining procurement processes as well as encouraging feedback for improvements from the industry. Another essential condition is the training and reskilling of employees both in the private and public sectors, so to minimise job losses and maximise job creation. Along these lines, in a Global Government Forum article[66], it is also pointed out that the public and private sectors should endorse each other to build employees' skills.

[62] Boston Consulting Group. 2021. Which Sectors Perform Best in Digital Transformation? URL: https://www.bcg.com/publications/2021/learning-from-successful-digital-leaders
[63] European Commission. 25 May 2022. AI Watch: Road to the adoption of AI by the Public Sector. URL: https://op.europa.eu/en/publication-detail/-/publication/34251428-dc12-11ec-a534-01aa75ed71a1
[64] Accenture, 2019. Transforming Public Service with AI. URL: https://www.accenture.com/_acnmedia/PDF-110/Accenture-Govtech-POV.pdf
[65] Governments, start-ups, medium and large companies, civil society.
[66] Global Government Forum. 2021. Making Artificial Intelligence fit for a life inside government. URL: https://www.globalgovernmentforum.com/making-artificial-intelligence-fit-for-a-life-inside-government/

1.4.1 An introduction to AI adoption

This section will provide detailed findings on the current state of play relating to AI adoption in the private sector. This will be done according to the following indicators:

- Market growth: Defined as the rate at which a market's size is increasing; compound annual growth rate (CAGR).
- Market adoption: Defined as the rate at which new technology is acquired and used by the market.
- Labour productivity: Defined as the output per unit of labour input.
- Employment: Defined as the number of people engaged in productive activities in an economy.

Given the fact that we prioritised forecasts and there a single data source covering all those indicators is missing, we relied on the most recent reports from top market analysts and consulting companies and organisations (World Economic Forum), whenever raw data at the Eurostat level was missing.

Market growth

The global AI market is growing at an incredibly fast rate. According to the industry report published by Mordor Intelligence (2021)[67], the market of global AI is forecasted to increase from EUR 45.34 billion in 2020[68] to EUR 167.48 billion in 2026[69], with a compound annual growth rate (CAGR) of 26.1%. Similarly, Statista forecasts the AI software market size to reach USD 126 billion by 2025, corresponding to EUR 113.96 billion[70].

Moreover, according to PwC Global (2017)[71], the total contribution of AI to the global economy is expected to reach EUR 14.2 trillion[72] by 2030, corresponding to a 14% increase in global GDP.

Market adoption

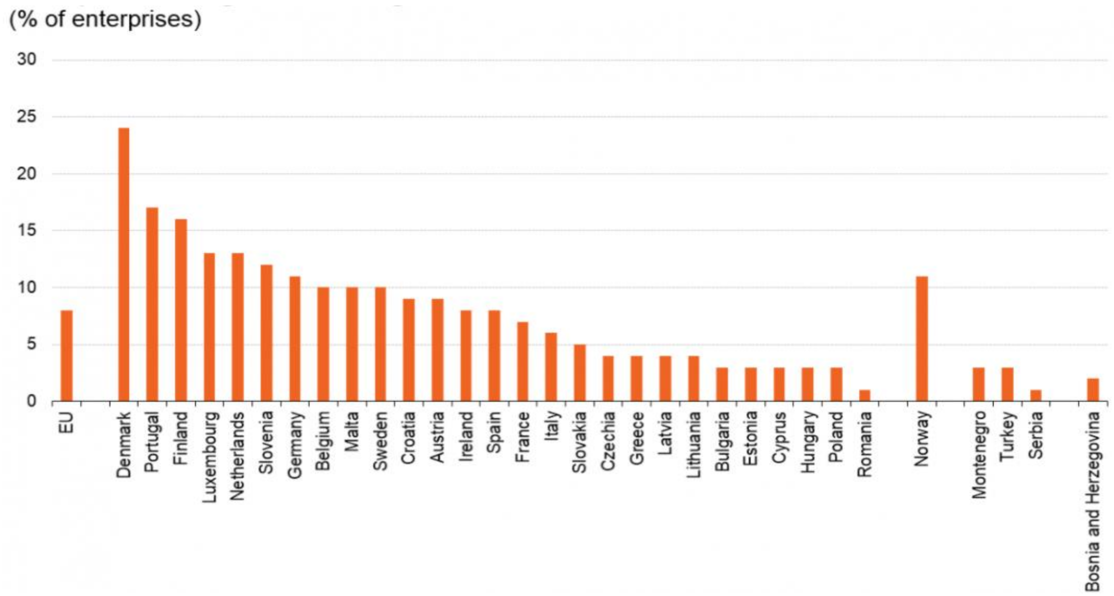
In terms of market adoption, the Worldwide Artificial Intelligence Spending Guide (2021)[73] by the International Data Corporation (IDC) forecasts global spending on AI to hit EUR 184.51 billion[74] in 2025, and European spending[75] on AI systems will jump from EUR 15.58 billion[76] in 2021 to more than EUR 45 billion[77] in 2025. The compound annual growth rate (CAGR) for 2021–2025 will be 26.7%.

[67] Mordor Intelligence. 2021. Artificial Intelligence Market - Growth, Trends, Covid-19 Impact, Forecast (2022 - 2027). URL: https://www.mordorintelligence.com/industry-reports/global-artificial-intelligence-market
[68] USD 50.13 billion as of 17 March 2022.
[69] USD 185.17 billion as of 17 March 2022.
[70] As of 17 March 2022.
[71] PricewaterhouseCoopers. 2017. Sizing the prize. What's the real value of AI for your business and how can you capitalise? URL: https://www.pwc.com/gx/en/issues/analytics/assets/pwc-ai-analysis-sizing-the-prize-report.pdf
[72] USD 15.7 trillion as of 17 March 2022
[73] International Data Corporation (IDC). 2021. Worldwide Artificial Intelligence Spending Guide. URL: https://www.idc.com/tracker/showproductinfo.jsp?containerId=IDC_P33198
[74] USD 204 billion as of 17 March 2022.
[75] International Data Corporation (IDC). 2021. European Spending on Artificial Intelligence Will Reach $22 Billion in 2022, Supported by Strong Investments Across Banking and Manufacturing. URL: https://www.idc.com/getdoc.jsp?containerId=prEUR148297521
[76] USD 17.3 billion as of 17 March 2022.
[77] USD 50 billion as of 17 March 2022.

Furthermore, according to Gartner (2019)[78], the number of enterprises using AI in business grew by 270% from 2015 to 2019. Along the same line, McKinsey&Co (2021)[79] reported that 56% of all respondents to the State of AI survey declared AI adoption in at least one function, an increase of 6 percentage points from 2020[80].

To further complement these findings, Figure 16 below provides a country overview of the percentage of enterprises using AI in 2021.

Figure 16 Enterprises using AI technologies by Member State, 2021



Source: Eurostat. 2021. Artificial Intelligence in EU Enterprises.[81]

In the EU, Denmark has the highest share of businesses using AI applications, followed by Portugal, Finland and Luxembourg.

Labour productivity

In terms of labour productivity, Accenture (2016)[82] found that AI as technology can enhance productivity by up to 40%. More specifically, based on PwC's Global Artificial Intelligence Study (2017)[83], increased productivity will contribute to approximately 40% of the previously mentioned increase in global GDP driven by AI of EUR 14.2 trillion. Moreover, based on the country-level analysis carried out by Accenture, Sweden and Finland are the countries with the highest forecasted increase in

[78] Gartner. 2019. Gartner Survey Shows 37 Percent of Organizations Have Implemented AI in Some Form. URL: https://www.gartner.com/en/newsroom/press-releases/2019-01-21-gartner-survey-shows-37-percent-of-organizations-have

[79] McKinsey & Company. 2021. The state of AI in 2021. URL: https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/global-survey-the-state-of-ai-in-2021

[80] McKinsey & Company. 2020. The state of AI in 2020. URL: https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/global-survey-the-state-of-ai-in-2020

[81] Eurostat. 2021. Artificial Intelligence in EU enterprises. URL: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210413-1

[82] Accenture. 2016. Why Artificial Intelligence is the Future of Growth. URL: http://dl.icdst.org/pdfs/files2/2aea5d87070f0116f8aaa9f545530e47.pdf

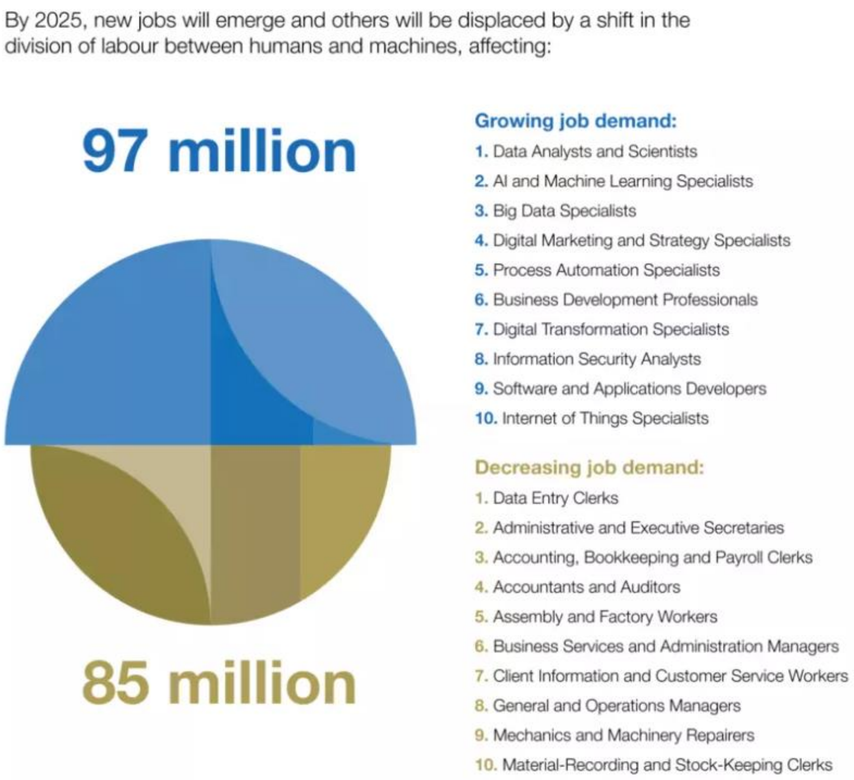
[83] PricewaterhouseCoopers. 2017. Sizing the prize. What's the real value of AI for your business and how can you capitalise? URL: https://www.pwc.com/gx/en/issues/analytics/assets/pwc-ai-analysis-sizing-the-prize-report.pdf

productivity levels for 2035. They are followed by the US, Japan and Austria, Germany, the Netherlands and the UK.

Employment

In terms of employment, AI uptake will have an impact on the job market. According to the World Economic Forum (2020)[84], the ratio of job loss to job creation due to AI will be 85 million to 97 million jobs by 2025, respectively. That is an overall addition of 12 million jobs, as presented in Figure 17 below.

Figure 17 Forecasted job landscape, 2020

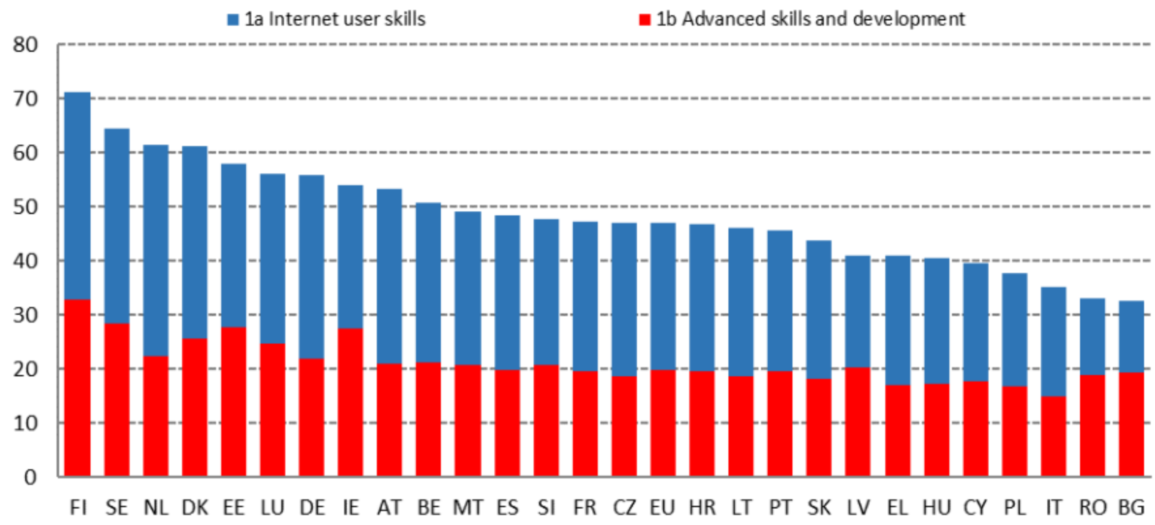


Source: World Economic Forum. 2020. Don't fear AI. It will lead to long-term job growth.[85]

These findings also imply both the reskilling and upskilling of the workforce. On the one hand, employees will have to either learn and be taught new skills (reskilling) or additional ones (upskilling). On the other hand, employers will have to ensure such processes. In this regard, it is interesting to look at the current level of human capital in the EU Member States calculated as part of the Digital Economy and Society Index (DESI)[86] and presented in Figure 18 below.

[84] World Economic Forum. 2020. Don’t fear AI. It will lead to long-term job growth. URL: https://www.weforum.org/agenda/2020/10/dont-fear-ai-it-will-lead-to-long-term-job-growth/
[85] World Economic Forum. 2020. Don’t fear AI. It will lead to long-term job growth. URL: https://www.weforum.org/agenda/2020/10/dont-fear-ai-it-will-lead-to-long-term-job-growth/
[86] European Commission. 2021. Digital Economy and Society Index (DESI) 2021. Human capital. URL: https://Digital-Economy-and-Society-Index-DESI-2021%2F1007%2FDESI-2021-Thematic-chapters---Human-capital

Figure 18 Human capital dimension by Member State, 2021



Source: European Commission. 2021. DESI 2021.

In the EU, Finland is the country with the highest level of human capital, followed by Sweden, the Netherlands and Denmark.

Main findings/implications

➔ The global AI market is expected to grow at a fast rate in terms of size and adoption, increase productivity, and generate employment.

1.4.2 Budget analysis of public procurement of AI

Following the desk research performed for this study on national governmental AI initiatives, it was found that a total of 15 countries[87] have publicly shared the funding amounts dedicated specifically to AI, which may include funding for R&D and private and/or public (projects) investment programmes. A total of 18 budgets have been uncovered throughout the research on national AI initiatives. The public funding is either expressed as a dated lump sum (i.e., a total portfolio for spending until a foreseen date) or an un-dated lump sum (i.e., no clear indication of portfolio spending timeline). In terms of dated lump sums, for 13 of the budgets, it was possible to calculate the yearly average spending on AI, which amounts to ca. EUR 141 million[88]. For example, in Germany, EUR 5 billion is made available for federal investments in AI until 2025, first announced at EUR 3 billion in 2018.

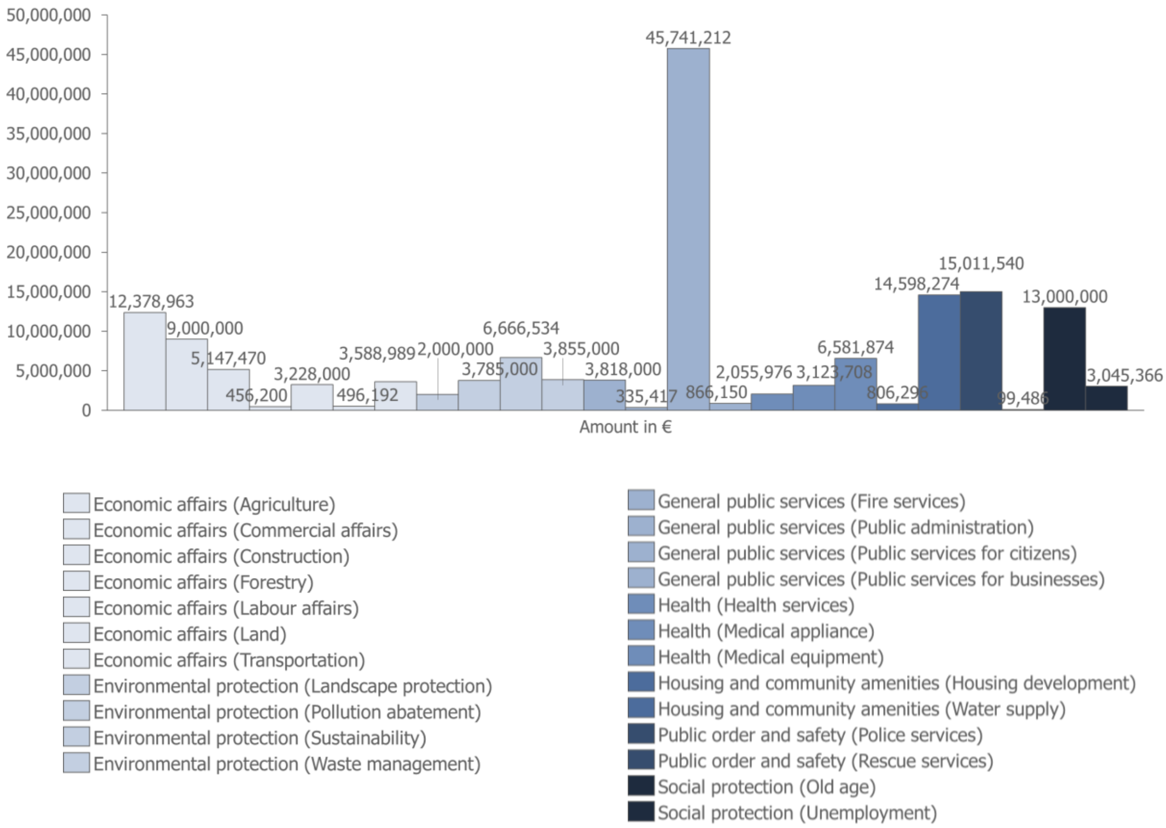
In terms of un-dated lump sums, with an unclear timeline for investment, the six remaining budgets average EUR 529 million[89]. This average amount is influenced (upward) by the Italian strategy that envisages a public investment of EUR 2.5 billion,

[87] Austria, Belgium (federal, Wallonia, Flanders), Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Lithuania, the Netherlands, Slovenia, Spain, Sweden.
[88] With an exact amount of EUR 141,504,087.58. This amount is an average yearly amount, referring to different base years depending on the initiative.
[89] With an exact amount of EUR 529,583,333.33.

whereas, for instance, the Latvian government plans to spend approximately EUR 1.5 million on digitalisation with a focus on AI.

Following the desk research on AI projects, the dedicated budgets are available for 78 projects. Projects that received funding through Horizon 2020 amount to 29 of the 78 projects. The average budget dedicated to an AI project is ca. EUR 7.8 million[90], which refers to an average of the total budgets found. The budgets of AI projects are also categorised according to dates (i.e., multi-annual budgets for several years) and un-dated lump sums. For the average calculations, the total sum of the budget was used. To further complement the budgetary findings, the average AI project budget amount broken down by public sector area is shown in Figure 19[91] below.

Figure 19 Average spending on AI projects classified by public sector policy area



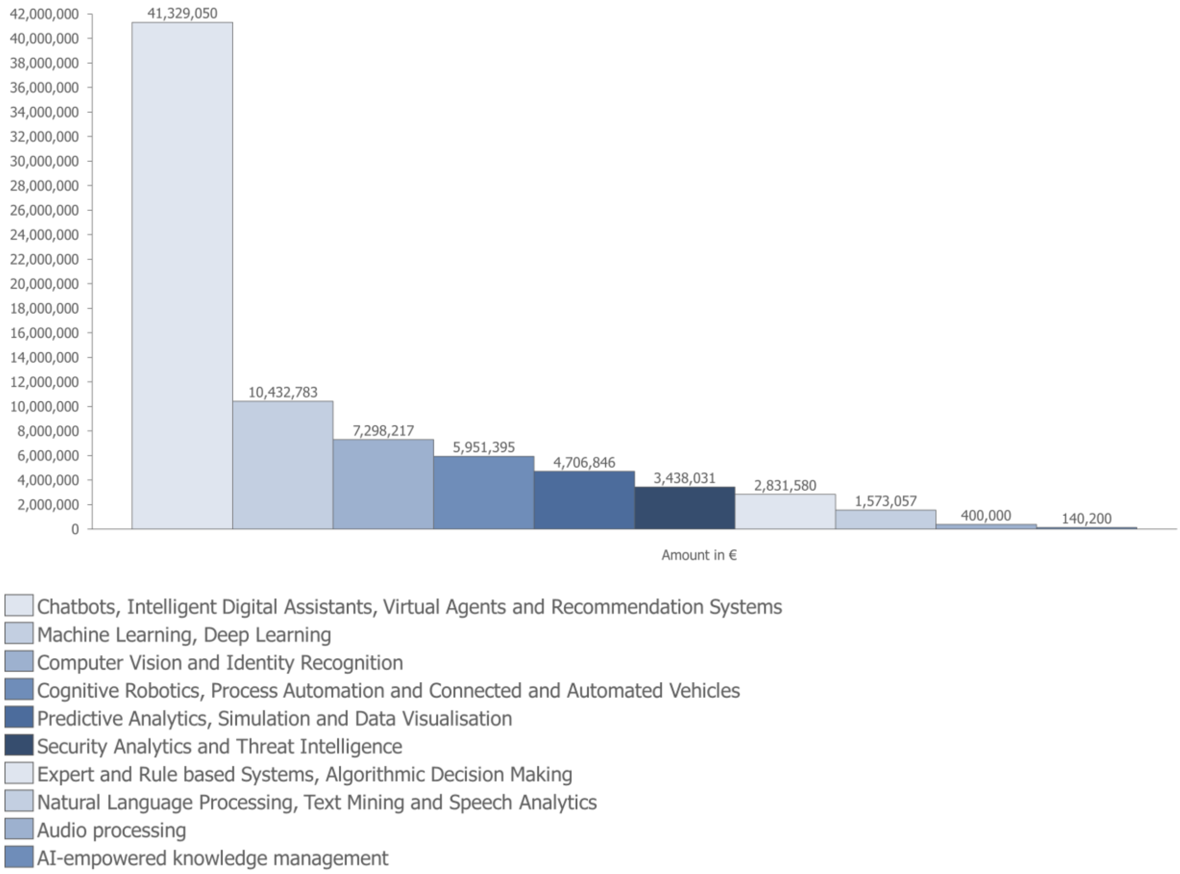
Source: Authors' elaboration.

The outlier in the graph refers to Public services for citizens (COFOG General public services). The reason for this, as will be shown in Figure 20 below, is the number of projects that fall into the AI chatbot category, which is the most popular AI project as was also found in the section Overview of AI projects in the public sector.

Furthermore, the average budget spent according to AI typology within the AI project analysis is depicted in Figure 20 below. For the average calculations, the total sum of the budgets was used.

[90] With an exact amount of EUR 7,846,566,72.
[91] Please note that for the following public sector policy areas, budgets are not at all available: Economic affairs; Education; Employment; Judicial system; Tax.

Figure 20 Average spending on AI projects classified by AI typology



Source: Authors' elaboration.

The limited data available and lack of granularity of quantitative records (budgets) on AI in public procurement can only provide the first insight into governmental investments and current budgets for AI technologies and associated public sector policy areas. The following analysis aims to complement these insights by delving into the readiness of AI technologies when observed in their overall performance at the market level.

Main findings/implications

- ➔ Preliminary indication of spending (to be noted that the findings are not statistically significant) on AI projects, seen from the national initiatives and projects point of view (both public sector area and AI typology for the latter).
- ➔ The currently implemented AI projects budget is highest in the following four public sector policy areas:
  - General public services (Public services for citizens)
  - Public order and safety (Police services)
  - Housing and community amenities (Water supply)
  - Social protection (Old age)
- ➔ The currently implemented AI projects' budget is highest for the four following AI typologies:

- Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems
- Machine Learning, Deep Learning
- Computer Vision and Identity Recognition
- Cognitive Robotics, Process Automation and Connected and Automated Vehicles

1.4.3 Market analysis on sector-level dynamics and AI technologies uptake

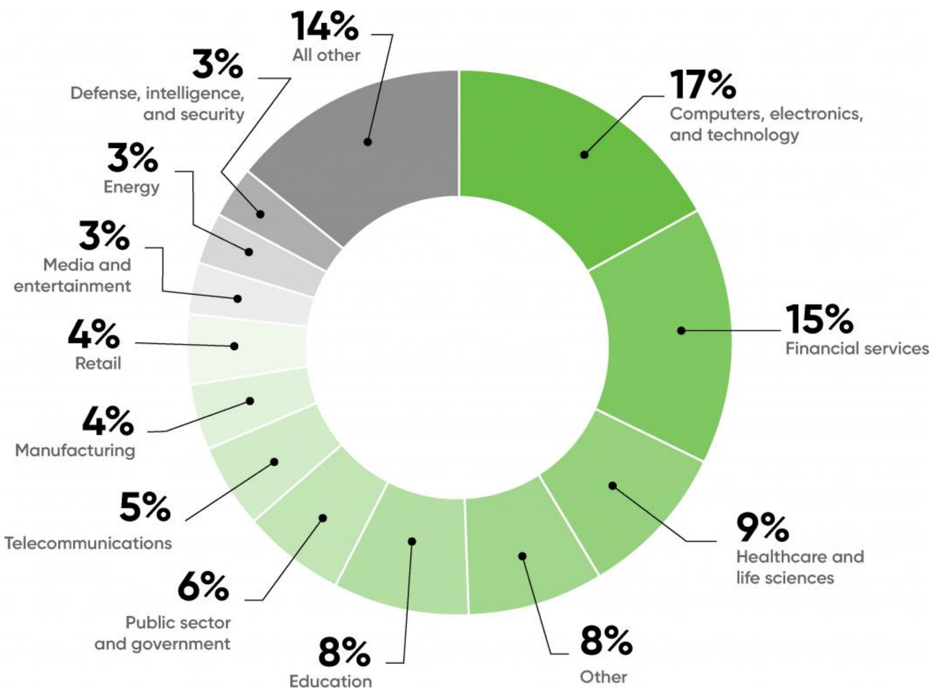
This section reports selected innovation-related indicators aiming to provide a high-level context of the private sector counterparts of the public sector areas, as AI technologies adoption and their relative readiness intertwine with the sectoral dynamics where these AI technologies are used. Different sources look at **AI adoption** at a sectoral level, which is a central indicator for our analysis. Together with this indicator, two other innovation-related indicators are reported below: **Digital intensity**, defined as the degree to which the different economic sectors have adopted digital technologies, and **R&D intensity** measured as expenditures by firms on R&D (ratio of a firm's R&D investment to its revenue).

AI adoption at the sectoral level

According to the findings of a global scale survey carried out by O'Reilly (2021)[92], the leading sectors for AI adoption at the company level are the **ICT**, **financial services**, **healthcare**, and **education** sectors[93]. The following industries were found to have adopted AI, as shown in Figure 21.

[92] O'Reilly. 2021. AI Adoption in the Enterprise 2021. URL: https://www.oreilly.com/radar/ai-adoption-in-the-enterprise-2021/
[93] Though 'other' sectors have scored high, the survey report does not disclose the sectors that were uncategorised.

Figure 21 AI adoption per industry, 2021



Source: O'Reilly. 2021. AI Adoption in the Enterprise 2021.[94]

In the same survey carried out by O'Reilly (2021)[95], respondents were asked to map their industry's AI maturity levels on a three-level scale ranging from considering to evaluating to mature. The top four sectors reporting mature practices are **financial services**; **telecommunications**; **retail**; **computers, electronics, and technology**. An additional finding is that the public sector and government score the highest for **evaluating** the adoption of AI, as well as **considering** doing so.

According to a PwC study (2017) on the economic impact of AI by 2030[96], the sectors that show the highest potential impact for AI adoption, listed from highest to lowest are **healthcare**; **automotive**; **financial services**; **transportation and logistics**, **technology, communications, and entertainment**; **retail**; **energy**; and **manufacturing**.

As a third source about AI adoption at a sectoral level, the IDC Worldwide Artificial Intelligence Spending Guide (2021), in Europe, reports **banking** and **manufacturing** as the highest spending on AI solutions in the forecasted period until 2025, while **healthcare** spending growing the fastest in that term. **Retail** AI spending growth is expected in the 2021-2025 term as well.[97]

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[94] O'Reilly. 2021. AI Adoption in the Enterprise 2021. URL: https://www.oreilly.com/radar/ai-adoption-in-the-enterprise-2021/

[95] O'Reilly. 2021. AI Adoption in the Enterprise 2021. URL: https://www.oreilly.com/radar/ai-adoption-in-the-enterprise-2021/

[96] PricewaterhouseCoopers. 2017. Sizing the prize. Global Artificial Intelligence Study: Exploiting the AI Revolution. URL: https://www.pwc.com/gx/en/issues/data-and-analytics/publications/artificial-intelligence-study.html

[97] International Data Corporation (IDC). 2021. European Spending on Artificial Intelligence Will Reach $22 Billion in 2022, Supported by Strong Investments Across Banking and Manufacturing. URL: https://www.idc.com/getdoc.jsp?containerId=prEUR148297521

As part of research carried out for DG CNECT by Ipsos (2020)[98], in the EU, AI adoption is most common among enterprises in the **ICT sector**, **education**, **human health**, **social work**, and **manufacturing**. While the lowest AI adoption is in the sectors of waste management, construction, transport, and food. The reason for this latter finding is arguably the lower relevance of using AI in these sectors.[99]

Main findings/implications

- ➔ The global AI market adoption indicator analysis forecasts the following four sectors to grow the most:
  - Financial services
  - ICT
  - Healthcare
  - Transport
- ➔ The forecast for the EU according to the AI adoption indicator is expected especially in the two sectors below (chosen based on varying findings of Europe-level data):
  - Healthcare
  - Manufacturing

Other indicators supporting the analysis of AI uptake

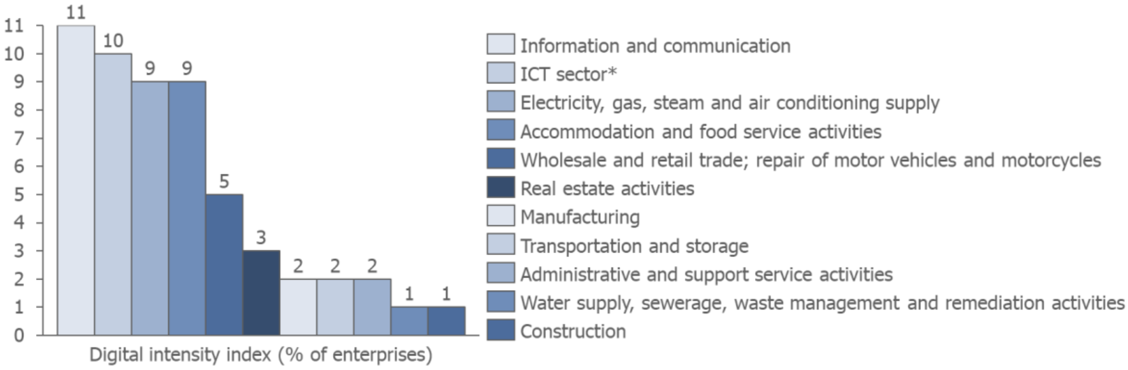
Digital intensity

The Digital Intensity Index measures the use of different digital technologies at the enterprise level.[100] This indicator is adopted by the European Commission (e.g. Eurostat) as well as worldwide to measure the general degree to which an economic sector has adopted digital technologies. This indicator is sensible for posting similar results at a sectoral level as the one looking at the Adoption of AI. Despite broader, digital intensity speaks about an important condition for AI adoption.

Based on the Eurostat Digital economy and society database, 'Digital intensity' for EU27, in several available NACE-classified sectors, measured according to the percentage of enterprises, is reported for Enterprises with high (DII version 3) and very high digital intensity index (DII version 3), as per Figure 22 and Figure 23 below.

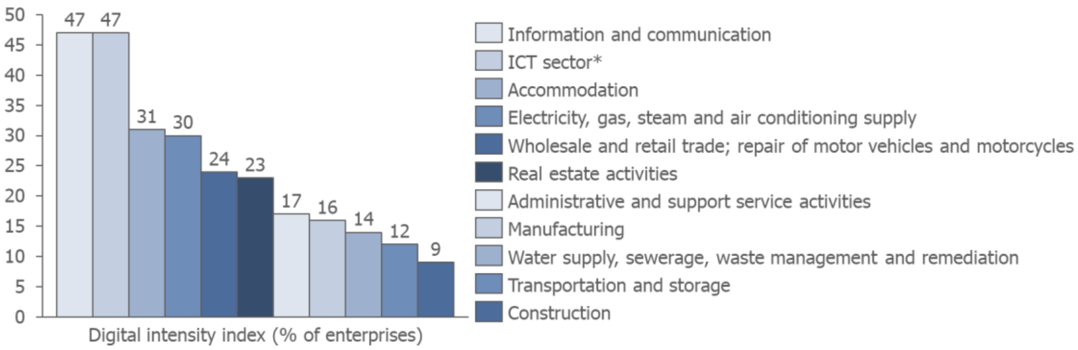
[98] European Commission, Directorate-General for Communications Networks, Content and Technology. 2020. European enterprise survey on the use of technologies based on artificial intelligence : final report. URL: https://data.europa.eu/doi/10.2759/759368
[99] European Commission, Directorate-General for Communications Networks, Content and Technology. 2020. European enterprise survey on the use of technologies based on artificial intelligence : final report. URL: https://data.europa.eu/doi/10.2759/759368
[100] Eurostat. 2021. How digitalised are EU's enterprises? URL: https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20211029-1

Figure 22 Digital intensity per sector, 2021 (very high digital intensity index)



Source: Authors' elaboration based on Eurostat 2021 data.
*Note: *Not an official NACE category.*

Figure 23 Digital intensity per sector, 2021 (high digital intensity index)



Source: Authors' elaboration based on Eurostat 2021 data.
*Note: *Not an official NACE category.*

The most digitally intense sectors in the EU27 are **information and communication**; the **ICT sector**; **accommodation**; and **electricity, gas, steam, and air conditioning supply**. It is to be noted, Eurostat does not provide digital intensity measurements for several sectors[101]. For this reason, further research was carried out.

In a study carried out by Mucha and Seppala (2021)[102], the following digital intensity scores were attributed to economic sectors, as shown in Figure 24 below.

[101] Agriculture, forestry and fishing; mining and quarrying; financial and insurance activities; professional, scientific and technical activities; public administration and defence, compulsory social security; education; human health and social work activities; arts entertainment and recreation; other service activities; activities of households as employers, undifferentiated goods- and services-producing activities of households for own use; activities of extraterritorial organisations and bodies.

[102] Mucha, T. and Seppälä, T., 2021. Estimating firm digitalization: A method for disaggregating sector-level digital intensity to firm-level. MethodsX, 8, p.101233. URL: https://www.sciencedirect.com/science/article/pii/S2215016121000261

Figure 24 Digital intensity score per sector, 2021

Sector	ISIC code (rev. 4)	Digital Intensity Score*
Agriculture, forestry, fishing	01–03	0.0463
Mining and quarrying	05–09	0.2361
Food products, beverages and tobacco	10–12	0.3254
Textiles, wearing apparel, leather	13–15	0.4246
Wood and paper products, and printing	16–18	0.4563
Coke and refined petroleum products	19	0.3532
Chemicals and chemical products	20	0.4087
Pharmaceutical products	21	0.3651
Rubber and plastics products	22–23	0.4365
Basic metals and fabricated metal products	24–25	0.3690
Computer, electronic and optical products	26	0.5648
Electrical equipment	27	0.5185
Machinery and equipment n.e.c.	28	0.5324
Transport equipment	29–30	0.6157
Furniture; other manufacturing; repairs of computers	31–33	0.5754
Electricity, gas, steam and air cond.	35	0.3016
Water supply; sewerage, waste management	36–39	0.3016
Construction	41–43	0.2698
Wholesale and retail trade, repair	45–47	0.5926
Transportation and storage	49–53	0.3194
Accommodation and food service activities	55–56	0.2870
Publishing, audiovisual and broadcasting	58–60	0.6157
Telecommunications	61	0.8796
IT and other information services	62–63	0.8241
Finance and insurance	64–66	0.8222
Real estate	68	0.0741
Legal and accounting activities, etc.	69–71	0.6620
Scientific research and development	72	0.6204
Advertising and market research; other business services	73–75	0.6806
Administrative and support service activities	77–82	0.6528
Public administration and defence	84	0.5333
Education	85	0.3944
Human health activities	86	0.4333
Residential care and social work activities	87–88	0.4111
Arts, entertainment and recreation	90–93	0.4889
Other service activities	94–96	0.6167

* These scores were estimated following the methodology developed by Calvino and colleagues [6] and using data available from OECD via a StatLink dx.doi.org/10.1787/888933617434. The scores themselves do not have direct interpretation other than providing ranking of sectors in terms of their digital intensity.

Source: Mucha and Seppala, 2021, Table 1: Reference data for sector-level digital intensity scores.[103]

Note: ISIC is a classification structure of economic activities (industries) based on a set of internationally agreed concepts, definitions, principles and classification rules.

Note: According to the authors, firms with revenue-weighted digital intensity scores below 0.386 are classified as low digital intensity, those with scores above 0.568 are classified as high digital intensity, and those in between are medium digital intensity.

[103] According to the methodology developed by Calvino and colleagues, the position of a given sector j in the summary classification is computed as an average of sector j's position in each considered dimension of the digital transformation, where the weight is 1/36, i.e. the total number of sectors included in the taxonomy. These sector and indicator-specific scores (i.e. a sector's position divided by 36) are then averaged across indicators, to yield one value per sector. More information: https://www.oecd-ilibrary.org/docserver/f404736a-en.pdf?expires=1647547698&id=id&accname=guest&checksum=21B7A687865053306A0ECD363169EF44

Though the digital intensity scores are calculated differently, the above findings provide insight into the economic sectors that are not studied by Eurostat. The four sectors with the highest digital intensity scores according to the above figure are **telecommunications**; **IT and other information services**; **finance and insurance**; and **advertising and market research**, other business services.

Main findings/implications

- ➔ Based on the analysis of the indicator on the digital intensity of the sectors, the following four sectors perform best:
  - ICT
  - Financial services
  - Electricity *(not considered for this study)*
  - Advertising *(not considered for this study)*
- ➔ The finding that the two most digitally-intense sectors are ICT and Financial services aligns with the findings of the AI adoption indicator at the global level, however, Healthcare sector data lacks Eurostat findings to carry out an aggregation of that sector.

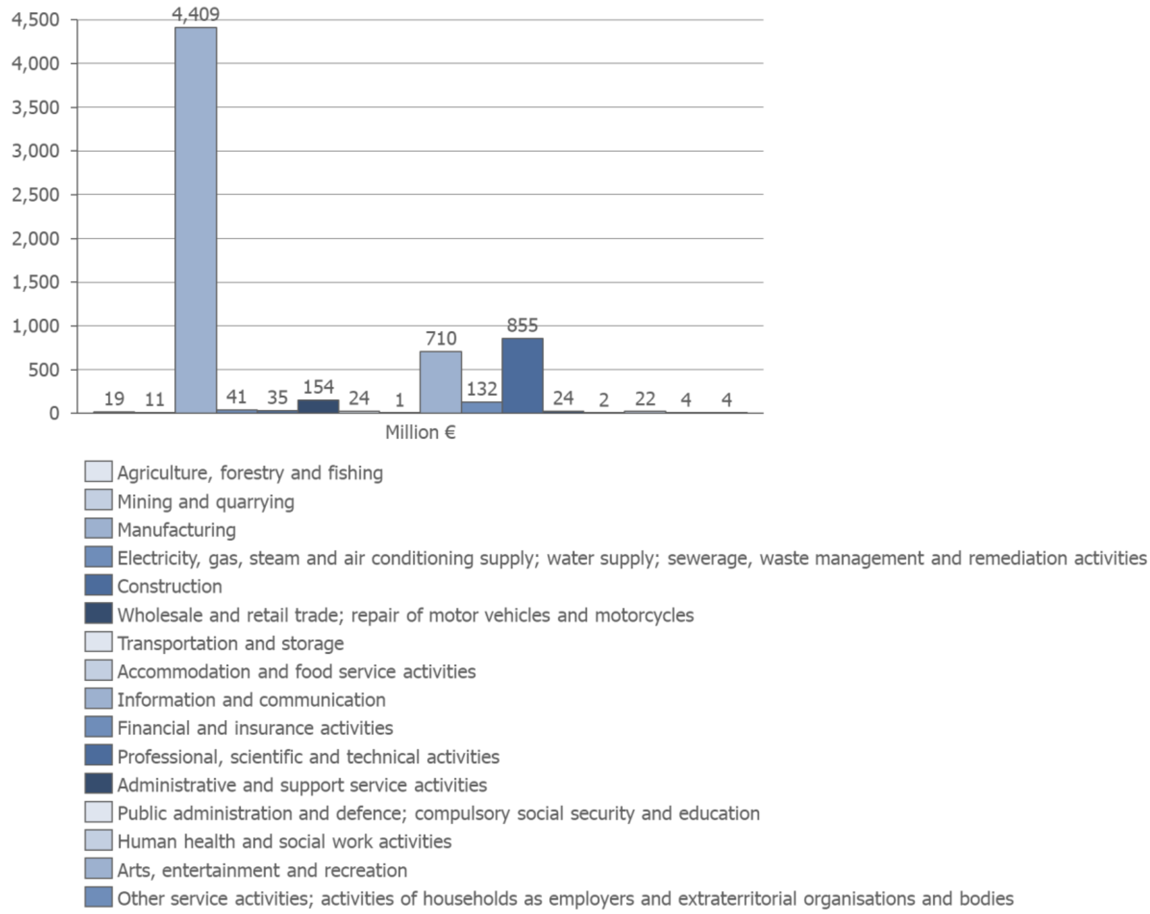
R&D intensity

The R&D intensity is measured by the expenditures by firms on R&D, as the ratio of a firm's R&D investment to its revenues. When relevant, R&D investment growth will also be analysed as an indicator as part of the economic analysis. R&D intensity serves as a good proxy to indicate where innovation (including possibly AI) can take place because it reflects where investments in innovation are done. In addition, R&D intensity also expresses the pre-conditions for technologies such as AI to be sustainably adopted. Sustainable R&D is defined as investments made by both private and public sectors that are translated into commercialised technologies. This analysis supports the understanding of which sectors are the readiest for large-scale AI deployment.

In 2017-18, as found by McKinsey[104], the R&D spend on the automobile industry was highest in Europe. According to data gathered from Eurostat (2019)[105], the following Figure 25 shows business enterprise expenditure on R&D per NACE sector.

[104] McKinsey Global Institute. 2019. Reviving innovation in Europe. https://www.mckinsey.com/featured-insights/innovation-and-growth/reviving-innovation-in-europe
[105] The Eurostat data lacks information for a number of Member States in each sector.

Figure 25 R&D business expenditure, 2019



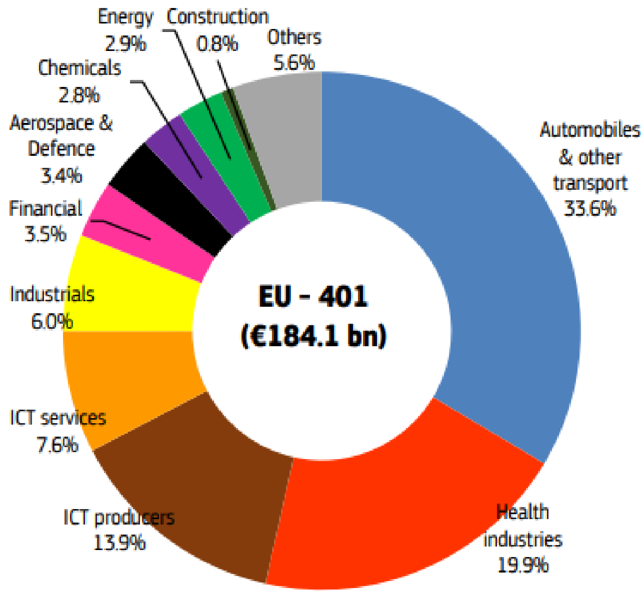
Source: Authors' elaboration based on Eurostat 2019 data.

The above graph shows that in the EU, the largest R&D business expenditure was in the Manufacturing; Professional, scientific and technical activities; Information and communication; Wholesale and retail trade, and repair of motor vehicles and motorcycles sectors.

To further analyse these findings with up-to-date data, as studied by the 2021 EU Industrial R&D Investment Scoreboard[106], these findings partially align with the findings on R&D investments' yearly growth rate in 2020. The highest R&D investments in the EU were made for **automobiles** and other transport, followed by **health** industries, **ICT producers** and **ICT services**, and can be observed in Figure 26.

[106] https://iri.jrc.ec.europa.eu/scoreboard/2021-eu-industrial-rd-investment-scoreboard ; European Commission. 2021. The 2021 EU Industrial R&D Investment Scoreboard. URL: https://iri.jrc.ec.europa.eu/sites/default/files/contentype/scoreboard/2021-12/EU%20RD%20Scoreboard%202021%20FINAL%20online.pdf

Figure 26 R&D investment per sector, EU, 2020



Source: European Commission, JRC/DG RTD, Figure S5. 2021. The 2021 EU Industrial R&D Investment Scoreboard.

These findings are also confirmed by the EIB[107], which analysed the innovation indicator, pointing out that the manufacturing sector of the EU has the largest share of 'new to the world's innovation. The EIB also underlines that the manufacturing sector also has the largest average investment share for R&D.

Europe is a leading innovator in the automobile, health, financial and ICT sectors, given the relative size of these sectors and their economic importance for the EU. This is further confirmed by the European Commission[108]. It is also generally in line with the strategic priorities of the EU in terms of innovation and growth.[109] As part of the ongoing InvestEU programme[110], the EU aims to strengthen investments for better connectivity in the sectors of health, education, transport, logistics, and media, while ensuring the widespread adoption of new technologies, among which AI.

Main findings/implications

➔ Based on the analysis of the R&D indicator, the following sectors are the best performers:
- Healthcare
- ICT
- Financial services
- Transport

[107] European Investment Bank. 2021. EIB Investment Survey. URL: https://www.eib.org/attachments/publications/eibis_2021_european_union_en.pdf
[108] https://ec.europa.eu/growth/industry/strategy/advanced-technologies/industrial-applications-artificial-intelligence-and-big-data_en
[109] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. A New Industrial Strategy for Europe. COM/2020/102 final. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1593086905382&uri=CELEX%3A52020DC0102
[110] https://europa.eu/investeu/home_en

Main findings/implications of sectoral analysis

- ➔ Based on the market analysis of sectoral dynamics, the four most ready sectors for AI adoption are the ICT sector; Financial services; Healthcare; Transport.

1.4.4 Uptake of AI technologies by AI typology

This report will adapt the AI Watch classification when looking at AI technologies. The AI Watch AI typologies classification is very detailed and includes multiple technologies under each category. To increase the clarity of the analysis hereafter, the AI Watch classification was compared to AI technologies that are commonly used in the literature on AI industry analysis, as shown in Figure 27 below[111].

Figure 27 Correspondence of AI typologies from AI Watch to Market-based classification

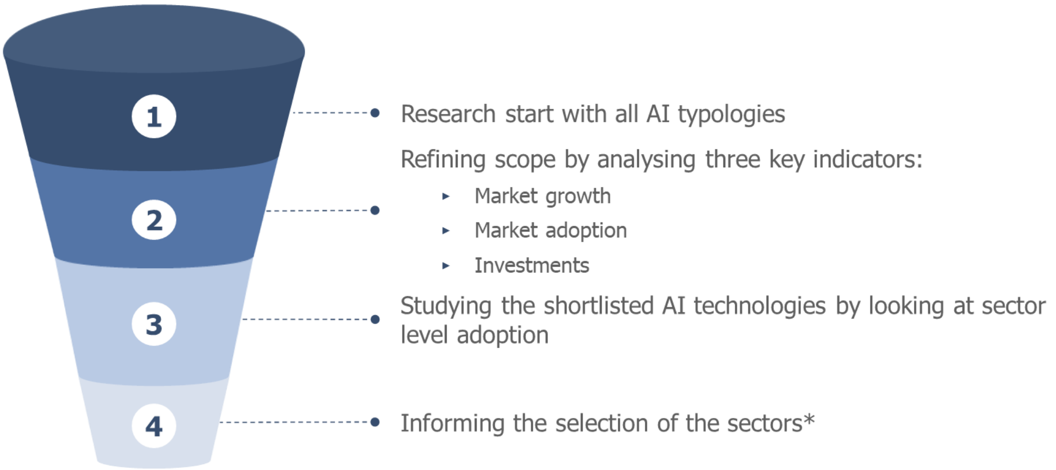
AI Watch	Market-based
Audio processing	Voice/speech recognition
Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	Chatbots
Cognitive Robotics and Process Automation, Connected and Automated Vehicles	Smart Robots
Computer Vision and Identity Recognition	Computer Vision
AI-empowered Knowledge Management	Knowledge Management Software
Natural Language Processing, Text Mining and Speech Analytics	Natural Language Processing
Predictive Analytics, Simulation and Data Visualisation	Predictive Analytics
Machine Learning, Deep Learning	Machine Learning or Deep Learning
Security Analytics and Threat Intelligence	Threat Intelligence

Source: Authors' elaboration.

This section of the report conducts a market analysis of the uptake of specific AI technologies by the private sector to identify those technologies considered mature by the market by looking at three key indicators: market growth, market adoption and investments. Shortlisted AI technologies will be then further explored by looking at their adoption at the sectoral level. Figure 28 below summarises the approach for studying the uptake of AI technologies and the funnel that will allow informing the selection of the four sectors for the remainder of this study's analysis.

[111] Due to the lack of findings on Expert and Rule based Systems, Algorithmic Decision Making, this category is not part of the analysis.

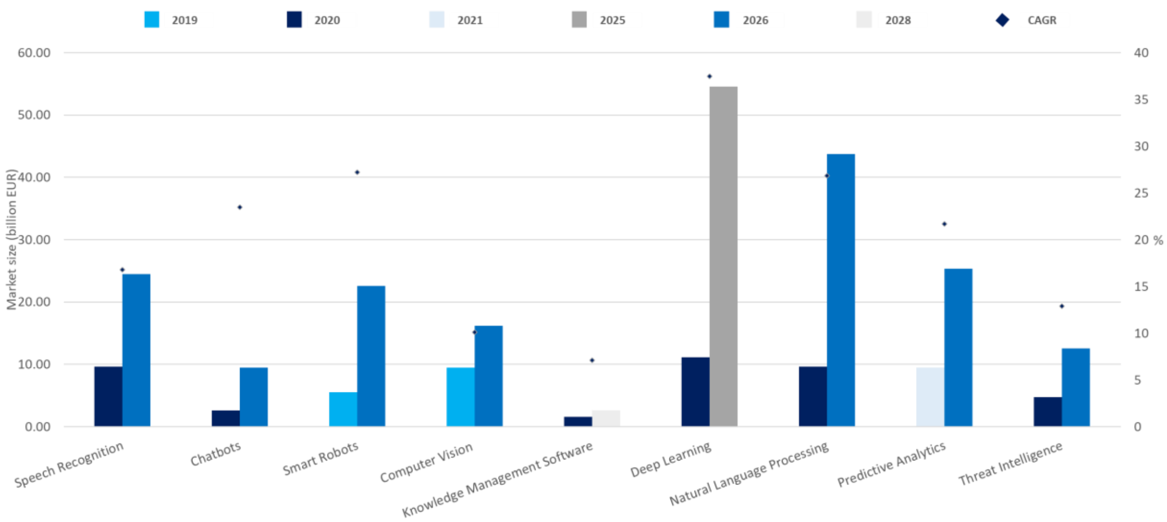
Figure 28 Approach for selection of sectors based on AI technologies analysis



Source: Authors' elaboration.
*Note: *This is only one dimension, complementary to other criteria of analysis.*

The market growth rate allows for assessing the progress of a business, a product or in this case, a technology. Figure 29 below presents the forecasted market size of specific AI technologies in 2026, along with their respective Compound Annual Growth Rates (CAGR). It is compiled based on different data sources and makes assumptions based on CAGR calculation for missing data.

Figure 29 Forecasted market size by AI technologies, 2020-2026



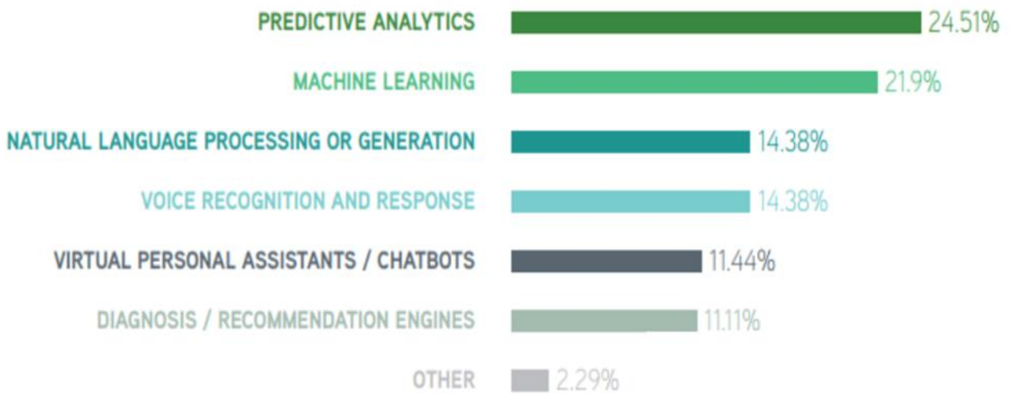
Source: Authors' elaboration based on secondary data collection.[112]

[112] https://www.statista.com/statistics/1133875/global-voice-recognition-market-size/; Markets and Markets. 2021. Chatbot Market by Component, Type (Rule Based & AI Based), Application (Customer Service, Customer Engagement & Retention), Channel Integration, Business Function (ITSM, Finance), Vertical, and Region - Global Forecast to 2026. URL: https://www.marketsandmarkets.com/Market-Reports/smart-advisor-market-72302363.html;
KBV Research. 2021. Global Smart Robots Market By Component (Hardware and Software), By Mobility (Mobile and Stationary), By Operating Environment (Ground and Underwater), By End User (Military & Defense, Logistics Management, Inspection & Maintenance, Field/Agricultural, Healthcare, Industrial, Domestic and Others), By Region, Industry Analysis and Forecast, 2020 – 2026/ URL: https://www.kbvresearch.com/smart-robots-market/;
KBV Research. 2020. Global Computer Vision Market By Product Type (PC-Based and Smart Camera-Based), By Component (Hardware and Software), By Application (Quality Assurance & Inspection, Measurement,

The technologies with the largest forecasted market size in 2026 are **Natural Language Processing (NLP)**, **Predictive Analytics, Speech Recognition** and **Deep Learning (or machine learning)**. The latter being the technology itself, embedded in all other categories that are application fields of such technology, will be considered as a stand-alone category that will have the purpose of confirming the findings.

Market adoption indicates the pace at which new technology is acquired and used by the market. A study conducted by Narrative Science (2019)[113] identified the most widely used AI-powered solutions. The findings are summarised in Figure 30 below.

Figure 30 Most widely used AI-powered solutions, 2019



Source: Narrative Science. 2019. Outlook on Artificial Intelligence in the Enterprise. [114]

In alignment with the findings in terms of CAGR despite being in a slightly different order, the AI technologies with the highest market adoption rate in 2018 were: **Predictive Analytics**, **Natural Language Processing**, **Voice Recognition** and as a consequence, **Machine Learning**. Moreover, the Hype Cycle for AI by Gartner (2021)[115] presented in Figure 31 below, confirms that **Natural Language Processing**

Identification, Predictive Maintenance, Positioning & Guidance and 3D Visualization & Interactive 3D Modeling), By Vertical (Industrial and Non-Industrial), By Region, Industry Analysis and Forecast, 2020 – 2026. URL:
https://www.kbvresearch.com/computer-vision-market/; Orbis Research. 2022. Global Knowledge Management Software Market Growth (Status and Outlook) 2022-2028. URL:
https://www.orbisresearch.com/reports/index/global-knowledge-management-software-market-growth-status-and-outlook-2022-2028; BCC Research. 2020. Deep Learning: Global Markets. URL:
https://www.bccresearch.com/market-research/information-technology/deep-learning-market.html; Mordor Intelligence. Year. Natural Language Processing (NLP) Market – Growth, Trends, COVID-19 Impact, and Forecasts (2022 - 2027). URL:
https://www.mordorintelligence.com/industry-reports/natural-language-processing-market; Markets and Markets. 2021. Predictive Analytics Market with Covid-19 Impact Analysis by Solution (Financial Analytics, Risk Analytics, Marketing Analytics, Web & Social Media Analytics), Service, Deployment Mode, Organization Size, Vertical, and Region - Global Forecast to 2026. URL: https://www.marketsandmarkets.com/Market-Reports/predictive-analytics-market-1181.html; Mordor Intelligence. 2021. Threat Intelligence Market – Growth, Trends, Covid-19 impact, and Forecasts (2022- 2027).
https://www.mordorintelligence.com/industry-reports/threat-intelligence-market

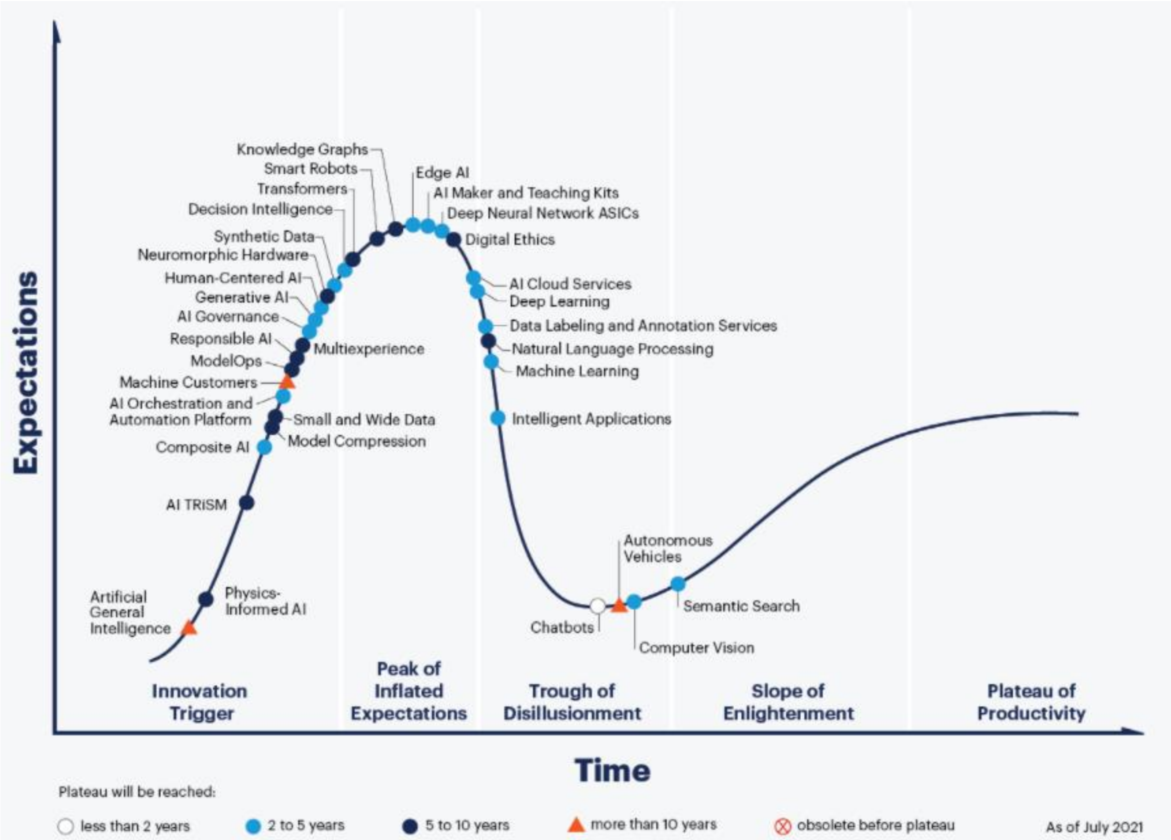
[113] Narrative Science. 2019. Outlook on Artificial Intelligence in the Enterprise. URL: https://narrativescience.com/wp-content/uploads/2019/02/Research-Report_Outlook-on-AI-for-the-Enterprise.pdf

[114] Narrative Science. 2019. Outlook on Artificial Intelligence in the Enterprise. URL: https://narrativescience.com/wp-content/uploads/2019/02/Research-Report_Outlook-on-AI-for-the-Enterprise.pdf

[115] Gartner. 2021. The 4 Trends That Prevail on the Gartner Hype Cycle for AI, 2021. URL: https://www.gartner.com/en/articles/the-4-trends-that-prevail-on-the-gartner-hype-cycle-for-ai-2021

and **Deep Learning** will reach the plateau of productivity, representing the beginning of mainstream adoption soon (i.e. 2 to 10 years).

Figure 31 Hype Cycle for Artificial Intelligence, 2021



Source: Gartner. 2021. The 4 Trends That Prevail on the Gartner Hype Cycle for AI.[116]

The investment being a forward-looking operation, according to estimates by Statista[117], these two technologies are also among those receiving the most worldwide funding in 2019. This further suggests that both technologies are ready to be invested in today to meet the demand expected soon when the plateau will be reached. It must be noted that Statista also reports Smart Robots and Computer vision being high in terms of AI funding received, nonetheless, their rates of market growth are not as high and their levels of market adoption are currently not available from the literature analysed.

Based on these key market indicators, namely forecasted market growth rate and market adoption rate, it can be stated that the readiest technologies to implement and therefore to invest in AI technologies are: **Predictive Analytics**, **Natural Language Processing** and **Voice Recognition,** as defined by the AI Watch classification**.** These findings are also a good indication of the maturity level, intended as the level of readiness of a technology to be implemented at a large scale, of the respective technologies.

[116] Gartner. 2021. The 4 Trends That Prevail on the Gartner Hype Cycle for AI, 2021. URL: https://www.gartner.com/en/articles/the-4-trends-that-prevail-on-the-gartner-hype-cycle-for-ai-2021
[117] Statista. 2019. Machine Learning Tops AI Dollars. URL: https://lb-aps-frontend.statista.com/chart/17966/worldwide-artificial-intelligence-funding/

Taking these findings one step further, it can be noticed that the three AI technologies that we have identified are also believed to be determinants of increasing labour productivity, contributing to an overall higher generating economic potential.

For instance, Statistical Analysis System (n.d.)[118] argues that Predictive Analytics, by improving organisations' operations, enables them to function more efficiently and ultimately increases overall labour productivity. Concerning Natural Language Processing, Wolters Kluwer (2020)[119] argues that this technology leads to a boost in productivity and overall improved quality in the employees' work as it won't replace the workforce but rather change the way of working. As for Speech Recognition, Forbes[120] states that this technology can increase overall productivity in many businesses such as in healthcare. In more general terms, the World Economic Forum (2022)[121] argues that Deep Learning can increase productivity as it can process amounts of data that humans can't and it "works like the human brain", in the sense that it learns from examples.

Furthermore, as previously shown under the An introduction to AI adoption, there is evidence of a positive relationship between AI technology and employment, however, similar evidence also exists against this statement, therefore implying that the employment effect of AI remains controversial. Moreover, there are currently no reliable data in the literature about the impact of specific AI technologies on employment. In this regard, the only exception is provided by Deloitte (2015)[122], which claims that AI technology, in particular Machine Learning, will lead to overall job creation, arguing that the common discourse on the job disruption effect of AI is biased due to "the relative unpredictability of its creative aspects". This finding can ultimately be extended to other AI technologies as most of them rely on machine learning algorithms, however, no study or evidence has been found in the literature to confirm this statement. In this regard, the AI Watch also confirms that Machine Learning is a broader AI category and that most AI technologies use some form of it.

Main findings/implications

- ➔ The AI technologies that have the highest economic potential and are the readiest to be implemented based on market growth, adoption, productivity and employment are Predictive Analytics; Natural Language Processing and Voice/Speech Recognition.

AI technologies and sector-level analysis

This section will analyse how, the three identified as most mature technologies, namely **Predictive Analytics, Natural Language Processing** and **Voice**

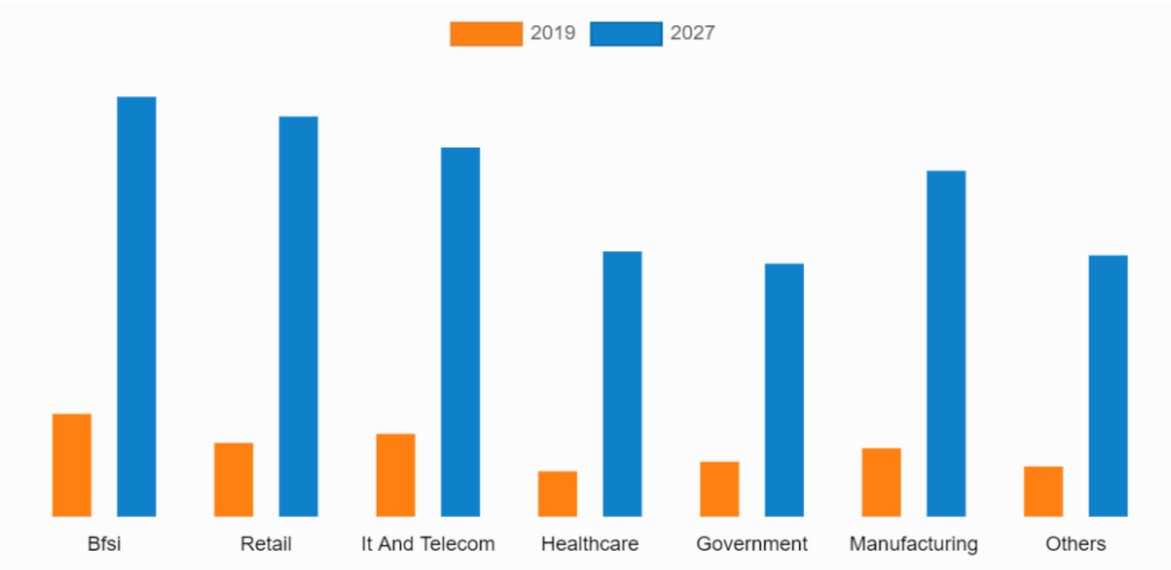
[118] Statistical Analysis System (SAS). N.d. Predictive analytics. What it is and why it matters. URL: https://www.sas.com/en_au/insights/analytics/predictive-analytics.html
[119] Wolters Kluwer. 2020. How natural language processing impacts professions. URL: https://www.wolterskluwer.com/en/expert-insights/how-natural-language-processing-impacts-professions
[120] Forbes. 2021. A Market to Harness: Speech Recognition Artificial Intelligence (AI) Innovations On The Rise. URL: https://www.forbes.com/sites/cindygordon/2021/12/23/a-market-to-harness-speech-recognition-artificial-intelligence-ai-innovations-on-the-rise/?sh=5fe17773134d
[121] World Economic Forum. 2022. How deep learning can improve productivity and boost business. URL: https://www.weforum.org/agenda/2022/01/deep-learning-business-productivity-revenue/
[122] Deloitte. 2015. Technology and people: the great job-creating machine. URL: https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/finance/deloitte-uk-technology-and-people.pdf

Recognition are uptaken up by different market sectors. To ultimately confirm the findings, the same analysis will also be applied to the general use of **Machine Learning**. The analysis will be functional, together with other variables, to inform the choice of the four priority sectors that are ready to uptake AI on a large scale in the public sector.

Predictive Analytics

According to Allied Market Research's report (2020)[123], the sectors that will hold the largest market share of Predictive Analytics technology by 2027 are Banking, Financial Services and Insurance (BFSI), Retail, IT & Telecom and Manufacturing. These results are shown in Figure 32 below.

Figure 32 Forecasted Predictive Analytics market share, 2019-2027



Source: Allied Market Research. 2020. Predictive Analytics Market. [124]

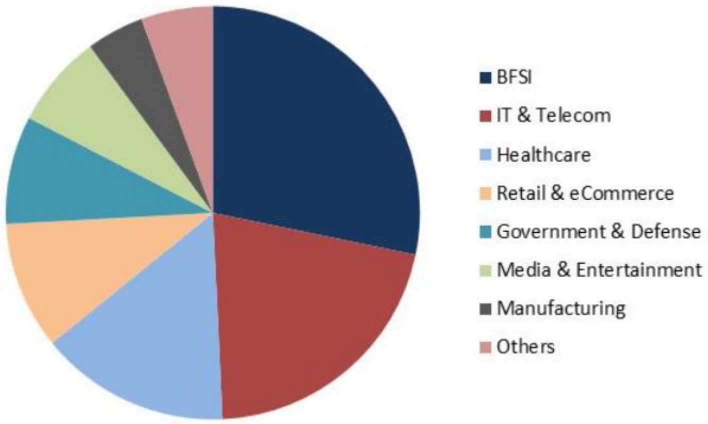
This significant increase in the adoption of Predictive analytics is due to this technology being largely used by organisations for conducting operations such as customer analytics, risk reporting, threat management, product innovation and enhancing customer experience by automating business operations and processes.

Natural Language Processing

According to KBV Research (2019), BFSI and IT&Telecom are the sectors that hold the largest market share for Natural Language Processing technology, followed by Healthcare and Retail&Commerce, see Figure 33.

[123] Allied Market Research. 2020. Predictive Analytics Market by Component (Solution and Services), Deployment (On-premise and Cloud), Enterprise Size (Large Enterprises and Small & Medium-sized Enterprises), and Industry Vertical (BFSI, Retail, IT & Telecom, Healthcare, Government, Manufacturing, and Others): Global Opportunity Analysis and Industry Forecast, 2020–2027**.** URL: https://www.alliedmarketresearch.com/predictive-analytics-market
[124] Allied Market Research. 2020. Predictive Analytics Market by Component (Solution and Services), Deployment (On-premise and Cloud), Enterprise Size (Large Enterprises and Small & Medium-sized Enterprises), and Industry Vertical (BFSI, Retail, IT & Telecom, Healthcare, Government, Manufacturing, and Others): Global Opportunity Analysis and Industry Forecast, 2020–2027**.** URL: https://www.alliedmarketresearch.com/predictive-analytics-market

Figure 33 Natural Language Processing market share, 2019



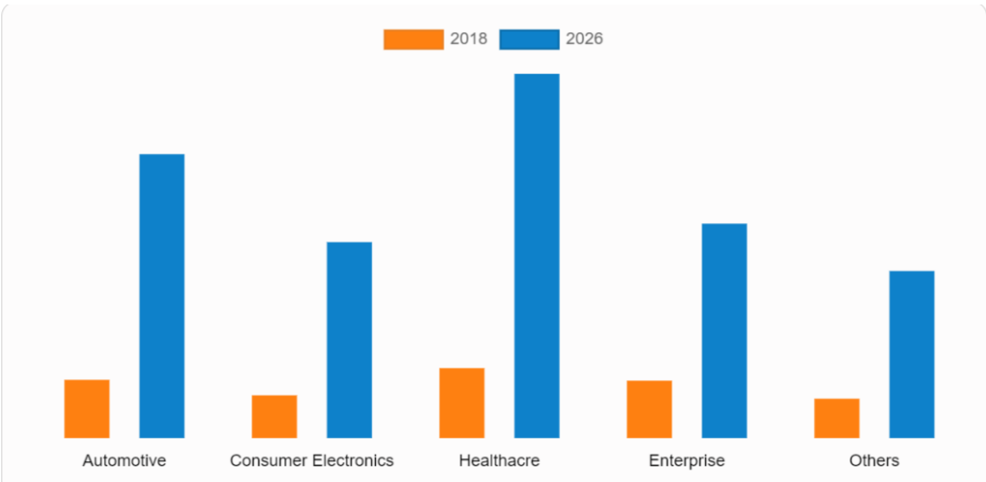
Source: KBV Research. 2019. Market Research Report.[125]

Being an easy-to-adapt and cost-effective cloud platform, NLP is found to be more suitable for professional services.

Speech recognition

According to Allied Market Research (2020)[126], Figure 34, Healthcare will be the sector holding the largest market share of Speech Recognition technology by 2026, followed by the Automotive sector.

Figure 34 Forecasted Speech Recognition market share, 2018-2026



Source: Allied Market Research. 2020. Speech Recognition Market.[127]

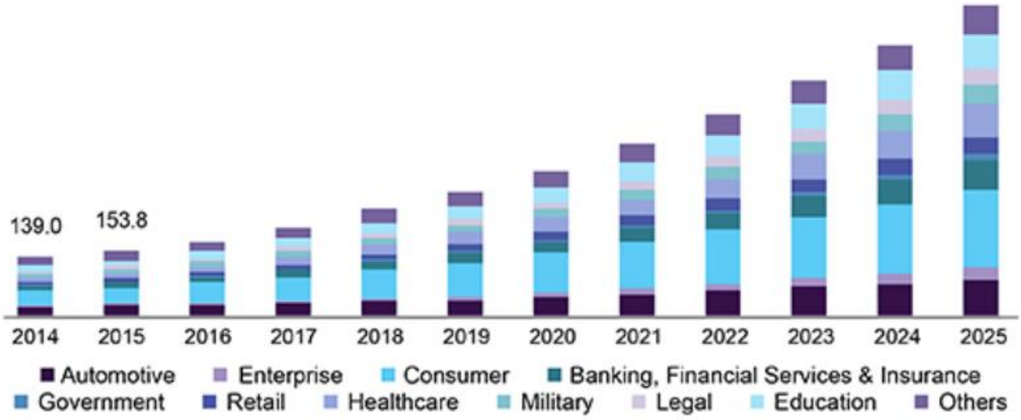
[125] KBV Research. 2019. Global Natural Language Processing Market By Component (Solution and Services) By Application (Text Classification, Machine Translation, Question Answering, Sentiment Analysis, Information Extraction, Automatic Summarization and Others) By type (Rule Based, Statistical and Hybrid) By Deployment Type (On-premise and Cloud) By Region, Industry Analysis and Forecast, 2019 – 2025. URL: https://www.kbvresearch.com/natural-language-processing-market/

[126] Allied Market Research. 2020. Speech Recognition Market by Deployment Mode (On Cloud and On Premise) and End Use (Consumer Electronics, Healthcare, Enterprise, and Others): Global Opportunity Analysis and Industry Forecast, 2019–2026. URL: https://www.alliedmarketresearch.com/speech-recognition-market

[127] Allied Market Research. 2020. Speech Recognition Market by Deployment Mode (On Cloud and On Premise) and End Use (Consumer Electronics, Healthcare, Enterprise, and Others): Global Opportunity Analysis and Industry Forecast, 2019–2026. URL: https://www.alliedmarketresearch.com/speech-recognition-market

Moreover, by looking at the US market volume, Figure 35, it can be observed that aside from Healthcare and excluding Consumers as it is not part of the NACE classification, the other sectors that are predicted to increase their use of Voice Recognition technology are Education, BFSI and Automotive.

Figure 35 Forecasted US Voice Recognition market share, 2014-2025

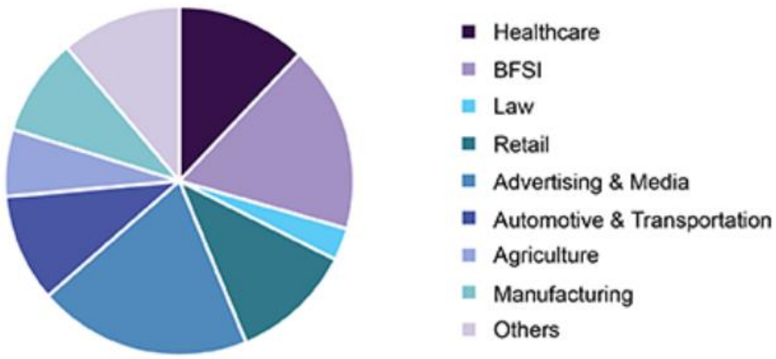


Source: Grand View Research. 2019. US Voice Recognition market.[128]

Machine Learning, Deep Learning

According to Grand View Research's Global Industry Report (2019)[129], the sectors that had the greater market share of Machine Learning and therefore where this technology is mostly deployed are Advertising & Media, BFSI and Healthcare, followed by Retail and Automotive & Transportation. These findings are presented in Figure 36 below.

Figure 36 Machine Learning market share, 2019



Source: Grand View Research. 2019. Market Analysis Report.[130]

[128] Grand View Research. 2019. U.S. Voice Recognition Market Size, Share & Trends Analysis Report By Vertical (Automotive, Enterprise, Consumer, Banking, Financial Services & Insurance, Government, Retail, Healthcare, Military, Legal, Education), And Segments Forecasts, 2019 – 2025. URL: https://www.grandviewresearch.com/industry-analysis/us-voice-recognition-market

[129] Grand View Research. 2019. Machine Learning Market Size, Share & Trends Analysis Report By Component, By Enterprise Size, By End Use (Healthcare, BFSI, Law, Retail, Advertising & Media), And Segment Forecasts, 2019 – 2025. URL: https://www.grandviewresearch.com/industry-analysis/machine-learning-market

[130] Grand View Research. 2019. Machine Learning Market Size, Share & Trends Analysis Report By Component, By Enterprise Size, By End Use (Healthcare, BFSI, Law, Retail, Advertising & Media), And

Healthcare is expected to take the lead and holds the largest Machine Learning market share by 2025. This is due to Machine Learning technology being used for quantitative insights for better diagnosis and using it to prevent diseases, hence "moving the field of medicine from reactive to proactive" (Grand View Research, 2019) and this will drive the market.

By combining these last findings altogether and looking at the overall picture, it can be concluded that the sectors that are the readiest to implement the chosen AI technologies (Predictive Analytics, Natural Language Processing and Speech/Voice Recognition) are: BFSI, Healthcare, Retail, IT&Telecom and Automotive. However, since the ultimate purpose of this report is to identify four priority public sector areas where accelerated public procurement could bring the highest EU-added value, retail can be dropped from the current selection as it is not relevant from a public sector perspective. Therefore, the suggested selection of the most relevant sectors focusing on the uptake of AI technologies by the market is **BFSI, Healthcare, IT&Telecom and Automotive.** This finding will be triangulated with additional criteria that combined will provide the final selection of the four public sector areas for the current study.

Main findings/implications

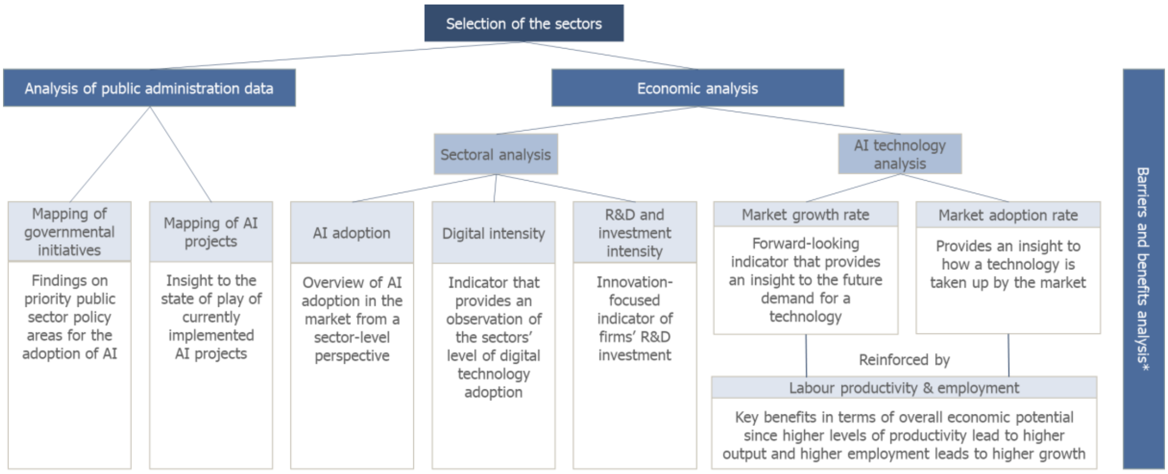
- ➔ Based on the market analysis of technology dynamics, the sectors that are most mature and have the highest economic potential when adopting the previously chosen AI technologies are Banking, Financial Services and Insurance (BFSI); Healthcare; IT and Telecom; and Automotive.

1.5 Final selection of public sector policy areas

Within this scoping report, the i) analysis of the state of play of public procurement of AI, the ii) analysis of the barriers and benefits for the adoption of AI, as well as iii) market analysis, provided different perspectives and information valuable for a selection of the four key sectors that are most ready for large-scale deployment of AI technologies in the public sector. The selection of the four key sectors is, hence, based on the information coming from these three high-level criteria. Figure 37 further explains how these three different perspectives inform the selection.

Segment Forecasts, 2019 – 2025. URL: https://www.grandviewresearch.com/industry-analysis/machine-learning-market

Figure 37 Criteria for selection of the key sectors



Source: Authors' elaboration.

*Note: *External factors analysed to understand what factors pose challenges/benefits for the uptake of AI.*

Firstly, the **qualitative and quantitative analyses of governmental AI initiatives** have contributed to providing an overview of governments' priority policy areas for the adoption of AI; and the analysis of AI projects to the current state of play of adopted AI policy areas and technologies.

The **economic analysis**, in turn, contributed to the selection of the four key sectors by assessing the sectors' digital maturity levels by looking at AI adoption levels, the digital intensity, and the R&D intensity of different sectors. The economic analysis further looked at the **economic potential of AI technologies** according to their market growth, adoption rates, labour productivity impact and employment generation.

Analysis was also carried out on **the barriers to and the benefits of the adoption of AI in the public sector.** This contributed to a better understanding of which challenges are to be overcome by the public sector. The observed benefits and the tools to support their achievements contribute to further considerations that can be made at the public sector level. Since these findings provided higher-level and horizontal explanations, they are not used to directly inform the selection of the priority sectors but rather work as complementary to the above. Specifically, the benefits, when materialised, should also be a measure of the European added value of increased large-scale deployment of AI in the public sector areas.

Based on the above, the **proposed selection of the four key sectors** that are ready for the large-scale deployment of AI are listed below and depicted in Figure 38.

Figure 38 Four key sectors

Source: Authors' elaboration.

Health (COFOG Health / NACE Q Human Health and Social Work Activities): the health sector has prevailed as a recurring key priority area for both the public sector and the private sector. The adoption of AI technologies may benefit the public sector by providing better health services, and the private sector to enhance the provision of medical products, appliances, and equipment for public procurement.

According to the AI typology sector analysis, the health sector is the one expected to take the lead in the adoption of Deep Learning and Speech Recognition technologies. In the AI project mapping, it was found that there are also other existing technologies in the sector such as cognitive robotics in addition to those mentioned.

Mobility (COFOG Economic Affairs / NACE H Transportation and Storage): the mobility sector implies multiple facets related to transportation, infrastructure/construction, and the manufacturing of vehicles. Both the public and private sectors can benefit from the adoption of AI technologies in these. For instance, the public sector may use AI to achieve smart cities' objectives, infrastructure monitoring, and better provision of public transport. The private sector may continue to further enhance manufacturing by providing the underlying AI technologies (e.g. in automotive) to the public sector. With Industry 4.0 (part of the Digital Single Market Strategy[131]), governments in collaboration with the private sector may make Europe a front-runner in the mobility sector.

Specifically, the AI technology that showed a particularly high rate of adoption in the private automotive sector, which can be extended to the wider mobility category, is Speech recognition. In the AI projects mapping, further technologies were also found such as computer vision, predictive analytics, and process automation.

E-Government (COFOG General public services / NACE O Public administration and defence; compulsory social security): the public sector aims to build the capacity to seize the advantage of AI in policymaking and public service delivery, as found in the AI initiatives and public sector projects. Indeed, governments can benefit from the

[131] European Parliament. 2015. Industry 4.0. Digitalisation for productivity and growth. URL: https://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS_BRI(2015)568337_EN.pdf

adoption of AI to optimise internal processes and provide modern public services. To further break down governmental tasks, five categories were identified by the authors: enforcement; regulatory research, analysis and monitoring; adjudication; public services and engagement; internal management.[132] These categories form the initial basis upon which the following in-depth sectoral research will build.

The currently in place AI typologies used for internal public administration processes are, among others, text mining, Natural Language Processing, and audio processing. As for public services, chatbots are the majority group of AI technology, followed by Natural Language Processing and audio processing among others.

ICT is incremental to the development of e-Government and is an underlying priority sector to all AI governmental initiatives (e.g. investments in the software industry developed by the private sector). To further digitalise public administrations and therefore public services, governments can procure modern technologies and invest in building a solid digital infrastructure.

Natural Language Processing is the AI technology that, according to the AI technologies analysis, will be adapted to the largest extent by the ICT sector, and is also showcased by the public sector AI projects that use AI technologies for language analytics.

Education (COFOG Education / NACE P Education): the education sector is identified as one of the top priority sectors for governmental adoption of AI, as depicted in the Member States' AI initiatives. The same importance has also been stressed at the EU level, with the European Parliament stating that "the public sector should be leading in demystifying AI and offering free and open education about AI"[133], to take the wider public on board, develop human-centric AI and increase public sector readiness for AI. Along the same line, as also noted in the Maltese AI Strategy, the adoption of AI will contribute towards making informed decisions for the implementation of relevant policies to achieve the targets set within the education strategy. According to the AI technologies analysis, Voice Recognition is the AI technology that is expected to have the highest adoption rate in the Education sector.

The following Table 2 depicts the level of importance of the different key sectors that were identified throughout the scoping report, as per the indicator studied. More specifically, the crosses indicate the extent to which these sectors appeared in the analysis.

[132] Engstrom, D. F., Ho, D. E., Sharkey, C. M., & Cuéllar, M.-F. 2020. Government by Algorithm: Artificial Intelligence in Federal Administrative Agencies. In SSRN Electronic Journal. URL: https://doi.org/10.2139/ssrn.3551505
[133] European Parliament. 2021. Artificial Intelligence and public services. URL: https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/662936/IPOL_BRI(2021)662936_EN.pdf

Table 2 Sector importance vis-a-vis studied indicators

Indicator/Sector	Health	Mobility	E-Government	Education	FinTech	Agriculture	Law enforcement
Mapping of government initiatives	xxx	xx	xxx	xx		x	
Mapping of AI projects in the public sector	xx	xx	xxx				x
Sector-level AI adoption	xx	x	xxx		xx		
Sector-level Digital intensity			xxx		xxx		
Sector-level R&D and investments	xxx	xx	xxx		xx		
AI typology analysis	xxx	x	xx	x	xxx		

Source: Authors' elaboration.

Based on the methodology adopted, the original proposal as the fourth key sector was FinTech, however, due to the lack of governmental inclusion and quantifiable economic impact of the FinTech sector, it was replaced by the Education sector.

The final proposal for the focus sectors balances the information available on public administration data and market data. The four sectors constitute the basis upon which the following research of this study builds.

2 Chapter 2: Qualitative and Quantitative analysis of key sectors

2.1 Introduction

Artificial Intelligence (AI) is already transforming the public sector and the numerous policy areas within its orbit. Rather than simply a steady natural progression of digitalization, a desirable end in itself, the continued and increased uptake and use of AI in the public sector is set to usher in a paradigm shift in the public sector with profound political, economic and social implications.

In lockstep with a robust regulatory framework, this area of technology has the potential to improve public administration and services both equitably and ethically if handled correctly. With the major inflexion point of the pandemic, the European Union has the chance to lead by example and responsibly champion the use of AI while making further progress on its goals of strategic autonomy and achieving the twin transition. Furthermore, with increased competition from abroad in key technologies such as AI, it is crucial that the EU not only keeps up but makes up ground in the sector. This chapter closely examines AI and the public sector through the lens of four key sectors to provide additional insights into its benefits, barriers and the current policy landscape.

Though still in its infancy, especially compared with its private counterpart which was responsible for 67% of total AI investment between 2018-20[134], the public sector´s approach, and its historically cautious relationship with AI is starting to shift. Having focused initially on strategy and regulation, the funding and use of AI applications are increasingly commonplace with some public authorities even starting to develop solutions themselves. In fact, in addition to the significant contributions to the health sector (which will be covered later in the chapter), the pandemic has increased the ambition of EU member states when it comes to AI[135]. Aided by the digitalization component of NextGenerationEU funds, all but three of the EU´s member states have published a national AI strategy by the time of writing[136]. Reflective of the variation in the technology domain itself, the areas of emphasis of each member state have been considerably different both in terms of the type of action (e.g., regulation, R+I) but also sectoral focus.

Although use and development are on the rise, the transformative potential of AI in the public sector is yet to be realized with applications generally focused on the so-called "low-hanging fruit" of the public portfolio. However, with more public actors both procuring and funding AI technology as well as spearheading development itself, the AI space will only grow more dynamic and competitive. This chapter explores and analyses four landmark public sectors which are both strategically crucial for the EU and ready to receive an injection of public investment and focus. These sectors are eGovernment, mobility, health and education.

Aims and objectives of the chapter

This chapter is part of a study by the European Commission to improve the understanding of AI and the public sector. Insights into the dynamics of this everchanging space should help increase investment in and the use of AI in the public

[134]Tatjana Evas, Maikki Sipinen, Martin Ulbrich, Alessandro Dalla Benetta, Maciej Sobolewski and Daniel Nepelski, AI Watch: Estimating AI investments in the European Union, EUR 31088 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-53433-4, doi:10.2760/702029, JRC12917

[135] Van Roy, V., Rossetti, F., Perset, K. and Galindo-Romero, L., AI Watch - National strategies on Artificial Intelligence: A European perspective, 2022 edition, , EUR 31083 EN Publications Office of the European Union, Luxembourg,2022, ISBN 978-92-76-52910- 1, doi:10.2760/385851, JRC129123.

[136] Van Roy, V., Rossetti, F., Perset, K. and Galindo-Romero, L., AI Watch - National strategies on Artificial Intelligence: A European perspective, 2022 edition, , EUR 31083 EN Publications Office of the European Union, Luxembourg,2022, ISBN 978-92-76-52910- 1, doi:10.2760/385851, JRC129123.

(and indeed the private) sector. This study aims to support the broader goals of AI adoption by providing evidence and operational recommendations. More specifically, this report aims to build on past work carried out on AI in the public sector and answer the call for more "deep dives at the country level through case studies and thematic analyses"[137]. This means expanding previous research in the area and its calls to address the contextual factors, institutional capacities, external and internal drivers and barriers that underlie AI implementation and the transformation of public administrations[138].

Within each sector, the report evaluates closely the principal drivers, barriers and trends as well as identify some best practices from interesting real-world AI use cases. While the analysis studies four key sectors, some lessons and insights can be applied to other sectors which might be less mature in terms of AI diffusion.

Likewise, as discussed in the Peer Learning Workshops on AI in the public sector, it is crucial to collect and share any best practices between EU governments. Finally, a coherent approach to studying is central to providing a "common reference point for identifying and better understanding the underlying pillars for relevant and meaningful assessment in the area"[139].

Chapter structure

In terms of structure, each sector is analysed with the same set of methods in a uniform order. A full methodology section including definitions and explanations of the data collection and quantitative techniques can be found as an annex below. Using a mapping of the pan-EU policy landscape as a base, each section starts with an outline of how AI can resolve a set of sector-specific problems and a value chain analysis followed by an assessment of the drivers and barriers in the form of PESTEL and SWOT analyses. This is followed by a case study examining an insightful and successful example of public policy on AI technology. The final part of each section features a quantitative analysis which uses linear regression to highlight correlations between the level of a country´s AI activity and a range of related variables.

The subsections are as follows:

- **Introduction and policy mapping**. Setting out the scope of the sector, highlighting typical use cases and a brief account of the progression of AI in the area. This section will give an overview of the policies and initiatives in each sector.
- **Challenges and Solutions**. Identification of key challenges and corresponding solutions in the selected sectors that could be solved using AI applications.
- **Value Chain Analysis**. Identification of key links in each sector's AI value chain.
- **Drivers and barriers**. A PESTEL (Political, Economic, Social, Technological, Environmental and Legal) and SWOT (Strength, Weaknesses, Opportunities and Threats) analysis.
- **Case Study**. A real-world example which examines a specific policy that uses or focuses on AI. This section also presents a series of best practices which made the policy successful and should be replicated.

[137] Misuraca, G. and Van Noordt, C., AI Watch - Artificial Intelligence in public services, EUR 30255 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-19540-5 (online), doi:10.2760/039619 (online), JRC120399.
[138] Misuraca, G. and Van Noordt, C., AI Watch - Artificial Intelligence in public services, EUR 30255 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-19540-5 (online
[139] Manzoni, M., Medaglia, R. and Tangi, L., AI Watch. Artificial Intelligence for the public sector. Report of the "4th Peer Learning Workshop on the use and impact of AI in public services", 28 October 2021, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-46347-4, doi:10.2760/142724, JRC127944.

- **Economic Analysis**. Validation of the findings of the earlier section through available indicators and provide quantitative evidence for AI investment from the public sector. This compares categories of AI public sector activity on a range of variables.

2.2 eGovernment

eGovernment, or digital public services, is defined in this chapter as the process of "organizational change to improve structures and operations of government"[140]. For the majority of this century, the technological driver for this progress has been Information and Communication Technologies (ICT) which has enabled "citizens, enterprises and organizations to carry out their interactions with government more easily, more quickly and at lower cost"[141]. The increased use of ICT in government has not diminished and remains a key policy goal at both the national and European levels as a central tenet of the Digital Decade – the European Commission´s vision for a digitalised EU. However, AI is also set to bring about even more profound and disruptive "organizational change" to the public sector and digital transformation rather than a mere continuation of digitalization[142].

Several recent pieces of research highlight this AI-driven paradigm shift which is underway within the public sector. Ahn and Chen make a categorical distinction between "IT-enabled bureaucracy" and "AI-augmented bureaucracy"[143]. The former refers to the type of eGovernment outlined above whereby statistics, computers and the internet are used to improve electronic service delivery while the latter combines 5G and IoT cloud computing with machine learning and algorithmic decision-making to harness real-time, large and high-quality data. This blend of advanced ICT technologies with powerful AI techniques can provide enormous public value including a detailed understanding of citizens' needs and solutions, enhanced simulation and planning capability and ultimately "smart government". Reis et al. also deploy the same distinction (and indeed terminology), noting that "digitization and digital transformation have been occurring in organizations since the 1950s"[144] but that AI, with its reliance on real-time and real data" is game-changing digital transformation. The authors also point to a Capgemini report which advocates the economic and social benefits of AI to the public sector and that "AI helps us to enter a new era of sophisticated and smart public services"[145].

This first sectoral analysis uses the more expansive European Commission definition of eGovernment as "digital public services"[146] rather than something inherently involving ICT technology. Furthermore, to avoid overlap with later sections as much as possible, this sector focuses on the category of "general public services"[147]. Using the COFOG classification, this includes Executive and legislative organs, financial and fiscal affairs,

[140] Field, T., Muller, E., Lau, E., Gadriot-Renard, H. and Vergez, C. (2003) The Case for E-Government: Excerpts from the OECD Report "The E-Government Imperative". OECD Journal on Budgeting, 3, 61-131.http://dx.doi.org/10.1787/budget-v3-art5-en
[141] https://digital-strategy.ec.europa.eu/en/policies/egovernment
[142] Reis, J., Santo, P.E., Melão, N. (2019). Artificial Intelligence in Government Services: A Systematic Literature Review. In: Rocha, Á., Adeli, H., Reis, L., Costanzo, S. (eds) New Knowledge in Information Systems and Technologies. WorldCIST'19 2019. Advances in Intelligent Systems and Computing, vol 930. Springer, Cham. https://doi.org/10.1007/978-3-030-16181-1_23
[143] Ahn, Michael J. and Yu-Che Chen. "Artificial Intelligence in Government: Potentials, Challenges, and the Future." *The 21st Annual International Conference on Digital Government Research* (2020)
[144] Reis, J., Santo, P.E., Melão, N. (2019). Artificial Intelligence in Government Services: A Systematic Literature Review. In: Rocha, Á., Adeli, H., Reis, L., Costanzo, S. (eds) New Knowledge in Information Systems and Technologies. WorldCIST'19 2019. Advances in Intelligent Systems and Computing, vol 930. Springer, Cham. https://doi.org/10.1007/978-3-030-16181-1_23
[145] Tinholt, D., Carrara, W., Linden, N.: Unleashing the potential of artificial intelligence in the public sector. Capgemini Consulting (2017)
[146] European Commission (2023) "eGovernment and digital public services": https://digital-strategy.ec.europa.eu/en/policies/egovernment
[147]Eurostat (2023) "COFOG": https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Classification_of_the_functions_of_government_(COFOG)

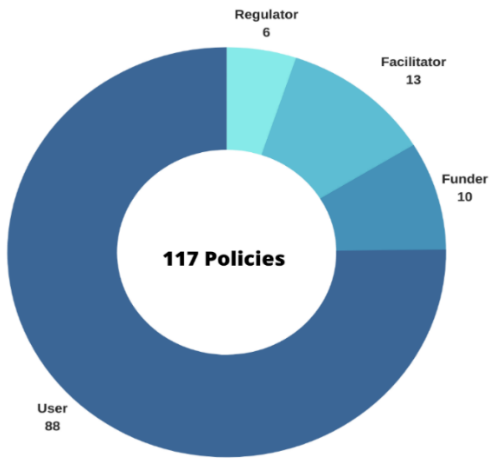
external affairs, Foreign economic aid, General services, Basic research, R&D general public services, General public services n.e.c., public debt transactions, transfers of general character between different levels of government. [148] According to the Innovative Public Services database[149], 30% of AI use cases (207 out of 686 cases) fall within the "General Public Services" domain. A "large and comprehensive category" per AI Watch[150], some AI applications which are explored in more detail include:

- Chatbots and virtual assistants: used to speed up internal processes and interact externally with citizens and business
- Comparison, detection and misinformation handling management
- Classification, storage and search of documents (even-hand written), videos and/or recorded speeches with metadata and information extraction
- Several kinds of data anomalies detection or potential fraud

The policy landscape: eGovernment and AI

As in other sectors, the current and potential uses for public administration are myriad for all levels of governance, something which is reflected in the variety of policies around the EU. Uses range from image and video recognition technology to analysing huge volumes of data to make predictions which are more comprehensive and accurate and/or support human or automated.

Figure 39 Policy breakdown per mode taken from the mapping exercise



Source: Authors' elaboration.

The most numerous uses are currently chatbots which allow citizens to interact with services in a semi-automated manner through virtual assistants or conducting sentiment analyses based on the interpretation of textual data (Chui et al., 2018; Eggers et al., 2017) supported by Natural Language Processing (NLP) to understand audio and text. Chatbots have been implemented throughout the EU at both the national and regional levels and span several different thematic areas, highlighting their versatility. This includes assisting tourists through the Plovdiv City Concierge

[148] Misuraca, G. and Van Noordt, C., AI Watch - Artificial Intelligence in public services (2020), EUR 30255 EN, Publications Office of the European Union, Luxembourg, ISBN 978-92-76-19540-5 (online), doi:10.2760/039619 (online), JRC120399.

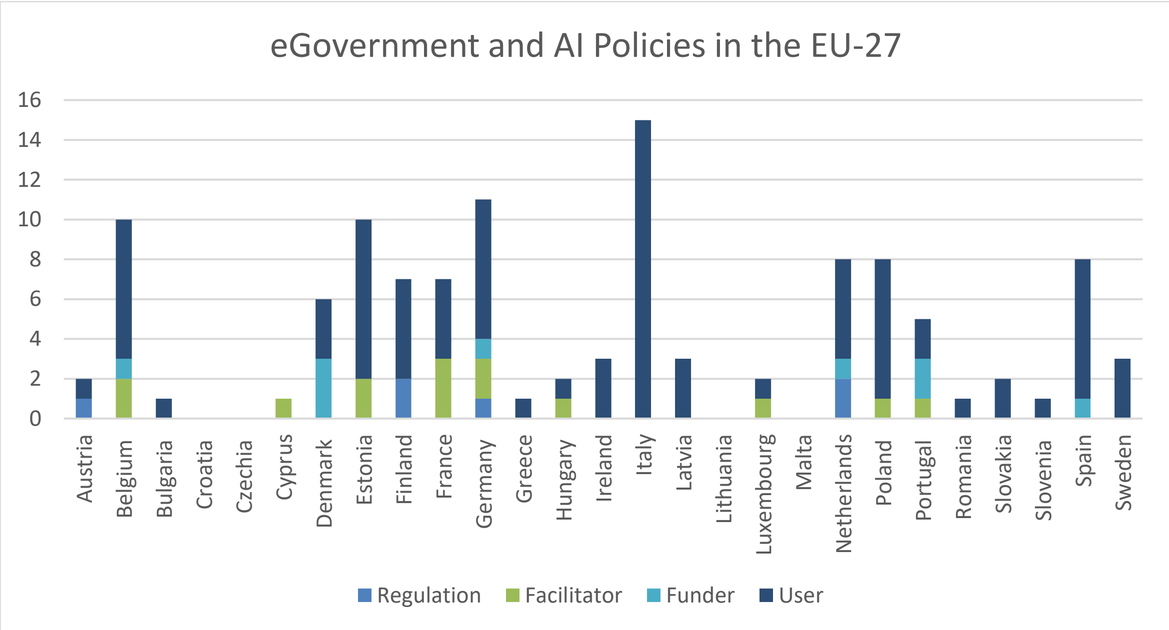
[149] Innovative Public Services Explorer: https://ipsoeu.github.io/ips-explorer/case/

[150] AI Watch (2022) European landscape on the use of Artificial Intelligence by the Public Sector.

(Bulgaria), immigration and business-focused chatbots in Finland and even retired people and interdepartmental communication in France and Germany.

Leading the way in the number of AI-focused policies is Italy (15) with larger national projects such as the IBM Watson content hub and Evasometro Anonimizzato, a tool which uses big data to analyse taxpayer behaviour, combined with a series of regional initiatives in areas such as Piemonte and Lombardia. Other member states have enacted larger programmes to improve public services through AI. In the case of Portugal, this takes the form of multiple AI-related measures within a broader digitalization programme SIMPLEX or a programme strictly dedicated to AI in Public services like Finland´s AuroraAI network (part of the wider AuroraAI programme) which links the services of central government organisations together with services in other sectors[151]. Below is a summary of the results of the policy mapping for eGovernment in the EU. A full explanation of the data sources and the precise nature of the categories used can be found in the methodology section in the annex below.

Figure 40 E-government and AI policies in the EU-27



Source: Authors' elaboration.

2.2.1 Challenges and AI solutions for e-government

The recent literature on the benefits of AI adoption by the public sector uses 3 dimensions derived from Twizeyimana & Andersson´s taxonomy[152]: Improved administration thanks in part to more efficiency, improved public services and improved social value through more trust and confidence. Building on this, AI Watch´s 2022 landscaping report forwarded this conceptualization into 3 value drivers of AI cases: Improved administrative efficiency, improved public services and open government capabilities.

While these AI applications solve highly prevalent problems, their value can also pose a risk to the public good if not handled with prudence. Often two sides of the same coin, this section will also outline the main risks that accompany each value driver of AI adoption in the public sector. The 3 AI Watch drivers are explored below with the addition of a 4th major value driver of AI in cybersecurity. It is worth noting that the

[151] DigiFinland (2022) "AuroraAI national artificial intelligence programme": https://digifinland.fi/en/our-operations/aurora-ai-national-artificial-intelligence-programme/

[152] Jean Damascene Twizeyimana, Annika Andersson, The public value of E-Government – A literature review, Government Information Quarterly, Volume 36, Issue 2, 2019, Pages 167-178,

value drivers themselves are mutually reinforcing and many of the solutions can provide value in multiple ways (e.g., a chatbot can improve the accessibility of government and free up resources simultaneously).

Figure 41 Summary of challenges and AI solutions for digital public services

Public sector challenge	*Provide quality services with limited resources*	*Improve the understanding of citizens´ needs and solutions*	*Improve the relationship between the state and citizen*	*Defend against cyber threats*
AI Value driver	Improved administrative efficiency	Improved public services	More open government	More secure public services
AI Applications	Automized Data entry Open AI process automation systems	Recommendation systems	Chatbots Intelligent Digital Assistants	Cognitive security analytics & threat intelligence
AI Techniques	Speech recognition, machine translation, visual form completion checking	AI-powered algorithms	NLP, Intelligent agents, affective computing and big data	NLP and machine learning

Improved administrative efficiency

The ability of AI to decrease the administrative burden of the public sector is likely the most recognizable value driver to organizations looking to adopt the technology. Often referred to as *low-hanging fruit*, indicating that the improvement is accessible, valuable though not deeply transformative, AI technology can "take over mundane tasks, freeing workers for more valuable work"[153] and release valuable public funds and budgetary savings which can be deployed elsewhere. According to "AI Multiple", 53% of state and local officials surveyed in the US had excessive paperwork burdens that impacted their ability to get their work done[154]. Furthermore, Deloitte estimate that automation of US federal government employee tasks could save between 96.7 million and 1.2 billion hours annually[155]. The same study reports that automation and AI have the potential to save between $3.3 billion and $41.1 billion.

Delving into the inventory of public sector use cases provided by AI Watch, 28% of cases improved the management of public resources (the highest number in the "improved administrative efficiency" dimension)[156]. Interestingly, only 3% provided cost-reduction indicating that meaningful budgetary savings highlighted in the Deloitte

[153] European Commission, Joint Research Centre, Manzoni, M., Medaglia, R., Tangi, L., et al., AI Watch, road to the adoption of artificial intelligence by the public sector : a handbook for policymakers, public administrations and relevant stakeholders, Publications Office of the European Union, 2022, https://data.europa.eu/doi/10.2760/288757
[154] AI Multiple (2023) "AI in government: Examples, Challenges and Best Practices": https://research.aimultiple.com/ai-government/
[155] Deloitte (2017) "AI-augmented government": https://www2.deloitte.com/us/en/insights/focus/cognitive-technologies/artificial-intelligence-government.html
[156] AI Watch (2022) European landscape on the use of Artificial Intelligence by the Public Sector

report are yet to be realized. Multiple applications to help increase efficiency already exist and have achieved a high level of maturity, developed by both the public and private sectors, to be implemented by public authorities.

However, more efficiency brings with it the possibility of job losses in the private sector as AI is used for tasks that were previously executed by humans. While this trend is nothing particularly novel and the overall impact of AI on the labour market is contested, "some categories of jobs in the public sector are destined to disappear"[157]. Mitigating and softening the loss of certain jobs, especially those that are more administrative, will require investment in up/reskilling initiatives for public sector employees (which will be covered in the education section in further detail).

Use Cases: Efficiency Gains	
Voice-to-text transcription and real-time universal translation:	This AI application involves software for the intelligent recognition and processing of language in several forms. This might be understanding and responding to natural language, the transposition of spoken to written language or even real-time universal translation and natural language processing systems[158]. The Finnish Tax administration has used this for the automation of subtitling videos and audio. The AI system is based on understanding speech and transforming it into text and is used by the Finnish Tax Administration. It is used to provide subtitles on videos and is part of a wider initiative within the administration to use Speech-to-Text technologies in various use cases.
AI process automation systems:	The value proposition of this application stems from its ability to automate standard tasks. Using rule-based assessment, workflow processing, schema-based suggestions, data mining, and care-based reasoning, what were formally human-led processes can now be carried out by automated systems. These can greatly enhance operational efficiency and support humans with mundane tasks such as data entry and processing requests for administrative application forms. The Danish government has used an *Intelligent Control Platform* that provides an automated assessment of how a selected company/business is more likely to commit fraud compared with others[159].

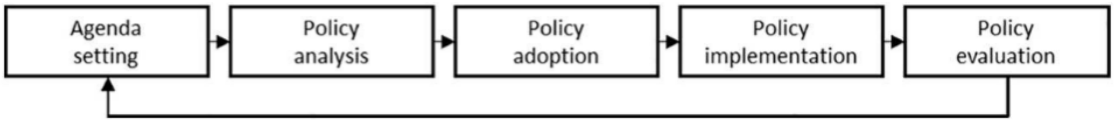
Improved decision-making and public services

Interrelated to but distinct from efficiency gains for the internal functioning of public authorities, AI can also drastically improve the quality of public services through more informed decision-making. Returning to AI Watch´s inventory of cases, 41% of cases offered "responsive, efficient and cost-effective services" followed by "increased quality of information and services" (22%) and "public (citizen)-centred services" (17%)[160].

[157] AI Watch (2022) road to the adoption of Artificial Intelligence by the public sector
[158] Bernd W. Wirtz, Jan C. Weyerer & Carolin Geyer (2019) Artificial Intelligence and the Public Sector—Applications and Challenges, International Journal of Public Administration, 42:7, 596-615, DOI: 10.1080/01900692.2018.1498103
[159] AI Watch (2022) European landscape on the use of Artificial Intelligence by the Public Sector
[160] AI Watch (2022) European landscape on the use of Artificial Intelligence by the Public Sector

Experts point to the utility of algorithmic processes in scenarios where "staff find it too difficult or time-consuming to externalize implicit knowledge". AI can fill this need and make up for the "limited cognitive capacity and struggle to process large amounts of information". AI applications have the potential to improve each step of the policy-making process (simplified below as Birkland´s stages heuristic framework of policy-making[161]).

Figure 42: The policy stages heuristic



Algorithms have been deployed to help set the policy agenda and improve the background knowledge on an issue of a government department or the wider public[162]. Kolkman shows that public authorities have deployed algorithmic models for policy negotiations such as the Land Registry of the Netherlands which used algorithms to project the estimated revenue of different types of legal services which were in turn used to defend against a raise in tariffs. The Dutch government has also used the SAFFIER II algorithmic model for long-term financial planning and council on its budgets. Used in tandem, "algorithmic models and analyst judgement has been shown to improve the accuracy of shortcuts". Proponents point to the value of an impartial algorithmic model which is an "alternative to biased, subjective and otherwise flawed human decision-making" and their ability to bring "reliability and objectivity to otherwise uncertain procedures"[163].

However, some experts have stated that algorithmic impartiality is overstated and, at times, even compounds existing human bias. A notorious case of this occurred in the UK in 2020 with an algorithmic-led grading fiasco for university entry exams which were unable to take place due to the COVID-19 pandemic. The algorithm used historical data and rewarded students in smaller classes in certain subjects with more favourable grades and disproportionately affected students from lower socio-economic backgrounds[164]. The saga also revealed another issue with algorithmic prediction in the public sector in opacity and complexity[165]. The so-called black-box issue, the lack of explainability of the AI algorithm puts it at odds with public demands for transparency and makes "it potentially impossible to account for specific AI-driven outcomes, and to correct actions with unintended consequences"[166].

Use Case: Improved Public Services	
Recommendation systems	Using an information filtering system and software-based systems which mine personalized information to predict preferences, algorithmic models can make predictions which are purportedly free from human bias if executed correctly. "One of the main benefits of AI is the ability to identify

[161] Birkland (2015) An introduction to the policy process: Theories, concepts, and models of public policy making. Routledge, London (2015)

[162] Kolkman (2022) The usefulness of algorithmic models in policy making, Government Information Quarterly, Volume 37, Issue 3

[163] Kolkman (2020) The usefulness of algorithmic models in policy making, Government Information Quarterly, Volume 37, Issue 3

[164] Kolkman (2020) "F**K the algorithm?: What the world can learn from the UK´s A-level grading fiasco": "https://blogs.lse.ac.uk/impactofsocialsciences/2020/08/26/fk-the-algorithm-what-the-world-can-learn-from-the-uks-a-level-grading-fiasco/

[165] AI Watch (2022) road to the adoption of Artificial Intelligence by the public sector

[166] AI Watch (2022) road to the adoption of Artificial Intelligence by the public sector

	patterns and make more accurate predictions based on available datasets"[167]. The Estonian government has used the OTT system – a decision support tool for consultants an AI system which assists its consultants with providing insights predicting the chances of an unemployed person getting a new job.

Open government

An area where AI can surpass orthodox digitalization of public administrations is the effect it can have on the openness, transparency and participation of citizens. With more open government, the separation between the public sector and the population it serves will be less impermeable thanks to "trust through higher participation by citizens in public sector activities and decision-making processes"[168]. Parts of the population which have historically found the public sector to be inaccessible whether that be for economic, linguistic, physical or technological reasons will be able to interact with the authorities thanks to AI applications such as chatbots or virtual assistants. However, this value driver is currently the least common in AI Watch´s inventory with only 12% of cases, with "increased transparency of public operations" offered by all of those cases.

Public authorities also run the risk of appearing even more dehumanized and like a faceless bureaucracy if AI applications are handled badly. Critics point to a loss of accountability of public servants by outsourcing their communication with the public to an AI application creating a "phenomenon where citizens are faced with impotence when confronted with "the computer says no" responses"[169].

Use Case: Open Government	
VDAB: Chatbot for job seekers[170]	Conversational bots can reduce waiting times and administrative bureaucracy freeing up valuable resources that can be deployed elsewhere. Using NLP, intelligent agents, affective computing and big data, chatbots provide automated answers to common questions and processes. In the Netherlands, the Flemish employment agency promised to make a job available to graduates within three months of leaving school. They used Cognitive applications to provide people with a personalised experience through digital channels.

Increasing cybersecurity of digital public services

The increasingly digital nature of the public sector has also increased the importance of cybersecurity. Public authorities are especially vulnerable to these new types of threats because of the large number of agencies and stakeholders involved in the

[167] Misuraca Gianluca et al, September 2020, *The use of AI in public services: results from a preliminary mapping across the EU*, https://www.researchgate.net/publication/345015463_The_use_of_AI_in_public_services_results_from_a_preliminary_mapping_across_the_EU

[168] AI Watch (2022) road to the adoption of Artificial Intelligence by the public sector

[169] AI Watch (2022) road to the adoption of Artificial Intelligence by the public sector

[170] Deloitte (2017) "VDAB: Helping tackle youth unemployment through Cognitive Analytics with a friendly digital job coach": https://www2.deloitte.com/be/en/pages/impact-report-2017/articles/clients/vdab.html

process of governing a society. Each agency, bureau or interaction with the public is subject to cyber-risks and cyber-intrusion. [171]

This vulnerability has been demonstrated by numerous attacks against public institutions. For instance, a group of hackers took control of the health data of French hospitals, asking for €1.2 million in ransom to release the data.[172] In addition, studies have shown that 80% of websites related to e-government around the world are susceptible to structure query injection (SQL) and cross-site scripting (XSS) because of an absence of an appropriate mechanism for authentication.[173] [174]

These difficulties are very salient and are shared with the private sector. AI for cybersecurity is already a mature market which receives high levels of investment and interest from the private sphere. However, the uptake of AI solutions for cybersecurity in e-government remains low in Europe. The low level of investment is reflected by a weaker European market and European cybersecurity firms are smaller and typically underperform compared with their American counterparts, notably in fundraising. There is a need for targeted funding of start-ups in Europe, but also to boost the demand for AI solutions for cybersecurity applications [175]and more synergy between the interest of the European private market in AI and cybersecurity and the objectives of the public authorities in eGovernment. AI applications can help to secure public IT infrastructure with 24/7 system monitoring, automated response to threats, identification and localisation of threats and intrusion or identification of malware.[176]

Policy-makers could thus encourage the development of this market by following their interest and increasing funding of AI projects for cybersecurity in the Horizon programme (around €2.5 billion were dedicated to this topic in Horizon 2020)[177], procuring and implementing existing solutions from European providers and using their own IT e-Government infrastructure for pilot testing of innovative solutions.

Use Case: Cybersecurity	
Cognitive security analytics: IBM Watson	Technology giant IBM provides AI cybersecurity solutions which use cognitive technologies to analyse security information through natural language processing and machine learning. The solution can retrace a cybercriminal's actions for deep insights into the breach, reconstruct the data involved in a security incident for a step-by-step view of the offence, and

[171] Conklin Arthur, White Gregory, February (2006), *e-government and cyber security: the role of cyber security exercices*, https://www.researchgate.net/publication/4216146_e-Government_and_Cyber_Security_The_Role_of_Cyber_Security_Exercises

[172] LeFigaro, 22/04/2022, *Des hackers demandent une rançon de 1.2 million d'euros à un hôpital de la Marne*, https://www.lefigaro.fr/flash-eco/des-hackers-demandent-une-rancon-de-1-2-million-d-euros-a-un-hopital-de-la-marne-20220422

[173] Bala Kiran et al, 30/06/2021, *Analysis of Cyber Security in e-government utilising blockchain performance*, https://assets.researchsquare.com/files/rs-938929/v1/bb9de2f7-7de9-4057-a7e1-e02dba97937b.pdf?c=1633016778

[174] Large agencies tend to be better equipped and drilled to face cyber-attacks. However, a large level of unreadiness remains to be observed. The conduction of exercises on how to react to cyber-attacks has demonstrated their efficiency in raising awareness and prompting modernisation of management structures and procedures. Conklin Arthur, White Gregory, February 2006, *e-government and cyber security: the role of cyber security exercises*, https://www.researchgate.net/publication/4216146_e-Government_and_Cyber_Security_The_Role_of_Cyber_Security_Exercises

[175] European Court of auditors, March 2019, *Challenges to effective EU cybersecurity policy*, https://www.eca.europa.eu/Lists/ECADocuments/BRP_CYBERSECURITY/BRP_CYBERSECURITY_EN.pdf

[176] Data Center Knowledge, 03/02/2022, *Top 3 use cases for AI in cybersecurity,* https://www.datacenterknowledge.com/security/top-three-use-cases-ai-cybersecurity

[177] European Court of auditors, March 2019, *Challenges to effective EU cybersecurity policy*, https://www.eca.europa.eu/Lists/ECADocuments/BRP_CYBERSECURITY/BRP_CYBERSECURITY_EN.pdf

	give IT security teams greater visibility even without special skills or training[178].

2.2.2 Digital value chain of e-government

A CEPS report on the European AI value chain defined it as the "organizational process through which an individual AI system is developed and put into use"[179], something which typically involves different types of stakeholders such as public authorities, technology providers and academia.

As with other emerging technologies in the past, some experts argue that the public sector needs take on the role of the "entrepreneurial state". This idea, coined by Mariana Mazzucato, highlights the role of the state in co-creating world-changing technology such as the internet and GPS [180]. Rather than simply relying on technology from the private sector, Mikhaylov et al. argue that government needs to "play a significant role in innovation"[181]. They argue that cross-sectoral collaborations with businesses and universities are integral to ensure that the power of AI can become a boon for the economy and society. They even point to recent policy paradigms such as the UK´s AI sector deal which has "institutionalized the partnership between government, industry and academia". Many experts point to the competence gap[182] between the public and private sectors whereby the latter has the specialization and funding to offer something such as an AI application.

More specifically, an AI Watch[183] report points to the argument that collaboration between public and private entities is desirable and likely take the form of either partnerships or procurement. It highlights 3 types of interaction in the implementation of AI solutions.

The implementation of AI solutions implies an interaction among different actors. The public sector is mainly involved in three types of relations:

- Government-to-Government (G2G). Processes between and within public organisations, like services and information transactions between the central-state government, state-local governments, and between department-level and attached agencies and bureaus.
- Government-to-Citizen (G2C). Services and information transactions by the government interacting with private users (citizens).
- Government-to-Business (G2B). Services and information transactions by the government to private organisations and other economic activities.

The report observed that 45% of AI solutions are designed to support direct interaction with the users and 43% support G2G relations of the governmental backend and public organizations. At 12%, G2B solutions were comfortably the least numerous.

Nevertheless, as a result of the complexity of AI applications, collaboration can take several forms as highlighted in the recent AI Act[184]. Understanding the complexities

[178] IBM (2023) "IBM Security Qradar SIEM): https://www.ibm.com/products/qradar-siem/addons
[179] Engler & Renda (2022) Reconciling the AI Value Chain with the EU´s Artificial Intelligence Act
[180] Mazzucato & Li (2020) The entrepreneurial State and public options: Socializing risks and rewards: https://www.ucl.ac.uk/bartlett/public-purpose/sites/public-purpose/files/final_the_entrepreneurial_state_and_public_options.pdf

[181] Mikhaylov, Esteve and Campion (2018) Artificial intelligence for the public sector: opportunities and challenges of cross-sector collaboration

[182] Mikhaylov, Esteve and Campion (2018) Artificial intelligence for the public sector: opportunities and challenges of cross-sector collaboration
[183] AI Watch (2022) European landscape on the use of AI by the public sector.
[184] Engler and Render (2022): Reconciling the AI Value Chain with the EU´s Artificial Intelligence Act

and which type of interaction will suit different scenarios in the public sector will soon become a prerequisite for public authorities looking to adopt AI applications. This is an area where information exchange and sharing of best practices is invaluable between public actors at the member state and European level.

Type 1: Internal AI development and deployment

Type 2: One entity develops an AI system for another entity (AI system contracting)

Type 3: One entity writes the code and trains the system then sells access through a branded application or API (restricted AI system access)

Type 4: A vendor writes code for an AI system but does not pre-train it or provide training data to purchasers (software with AI code)

Type 5: Vendors of learning AI systems

Type 6: initial development by one entity and fine-tuning by another (AI system-fine tuning)

Type 7: One entity integrates different AI systems into a new one (AI model integration)

Public procurement process of AI

With the complexity of AI solutions as well as the limited resources and generalist disposition of public administrations, procurement is becoming increasingly commonplace – demonstrated by the revised procurement processes of 13 member states in their National AI Strategies. As AI becomes more pervasive in the lives of ordinary citizens, member states need to be able to supply a high quality of service in line with what is provided by the private sector. As with procurement writ-large, governments rely on the expertise and previously developed models of technology providers and may lack the necessary skills to fully understand or trace algorithmic causality[185].

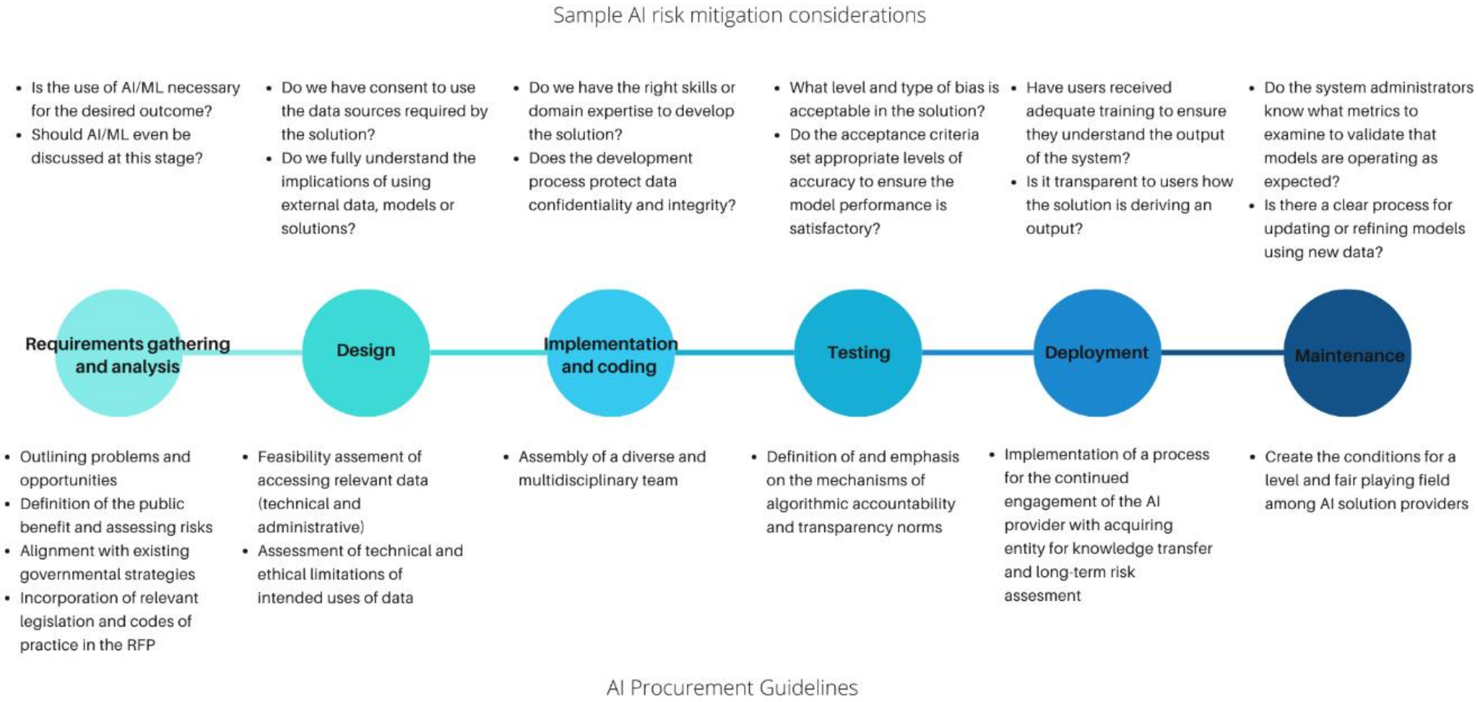
In the words of a World Economic Forum guidelines on AI procurement,[186] "technology providers understand these challenges and look to governments to create clarity and predictability about how to manage them, starting in the procurement process". While governments can build on institutional knowledge and adapt previous procurement processes, there are key considerations for the process of the procurement of AI. While there are fundamental differences between partners in the value chain, cooperation and "common sense frameworks can help governments overcome reluctance to procure"[187].

Successful procurement of AI solutions is bookended by crucial steps in the overall adoption of the technology. Before the procurement, authorities should carry out a thorough analysis of the precise value proposition of the AI solution and "should consider in-house knowledge on AI for the– partial or complete – internal development of AI, for the direction and adjustment of the system developed by external suppliers, and/or for ensuring proper management of procurement activities"[188]. Similarly, the procurement of the technology needs to be followed and backed up by successful implementation following a piloting phase with a long-term strategic vision and in-built flexibility for the continued engagement of the technology provider. The Adopt AI programme will help member states with the intricate process of AI procurement and below is a synthesis of two pieces of advice from the World Economic Forum´s AI

[185] WEF (2020): AI Procurement in a Box: AI Government Procurement Guidelines
[186] Ibid
[187] Ibid
[188] WEF (2020): AI Procurement in a Box: AI Government Procurement Guidelines

procurement in a box toolkit – the SDLC stages and some corresponding recommendations.

Figure 43: Procurement process of AI



2.2.3 Main drivers and barriers

The table below presents a PESTEL analysis of the uptake of AI technologies in public procurement in the e-government sector.

Table 3 PESTEL analysis of the uptake of AI technologies in public procurement in the e-government sector

Criteria	Drivers	Barriers
Political	• At a time of low trust in political institutions, there is a need to increase transparency, anticorruption and accountability. • Public authorities want better information to make better decisions and AI-powered tools can increase the capacity of the government to meet the needs of the population and serve them by improving the quality of decision-making. This can mean an increase in anticipatory governance and policy through more accurate predictions. Digital modelling of policy options can help make more effective governmental decisions, such as in the context of urban governance and planning. • There is high potential in the cybersecurity market which needs to see more funding for AI projects for cybersecurity.	• The growing complexity of AI solutions makes it difficult to predict their concrete impact on redefining governance. There is a lack of consensus on how to handle the challenges related to AI in the public sector as well as a scarcity of research on AI governance, policy and regulatory issues. • AI-powered eGovernment requires a re-design of existing vertical and hierarchical-oriented administrative structures. For a fruitful implementation of AI solutions in public administration, an organisational transformation is required. • An appropriate strategic approach to the implementation of AI needs to be secure and ethical which requires constant updating at the same pace as the development of the technology.
Economic	• The promise of decreased administrative burden for both administrators and society can lead to important time and cost savings. Most of the AI initiatives undertaken by public authorities are done to achieve efficiency gains. AI applications free up precious cognitive resources of public workers, which can then be allocated to tasks of higher added value.	• Adoption of AI involves a high initial set-up cost, and public resource allocation, especially in planning, programming and budgeting the resources for the public sector.

Social	• Citizens want more service efficiency and service quality which incentivises the usage of AI by public authorities. • AI applications offer new avenues of participation and to better involve citizens in planning decisions. AI systems could synthesise millions of responses and identify the most important points of view and their weighting.	• Caution is required in the implementation of AI solutions as AI can either increase or decrease trust in public authorities from their citizens. There is a need to investigate not only the impacts of AI on levels of trust but also to understand mechanisms that build the trustworthiness of AI, which is closely related to providing transparency, explainability and reliability. • Attracting a sufficient number of experts with the required communications skills by public authorities can communicate the intricacies of AI technologies.
Technological	• There is often high scalability and replicability in AI solutions. A successful solution implemented in a specific country (at the national level) can be easily adapted and applied in other countries or even at regional or European levels.	• Lack of interoperability in AI systems can be a shortcoming especially when moving beyond pilot phases. Interoperability can ensure the compatibility and integration of different data and, therefore, guarantee a smooth implementation and adoption of AI. • Many AI techniques for improved delivery in e-government are still relatively immature (except well-known solutions such as customer chatbots). In this aspect, relatively new solutions (for example neural networks for deep learning for handwriting recognition and fraud detection) need further R&D efforts. The development of appropriate technical standards and encouraging experimentation are crucial for the increase of AI deployment. • Many local government bodies or smaller communities do not have the means to be part

		of a vivid data ecosystem, which is a minimal requirement to develop AI. • The shortage of in-house knowledge on AI for the internal development, direction and adjustment of the systems developed and to ensure proper management of procurement activities. Algorithms can be biased and this might lead to erroneous suggestions that require correcting when they occur.
Environmental	• AI solutions can be used to optimize the use of resources to deliver general public services. Subsequently, the digitalisation of administrative operations can result in the minimisation of materials used and waste reduction.	• Data centres are critical for storing the large amounts of data needed to power AI systems, but demand a huge amount of energy. In addition, training advanced artificial intelligence systems, including deep learning models, can require high-powered GPUs to run for days at a time.
Legal	• Public procurement has the opportunity to take a leading role in establishing rules and technical standards for AI solutions that could be then taken and implemented by the private sector.	• There are still important concerns that require clarification and regulation related to biases, transparency and attribution of responsibilities and accountability. • A common requirement is the simplification of regulatory frameworks enabling and facilitating data sharing (for AI) which leads to improved data accessibility.

Source: Authors' elaboration based on the challenges and the value chain analysis.

Figure 44 Strengths, Weaknesses, Opportunities and Threats of the uptake and public procurement of AI-technologies in the e-government sector

S

Political will - There is general acceptance by most member states that administrative issues under the responsibility of public authorities shoykd be automatized with AI systems. The public sector presents adequate readiness and willingness to operationalize existing technologies, develop alternatives and acquire the expertise. Additionally, the involvement of citizens in planning decisions that AI applications can offer, can increase this social acceptance as inhabitants feel part of the process. However, it is crucial to adopt trustworthy AI solutions

Large amounts of data of the public sector - Governments and public organizations have large amounts of available data and the full potential of these datasets has yet to be unlocked. Across countries, initiatives to share data and open data exercises between public entities and other collaboration partners are emerging. These initiatives will ensure the ability to combine data sources and increase the validity of data. It should be considered that available data volume of smaller countries is smaller.

W

Lack of skilled workforce – There is a lack of expertise and digitally skilled employees in public authorities and AI solution providers with knowledge in governmental and administrative procedures in order to provide them efficient tools and technologies capable of answering to real needs.

Unsatisfactory data sharing across organisations – In order to achieve high volumes of data and the requirements to combine different types of data from key thematic issues is required. The absence of data standards, lack of data interoperability due to technical standards and hardware and software variations, among others, make this data sharing more complex.

Data quality and management – The outcomes of the application of AI solutions strongly depend on the quality of the input data as well as its management. In this aspect, the large volume of available data needs to be treated and organized in order to provide the required results.

O

Increase on the investment - Investment in R&D for AI technologies and the launch of pilot projects can incentivise the further development of more mature AI technologies and the scale up of the existing ones, as well as the enhancement of the cybersecurity market, which is a current need for the implementation of AI tools in the digitalization pathway of services provided by public authorities.

Bring services closer to people – Adoption of AI technologies in general public services can make those services available, inexpensive and easy to use for citizens. Additionally, AI presents the opportunity to improve interaction between citizens and governments through the provision of better and more inclusive services and the enhancement of citizen participation in the activities of the public sector.

Replicability- Adoption of AI technologies in general public services presents high scalability and replicability. A successful solution implemented in a specific country (at national level) can be easily adapted and applied in other countries or even at regional or European levels. Common needs at different levels can be addressed through the same tool by adapting it to the new environment. AI technology providers can reproduce the solution in any other entity with similar nature and necessities.

Accelerating the uptake of legal and ethical frameworks- Regulations and laws aren't keeping up with the rapid development of the technology. The adoption of AI technologies by the public sector has the potential to speed up the simplification of regulatory frameworks, as well as clarifying several aspects in terms of biases, transparency and accountability.

T

Privacy concerns - Collection, storage, disclosure, processing, and dissemination of personal data is required to power AI based solutions in general public services.

Algorithmic bias – As the usage of AI-based algorithms by public organisations increases, the possibility of amplifying discriminatory biases increases. As algorithms are implemented in heterogeneous socio-technical systems, it is important to consider the potential propagation of existing social biases across gender, race, sexuality and ethnicity.

Source: Authors' elaboration based on the challenges, value chain and PESTEL analysis.

2.2.4 Case Study: Mercè - citizen science for better urban life (Spain)

Key actors

Project User: 300.000 Km/s

Contributors: Ministry of Science and Innovation of Spain and Fundación Española para la Ciencia y la Tecnología

Supported by: Barcelona's town hall, COAC, COTEC, UrbanNext and S+T+ARTS

Goals

The Mercè project forwards a new line of work that applies new machine-learning techniques to the disciplines of urban planning, geography, sociology, economics, science and urban health to build objective knowledge and open data about urban environments. Mercè is a citizen science experiment that aims to involve citizens in the training of an algorithm that allows the design of more liveable cities. Through this experiment, it is possible to translate the individual perceptions of many citizens about the habitability of cities into objective knowledge, reusable in urban planning. The relevance and innovation of the project are based on applying information and communication technologies to different transversal fields of knowledge. The project develops a workflow based on public/open data and machine learning techniques to promote algorithmic transparency in data science and citizen participation with great social impact.

Description

Mercè is an artificial intelligence algorithm in which citizens can show their preferences and generate a knowledge bank that will make it possible to identify the patterns that exist between different opinions, making the subjective measurable and defining metrics on the qualitative to put the liability on urban agendas as something tangible. In this context, city halls have multiple challenges related to urban planning that have to be solved to make cities environments in which human life can be developed optimally: mobility, land management, the provision of the correct proportions of housing and its relationship with services and facilities, the location of economic activities, the balance with the environment and the surroundings, among others.

Therefore, liveability appears as a concept with a very high degree of subjectivity, which varies according to the cultural context and the vital condition of each person. In this line, the main challenge for the development of Mercè relied on how to measure this phenomenon.

To overcome this challenge, Mercè project experimented with new channels of digital participation to convert the subjective perception of many citizens into objective information, making the subjective measurable and defining metrics on liveability and making it something quantitative for urban agendas.

For the application of these technologies, Mercè is powered with two information sources:

- **Individual citizens** create data either from their mobile devices, through social networks, online shopping, video calls and digital photographs.
- **Administrations and private companies** generate data on their management of urban services, administrative procedures, citizens' use of their services or internal operations, and on the use of their services by citizens.

With all this information and the application of machine learning algorithms, it was possible to recognise common patterns from input data. The Mercè project applied this set of technologies to urban planning through a citizen science experiment that allowed participants to express their preferences and, thanks to an artificial intelligence algorithm, to classify these opinions and associate them with the characteristics of the urban environment according to the habitability they generate.

The next challenge was related to the training of the algorithm. The data model developed in the first part of the experiment consisted of 15,611 streets with 212 variables associated with each of them. The next step was to be able to generate a simplification of the model to maximise the participation result: if only 20% of the streets were evaluated, the number of times a citizen can vote for it increases. Therefore, the streets were clustered based on their characteristics. Another fundamental part of the training process is the design of participation: how can citizens interact in a scientific process of data classification? In this sense, they opted for an online voting app[189] whose design and operation design and operation must guarantee the participation of different groups: from an individual citizen of any age, sex and origin to a specialised public related to the subject of the experiment.

Another key pillar of the strategy of citizen involvement strategy has been to build alliances for the dissemination[190] of the project with several relevant entities in the world of citizen science and architecture.

Results

The final result of the Mercè experiment is **a map of the habitability of the city**[191] that shows us, according to five typologies, which are the most and least habitable streets. Additionally, the application of the machine learning algorithm enabled the identification of the characteristics of the most habitable streets, as well as the characteristics of the least habitable streets generating a complete report with the results[192]. In this line, streets were classified and characterised in five typologies: very unhabitable streets, not very habitable streets, streets with medium habitability, habitable streets and highly habitable streets.

According to these five typologies, the Mercè tool generates a habitability map of the city of Barcelona, in which the streets are coloured depending on their habitability. Thanks to this characterisation of the streets, the Mercè tool enables the identification of demographic patterns. If the most habitable streets are mostly residential, have little traffic and have a quality public space thanks to trees and lush vegetation, it is interesting to ask whether these urban characteristics are equally shared by men and women, young and old, locals and foreigners. The tool allows the identification of priorities and differences between gender, age and origin.

The results obtained from the Mercè project enabled the validation of the tool itself and helped the city hall of Barcelona to understand the factors that make a street more or less habitable. In this line, it helped in the identification of the less habitable streets, which can be classified as action areas, and the most habitable streets considered as real examples of what inhabitants want.

Data-informed urban planning facilitates **greater clarity in the planning process** because what motivates it and how it is formulated is expressed through parameters and conditions that have been validated, agreed upon and traceable. This means that **urban planning documents must be constructed based on concrete objectives and indicators**, which are measurable and which make it possible to determine their success or their need for reformulation. And this evaluation can also be carried out by citizens.

[189] Mercè App, link

[190] The Mercè project counted with the collaboration of the College of Architects of Catalonia, the Urban Next platform, a global content network focused on architecture and urbanism and the Ibercivis Foundation, a benchmark organisation in Spain that develops, promotes, makes visible and researches citizen science.

[191] Habitability map of Barcelona generated with Mercè tool, link

[192] 300.000 Km/s (in collaboration with Ministry of Science and Innovation of Spain and Fundación Española para a Ciencia y la Tecnología), December 2020, *Mercè- A citizen science experiment: citizens training algorithms to make more liveable urban environments*, link

Successes and Key lessons:

- **The participation and involvement of all citizens are key** to addressing the radical transformation of lifestyles that we will experience in the next decade and the challenges it entails. This participation must be accompanied by technology, making planning processes incorporate new shared standards between cities, but above all, it must be guided by the liveability of cities as the ultimate goal and driver of change.
- The aspect of giving voice to citizens ensures that the actions carried out by the public administration are in line with the needs and requirements of inhabitants. Additionally, the involvement of citizens allows strategic plans and agendas to be focused on real necessities and design pathways towards the actual challenges, which will lead to the implementation of efficient solutions and measures. In the case of the Mercé tool, it transforms urban planning and urban agendas into participatory, transparent, evaluable and fair strategies.
- **The importance of real indicators for decision making.** Mercé provides cities with a tool and a methodology based on collective and participatory artificial intelligence and open data models to build bottom-up citizen indicators that allow both the design of a more habitable city and the offer of strategies to evaluate projects, actions and urban policies already deployed.
- In this line, Mercè enables city planning that moves from using information for diagnosis to using knowledge for forecasting. The different indicators used by Mercé allow urban planning documents to be constructed based on concrete objectives and indicators, which are measurable and which make it possible to determine their success or their need for reformulation. And this evaluation can also be carried out by citizens.
- **Collaboration is crucial for the creation and later adoption of AI technologies** by public entities. In the case of the Mercè project, the tool was fully built and created by 300.000 Km/s a private architecture studio in Catalonia. However, as it was considering a strategic solution that could help in the development of urban agendas and strategies in different towns, cities and even regions, the project was supported by the Ministry of Science and Innovation of Spain and Fundación Española para la Ciencia y la Tecnología. Additionally, as the creation of the tool has taken Barcelona as the pilot city, the town hall of Barcelona has also been implied in the project.
- Furthermore, the contribution of private entities has been essential for the successful conclusion of the project, which ended up with a fully developed AI solution, Mercè. These entities supported the project from a private and specialised point of view in terms of ICT and sectorial areas that the project addresses.
- Therefore, it can be said that each entity, regardless of their nature, had a key and specific role in the project and the effective contribution among them guaranteed the creation of an efficient and highly applicable AI-powered tool.

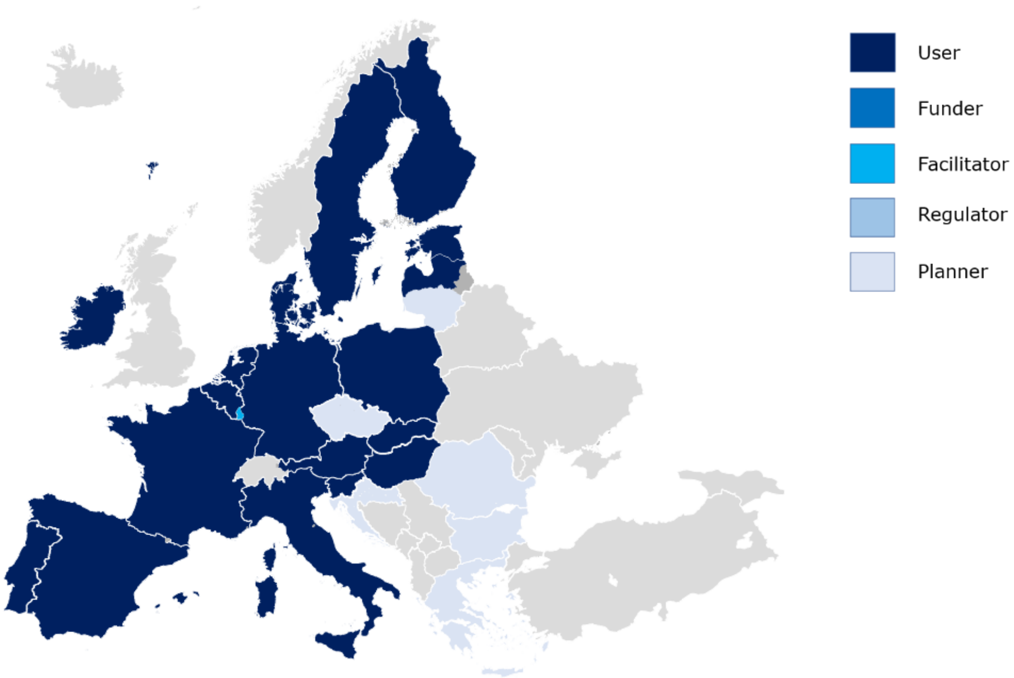
2.2.5 Economic Analysis

Proponents of AI in the delivery of public services point to its ability to increase efficiency and accessibility. The variables chosen for use in the linear regression models test these supposed benefits of AI in general public services with more efficient government. In line with Misuraca and Van Noordt´s framework in the introduction, this asks whether there is any evidence that supports the expected outcome that countries using more AI will have more digitalized public services.

The three models use the DESI´s **eGovernment** indictor group and measure citizens´ use of eGovernment services (in the last 12 months)[193]. To test the online government services accessibility, model 1 uses the "citizens´ use of eGovernment services" DESI indicator which measures: the individuals who have used the internet, in the last 12 months, for interaction with public authorities[194]. To test whether countries with more AI investment in eGovernment have better interaction with both citizens and businesses, models 2 and 3 use the DESI´s "digital public services for citizens" and digital public services for businesses" indicators. These measure the extent to which a service or information concerning service for citizens and businesses is provided online, and via a portal[195].

Figure 45 Member states typology

N.B Cyprus is categorized as a Facilitator and Malta as a planner



[193] Eurostat, Table isoc_r_gov_i: Individuals who used the internet for interaction with public authorities

[194] Eurostat, Table isoc_r_gov_i: Individuals who used the internet for interaction with public authorities

Table 4 Regression table – E-government

	Use	Citizens	Businesses
User	71.50	77.76	85.02
Facilitator	-14.25	-21.62	0.78
Planner	-23.71	-9.00	-12.89
R^2	0.28	0.16	0.18
Observations	27	27	27

*Intercept is the figure for the *User* category but also the baseline to interpret the rest of the coefficients in the model

- **Use:** AI *User* countries are the category with the highest use with 71.5% of citizens using the internet for public services. *Facilitators* have 14% lower use than *users*. *Planners,* countries with no investment in AI in general public services, have almost 24% lower use than those that have already developed AI solutions.
- **Citizens:** *Users* of AI also have the best rate of information for citizens online for "citizen life events" such as moving or small claims. With a score of nearly 78, AI *Users* are 9 points better than *planner* countries.
- **Businesses:** This trend is similar for business life events where *Users* and *Facilitators,* which are roughly the same, are nearly 13 points higher than those countries without AI in their public services.

2.3 Mobility

As streets, train carriages and airports emptied seemingly overnight, the advent of the COVID-19 pandemic served as a reminder of the everyday reliance on mobility but also as a chance to take stock of how this cornerstone of society might be improved. No longer limited to the realm of science fiction, the era of driverless cars, drone taxis and other uses of AI in the mobility space is on the horizon with the global market for AI in the sector expected to reach $3.5 billion by 2023[196].

This growth in AI-enabled mobility, defined by the ELTIS glossary as the "potential for movement and the ability to get from one place to another using one or more modes of transport to meet daily needs"[197], can be attributed to AI´s transformative potential at every level of the mobility ecosystem and multiple modes of transportation. On a

[196]Joshi (2019): How AI can transform the transportation industry: https://www.forbes.com/sites/cognitiveworld/2019/07/26/how-ai-can-transform-the-transportation-industry/?sh=16eb45374964

[197] ELTIS (2002): "Mobility": www.eltis.org/glossary/mobility

broader level, AI can help plan, design and manage mobility networks[198], processing past and real-time data to administer flows of traffic and people on road networks and public transport. AI is already being utilized for detection and prediction in areas such as aviation, with estimated more precise arrival times at Singapore´s Changi Airport[199] and road maintenance on Germany´s Deutsche Bahn[200] . In addition to infrastructure and systems, AI in mobility is also developing quickly within the modes of transport themselves, especially in the area of autonomous vehicles (AVs). In cars, lorries and buses, AVs deploy deep learning in a range of capacities including localization dynamic scene understanding, path planning, control and user interaction[201]. Even at the level of the individual user, mobility-related applications for smartphones and an increased range of micro-mobility options like e-bikes and electric scooters are already harnessing the power of AI and seem like a harbinger for an age of integrated and cleaner mobility, particularly in urban areas.

Despite the clear growth of the sector that has seen $51.5 billion invested in automotive AI alone since 2010[202], uptake is still languid in the EU with only 37.5% of respondents to an Ipsos survey[203] (for European SMEs in the transport sector) stating there were using at least 1 AI technology. Despite 55% planning to incorporate AI into their enterprise in some capacity over the next 2 years, issues that are stifling uptake in other sectors can also be found in mobility such as budget constraints[204].

To this effect, public leadership has a key role to play, especially given the current state of the sector which is highly siloed in the private sector with 76% of interactions occurring within the B2B space[205]. Up to this point, much of governmental bandwidth has been taken up by the prescient task of regulation, especially crucial given the quotidian nature of the mobility sector and the risks concerning personal safety. Indeed, at the European level, the OECD described the EU´s approach to AI ethics and regulation as "comprehensive" but also cited the need for speed and malleability, especially transient with the high pace of innovation in mobility. Lagging behind other geographies such as the US and China, the EU must go beyond regulation and play a more active role through procurement. The improvement of data infrastructure, for example, is critical given that around half of those surveyed in an EIT Mobility report highlighted poor data availability and quality as a bottleneck to the sector.

In the overall landscape of AI technologies, according to the European Investment Bank, the EU needs to fill a €10 billion gap[206] to compete with the USA and China who together currently account for around 80% of the total investment in AI and

[198]EIT Urban Mobility (2021) Urban Mobility Next #3 AI Mobility Landscape in the EU: https://www.eiturbanmobility.eu/wp-content/uploads/2021/09/EITUM-UrbanMobilityNext3_Final.pdf

[199] Lee and Miller (2019) AI gets real at Singapore´s Changi Airport https://ink.library.smu.edu.sg/cgi/viewcontent.cgi?article=1115&context=ami

[200] DB (2020) Predictive maintenance using artificial intelligence: https://www.dbsystel.de/dbsystel-en/about-us/news/Predictive-maintenance-using-artificial-intelligence-5569190

[201] Fernandez Llorca & Gomez Gutierrez (2022) Artificial Intelligence in Autonomous Vehicles: towards trustworthy system: https://publications.jrc.ec.europa.eu/repository/handle/JRC128170

[202] Cornet et al (2017) The road to artificial intelligence in mobility – smart moves required: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/the-road-to-artificial-intelligence-in-mobility-smart-moves-required

203 European Commission (2020) European enterprise survey on the use of technologies based on artificial intelligence: https://digital-strategy.ec.europa.eu/en/library/european-enterprise-survey-use-technologies-based-artificial-intelligence

[204] EIT Urban Mobility (2021) Urban Mobility Next #3 AI Mobility Landscape in the EU: https://www.eiturbanmobility.eu/wp-content/uploads/2021/09/EITUM-UrbanMobilityNext3_Final.pdf

[205] EIT Urban Mobility (2021) Urban Mobility Next #3 AI Mobility Landscape in the EU: https://www.eiturbanmobility.eu/wp-content/uploads/2021/09/EITUM-UrbanMobilityNext3_Final.pdf pdf

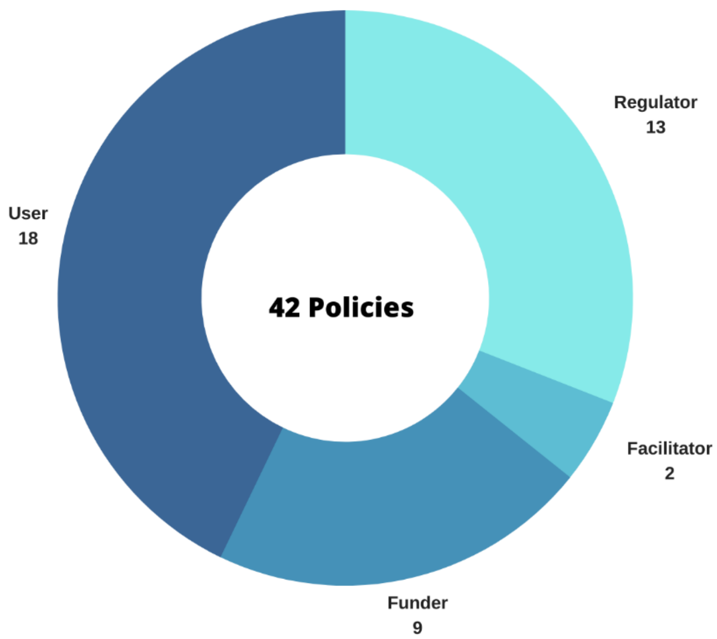
[206] EIT Urban Mobility (2021) Urban Mobility Next #3 AI Mobility Landscape in the EU: https://www.eiturbanmobility.eu/wp-content/uploads/2021/09/EITUM-UrbanMobilityNext3_Final.pdf

blockchain[207]. Globally, the mobility sector is estimated to be worth €6500 billion annually[208] and, with its enormous potential and environmental implications, should form a core pillar of the EU strategy on AI usage and value.

The policy landscape: Mobility and AI

Perhaps as expected, the OECD´s AI observatory´s policy catalogue shows that the principal regulatory focus has been on automated vehicles. Indeed, the only intervention of certain countries, such as Spain and Austria, has been limited to regulations that have passed legislation on automated driving and a code of practice (AT) and authorizations to test automated driving systems and parking systems (ES).

Figure 46 Mobility and AI – breakdown by policy mode



Source: Authors' elaboration.

With three of the top ten automotive manufacturers worldwide in terms of revenue[209], Germany´s approach to AI and mobility has been a leading example of public intervention in Europe. In 2018, rather than merely a section of a broader AI strategy, the Federal Ministry for Transport and Digital Infrastructure published a focused *Action Plan for Digitalization and AI in Mobility.* The subsequent policy outputs include a series of AI centres for mobility, a dedicated data initiative for mobility and the mFund, a €200 million programme which funds R&D projects in Mobility 4.0.

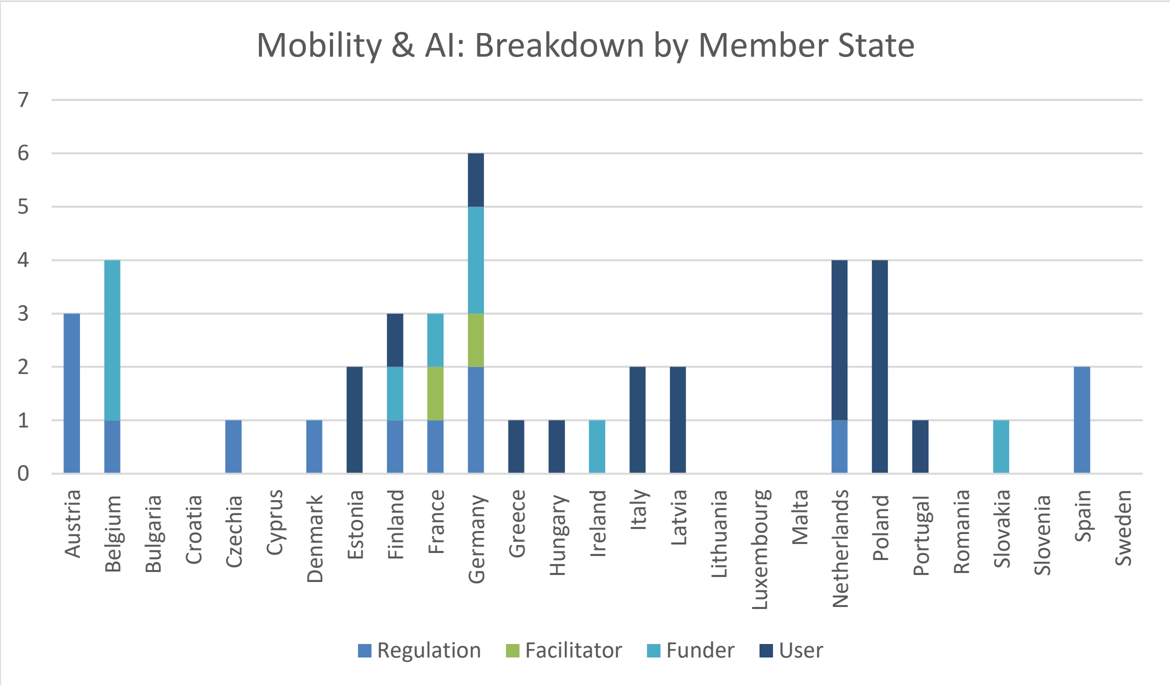
Likewise, France, Belgium and Finland have also launched procurement programmes mostly in the form of R&D or business grants through their respective innovation agencies such as Innoviris[210] (Brussels region) and the "challenges IA" initiative in France. These have focused more on providing SMEs and start-ups with a public investment such as the Brussels cooperative *urbike*[211], a project seeking to prove the viability of bicycles as a solution for the infamous last-mile problem in logistics.

[207] EIT Urban Mobility (2021) Urban Mobility Next #3 AI Mobility Landscape in the EU: https://www.eiturbanmobility.eu/wp-content/uploads/2021/09/EITUM-UrbanMobilityNext3_Final.pdf.pdf
[208] Business Finland (2018) "Smart Mobility Program Starts": https://www.businessfinland.fi/en/whats-new/news/2018/smart-mobility-program-starts
[209] Companies market cap (2023) "Top publicly traded automakers by revenue" https://companiesmarketcap.com/automakers/largest-automakers-by-revenue/
[210] Innoviris.brussels (2023): https://innoviris.brussels/
[211] Urbike (2022): https://urbike.be/

Meanwhile, countries like Slovakia and Hungary are focusing more on early-stage R&D with the Smart Mobility Lab [212]and the National Laboratory for Autonomous Vehicles[213] which link academia and industry to design and develop innovative mobility solutions.

In addition to the more recent push in national-level procurement, the concept of *living labs* in mobility is well established throughout the EU. Recognized in 2006 by the Commission and its Sustainable and Smart Mobility Strategy for Europe´s Urban Mobility. The concept seeks to encourage the development and testing of innovative mobility solutions in the real-world environment in which they would be used. Typically, these are 2–4 year projects that bring together academia/RTOs, end-users and public authorities. *Urban mobility initiatives*, including living labs, test beds and lab-like initiatives, are most numerous in Spain (25), the Netherlands (22) and Germany (18) inevitably in large urban centres such as Madrid (5), Amsterdam (4) and Hamburg (3). Taking the *City Flows* Milan living lab in the city´s Central Station as an example, a monitoring decision support system uses historical and real-time data to measure crowd movements from multiple modes of transport entering the station including two subways lines, bus and tram stop, bike, scooter, taxis and car-sharing traffic.[214]

Figure 47 Mobility and AI – breakdown by Member State



Source: Authors' elaboration.

2.3.1 Challenges and AI solutions/applications in the mobility sector

Several key trends have profoundly transformed and impacted transportation & mobility (T&M). Broadly speaking, T&M companies are faced with the need to cut costs while maintaining high-level quality for their transportation offer. For example, protectionism's impact on T&L led global airlines to slash profit forecasts out of fear of higher protectionism while M&A intensity dropped by 22.6% in the sector.[215] [216]

[212] Smart Mobility Lab (2023): https://smartmobilitylab.sk/
[213] Autonomous Systems National Laboratory (2022) https://autonom.nemzetilabor.hu/
[214] City Flows Project (2022): https://cityflows-project.eu/milan/
[215] Win-win solution, 2019, *Global airlines slash profit forecast 21% on protectionism fears,* http://win-winsolution.com/feed-items/global-airlines-slash-profit-forecast-21-on-protectionism-fears/
[216] PwC china, 2017, *Key findings from the transportation & logistics industry,* https://www.pwccn.com/en/research-and-insights/ceo20/transport-and-logistics.html

[217]Similarly, the COVID crisis caused many transportation companies to accumulate debt to maintain activities in a context of extremely limited market demand.

In addition to these difficulties, the legal and societal requirements to lower energy consumption and CO2 emissions are particularly pertinent for the transportation sector. Considerations such as reducing congestion of transport infrastructure and networks are extremely important for road and rail transportation. Even though AI applications represent a partial solution to address these challenges, the transportation industry remains relatively underdeveloped in terms of its AI progression. For example, a PwC 2016 global survey showed that only 9% of T&L companies have a dedicated data & analytics department.[218] Furthermore, 23% of surveyed companies mentioned they had no significant data analytics capabilities.[219]

Transportation players are focused on addressing their two most urgent digital challenges: improving data quality and standardising data formats. Data remains fragmented and stored in different data silos that correspond to the different transport modes that compose the industry. The harmonising data format is made even more difficult because of the poor quality of the available data (inconsistent data collection, heavy use of traditional paperwork, etc). Consequently, cross-modal efforts to address this challenge are key for the deployment of AI solutions.[220]

Figure 48 Summary of challenges and AI solutions for mobility

Public sector challenge	*Reduce costs*	*Reduce environmental footprint*	*Reduce congestion of infrastructure and networks*	*Reduce accident rates*
AI value driver	Efficiency gains through cost-cutting	Improved environmental performances	Congestion control and prediction	Road safety and accident prediction
AI applications	Smart-maintenance	Vehicle control (autonomous driving, emission control systems)	Smart traffic-management systems	Intelligent systems for visual monitoring, vehicular accident modelling
AI techniques	Computer vision	Artificial neural networks, fuzzy logic	Genetic algorithms	Expert systems

[217] PwC, 2018, *M&A in the transport & logistics industry*, https://www.pwc.com/sg/en/publications/assets/transport-logistics-ma-2018.pdf
[218] PwC, 2016 (B), *2016 Global Industry 4.0 Survey, transportation and logistics key findings*, https://www.pwc.se/sv/pdf-reports/industry-4-0-building-the-digital-enterprise.pdf
[219] PwC, 2016 (B), *2016 Global Industry 4.0 Survey, transportation and logistics key findings*, https://www.pwc.se/sv/pdf-reports/industry-4-0-building-the-digital-enterprise.pdf

[220] YourEdi-Transmetrik, 2018, Big Data and big roadblocks: how the logistics industry can overcome its big data challenges, https://www.youredi.com/blog/logistics-industry-can-overcome-big-data-challenges and International Journal of logistics systems and management, 2019, Challenges and opportunities for logistics *standardization in Asia-Pacific countries: a descriptive case-study,* https://decisionsciences.org/wp-content/uploads/2019/06/p584364.pdf

Efficiency gains through cutting costs

AI offers solutions and opportunities for efficient cost-cutting strategies in most transport modes. Uses include such as last-mile delivery robotics,[221] fleet management solutions, AI solutions for less-than-truckload optimisation[222], automation of client-facing interfaces, smart maintenance, etc.[223] Smart infrastructure.

In this sector of the economy, public and private mobility providers are confronted with the daunting challenge of having to cut their costs to remain competitive while providing the same level of service at the same or higher quality level. Despite this, the level of uptake of AI solutions that could help achieve this complex goal can greatly vary due to factors such as a lack of business incentives for greater uptake of AI solutions or a lack of IT infrastructure to enable faster deployment.

Development of trans-modal solutions and transfer (e.g., fleet maintenance and autonomous vehicles solutions from the automotive to railway sector) could generate economies of scale and increase the market potential for the development of new solutions. Public procurement will have to play the leading role in the railway industry for cost-cutting strategy. This is because public authorities are the main actors in both operating the infrastructure and rolling-stock in railway ecosystems. Greater interoperability and transfer of technologies from road transport could greatly benefit the rail sector.

In air, road and maritime transport, public procurement of advanced AI systems for smart infrastructure is expected to generate important cost-cuts. This is the case of automated ports for berth activities and optimisation of routes. Smart infrastructure would also accelerate the deployment of new innovate solutions from private players and generate new market opportunities (e.g., start-ups to provide machine learning and automated analytics for port and road fleet management).

Use Case: Efficiency gains	
Deutsche Bahn smart maintenance	This rail giant uses computer vision from a network of cameras and sensors to inspect the roofs of trains, relieving employees and reducing the time "from several hours to a few minutes".[224] Furthermore, DB is currently testing AI processes, for example, to predict material requirements in the factories or the right time to maintain or replace wheelsets which further increases vehicle availability.

Improved environmental performances

The challenges raised by key environmental questions are central to the future of mobility. Transport accounts for 27% of greenhouse gas emissions, the majority of

[221] Last-mile delivery represents a disproportionate share of time and expenses for the T&L road value chain. Aside from sharing apps, R&D initiatives also explore robotics solution to automatise this segment of the value chain. InsiderIntelligence, 15/04/2022, *The challenges of last mile delivery*, https://www.insiderintelligence.com/insights/last-mile-delivery-shipping-explained/

[222] Less-than-truckload represents an important burden for road transport. Loading a truck with several shipments causes much more complexities to organise delivery and quickly escalating costs.

[223] For example, empty fleet management in shipping represents 8% of operational costs and remains under-digitalised. AI solution could generate quick and important savings and optimisation. Cloud one, sin dato, *AI Case study 3: cost-saving AI in manufacturing logistics*, https://www.tradecloud1.com/en/ai-case-study-3-cost-saving-ai-in-manufacturing-logistics/

[224] Global Railway Review (2021) "Deutsche Bahn expands use of artificial intelligence to improve punctuality": https://www.globalrailwayreview.com/news/123981/deutsche-bahn-artificial-intelligence/

which (71.7%) stems from road transport.[225] Artificial intelligence can greatly contribute to decreasing the environmental impact of mobility. For example, a pilot test in Pittsburgh showed that smart traffic-management systems could reduce travel time by 25% and cut polluting emissions by up to 21%.[226]

Applications such as Intelligent Travel Systems (ITS) offer this type of environmental upside. However, on top of their potential for the reduction of CO2 emissions, modernised infrastructure is a prerequisite for the uptake and deployment of autonomous vehicles in Europe. Clear marking for smart cars, a new 5G communication network and transmitters installed on the transportation grid are necessary for an autonomous car to show its entire potential.[227]

However, the implementation and deployment of Intelligent Transport Systems (ITS) greatly differ between countries in Europe. South-East European countries, for example, have a different level of deployment with difficulties in integrating (interoperability) with other levels (cross-national and European integration).[228]

Several measures could help the modernisation of transport networks across Europe and the standardisation of smart systems for the deployment of autonomous vehicles across borders. Machin et al highlights several other AI applications focused on environmental benefits such as fuel efficiency:

• Anti-lock braking systems

• Lateral and frontal control of vehicles

• Adjusting trajectories in Remotely Operated Vehicles (ROV)

• Parameters optimization for unmanned vehicles

• Stability improvement in vehicles

• Optimization of vehicle suspension systems

• Minimize consumption and emissions of Plug-in Hybrid Electric Vehicles (PHEVs) and Electric Vehicles (EVs)

• Human-knowledge integration into Automatic Guided Vehicles (AGVs)

Use Case: Improved environmental performances	
HOPU	The HOPU solution brings a suite of dashboards with CO2 indicators related to mobility founded on predictive models based on real-time air quality measurements and AI to optimise the traffic flows in cities and ports over FIWARE open platform It allows third parties to provide high-value green and innovative mobility services for citizens, companies, and public

[225] EEA, 18/12/2020, *Greenhouse gas emissions from transport in Europe*, https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-12#:~:text=In%202017%2C%20transport%20(including%20aviation,increased%20by%200.7%20%25%20in%202018.

[226] Sacyr, sin dato, *Smart traffic lights to reduce air pollution*, https://www.sacyr.com/en/-/semaforos-inteligentes-para-reducir-la-contaminacion#:~:text=The%20pilot%20tests%20in%20Pittsburgh,emissions%20by%20up%20to%2021%25.

[227] EC, May 2017, *Public Supports measures for connected and automated driving*, https://op.europa.eu/en/publication-detail/-/publication/0f3e5c98-66ad-11e7-b2f2-01aa75ed71a1/language-en

[228] Rijavec Robert et all, January 2013, *Intelligent Transport Systems deployment and integration in South East Europe*, *https://www.researchgate.net/publication/270571783_Intelligent_Transport_Systems_deployment_and_integration_in_South_East_Europe*

	administrations. This tool is focused on the decision-makers, providing a set of functionalities to analyse and simplify large amounts of data related to mobility and its impact. By leveraging high-value open data, private data and satellite data sets available in the cities, this process provides a context for the real-time data that allows the definition of new correlations and, for that reason, new mobility and urban design aspects that affect air quality.[229]

Congestion control and prediction

Experts estimate around €100 billion in costs could be saved from traffic congestion annually if traffic management systems could be improved[230]. This improvement would have other positive externalities such as a decrease in the number of accidents (decreasing the human-factor in driving decisions, which is responsible for 90% of all crashes) and lower emissions.

AI systems have the potential for improvement in traffic management that are far-reaching such as forecasting demand, identifying passenger behaviour, automating cumbersome tasks, help to design transport systems and networks.[231]Even though the different transportation modes (maritime, airway, road and railway) are differently affected by the challenges and difficulties related to traffic management systems, all modes require a ramp-up in investments and the acquisition of new systems. In some cases (e.g., port management and road management system) new technologies are lacking and require new R&D investments (e.g., new sensors for an automated train in opened areas). Cross-modal collaboration through an open ecosystem (data exchange between connected infrastructure across the entire value chain) and technology transfer (e.g., application of automated vehicles for rail) could improve the network utilisation rate and decrease costs. The creation of an "Information Vessel" could exchange along the entire value chain from a cross-modal perspective. Documents for the transportation of merchandise can be hundreds of pages long and cumbersome. [232] [233] There are efforts to standardise Electronic Data Interchange Systems (EDI).[234] However, these approaches are too focused on B2G exchange, leaving aside B2B documents that entail much more information and data. A bottom-up approach should be preferred, including supporting the upscaling of initiatives already launched by the industry (E.g., the ECLIC initiative in chemical transportation). Areas of smart traffic management are not sufficiently investigated or acquired. This is the case, for example, of smart parking management. Machin et al. provide a list of the most common AI topics in this area:

- Traffic flow prediction in urban networks (short and long terms)

[229] EIT Urban Mobility (2021) Urban Mobility Next#3 AI mobility Landscape in the EU https://eit.europa.eu/sites/default/files/eitum-urbanmobilitynext3_final.pdf

[230] Optimisation of transportation grid could generate savings of approximately €100 billion annually by improving trafic congestion. European Parliament, January 2021, *Artificial Intelligence in Road Transport cost of non-europe report*,

[231] European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[232] Transinfo, 2019, *Standardisation in logistics is the inevitable future*, https://trans.info/en/standardisation-in-logistics-is-the-inevitable-future-sscc-number-can-make-things-a-lot-easier-162905

[233] Wartsila, 2019, *Blockchain: the case for digitalising shipping,* https://www.wartsila.com/twentyfour7/innovation/blockchain-the-case-for-digitalising-shipping

[234] International Journal of logistics systems and management, 2019, *Challenges and opportunities for logistics standardization in Asia-Pacific countries: a descriptive case-study,* https://decisionsciences.org/wp-content/uploads/2019/06/p584364.pdf

• Vehicles speed and route prediction

• Traffic volume prediction

• Route planning to avoid traffic jams

• Reduction of the time stopped at intersections

• Traffic signals control

• Traffic congestion reduction

Use Case: Congestion Control	
Siemens mobility – forecasting traffic and optimise logistics	AI's processing, control and optimisation capabilities have been applied to traffic management and decision-making systems to enhance and streamline traffic management and make our roads smarter, i.e., smart traffic light systems[235]. The project uses AI to optimise traffic light control and reduce the waiting time at an intersection. Simulations suggest it can decrease waiting times at lights by up to 47% compared to a traditional pre-timed signal plan.

Road safety and accident prediction

Improvements in the management of the traffic system in conjunction with in-vehicle AI technologies would have other positive externalities such as a decrease in the number of accidents (decreasing the human-factor in driving decisions, which is responsible for 90% of all crashes) and lower emissions. [236] Machin et al. highlights 3 principal ways in which AI can increase road safety and reduce accidents: prevention of traffic accidents, analysis and processing of the circumstances that cause accidents and the mitigation of the severity of accidents[237].

Risks posed by driver behaviour, traffic, the state of the roads and considerations such as weather are data points which can be gathered by sensors in the vehicle and processed using AI whether that be fuzzy logic or artificial neural networks – the two most used AI techniques in this area per Machin et al. More specifically they forward a list of systems and applications for increasing road safety which can be seen below:

• Intelligent systems for visual monitoring

• Vehicular accident modelling

• Accident frequency analysis

• Determining the causes of the accident

• Traffic accidents evaluation

• Driver fatigue detection

• Dangerous driving identification

[235] EIT Urban Mobility (2021) Urban Mobility Next#3 AI mobility Landscape in the EU https://eit.europa.eu/sites/default/files/eitum-urbanmobilitynext3_final.pdf

[236] Optimisation of transportation grid could generate savings of approximately €100 billion annually by improving trafic congestion. European Parliament, January 2021, *Artificial Intelligence in Road Transport cost of non-europe report*, https://www.europarl.europa.eu/RegData/etudes/STUD/2021/654212/EPRS_STU(2021)654212_EN.pdf

[237] Machin, Mirialys & Sanguesa, Julio & Garrido, Piedad & Martinez, Francisco. (2018). On the use of artificial intelligence techniques in intelligent transportation systems. 332-337. 10.1109/WCNCW.2018.8369029.

• Automatic incident detection

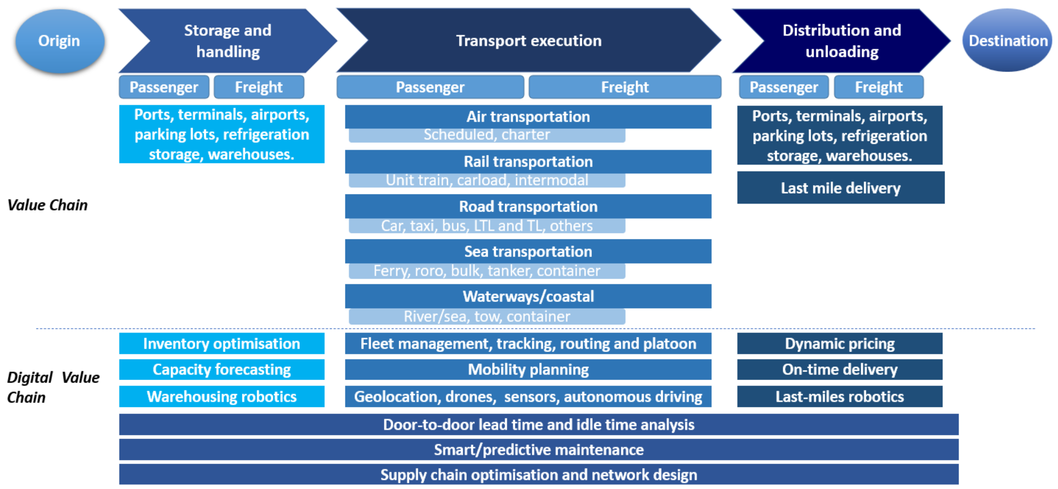
• Automated braking systems

Use Case: Road Safety	
AI Aware – Predicting and prevention road crashes with AI	Using predictive AI algorithms, this collaboration between Volvo Car Corporation, HERE, Carmenta Automotive, Ericsson, Zenseact, Trafikverket and the Gothenburg City and Swedish Transport Association, to detect when there is a risk of a vehicle colliding with another vehicle, a pedestrian or other obstacle. It then sends predictive alerts to vehicles to prevent the crash from happening[238].

2.3.2 Value chain analysis

Schematically, the transportation & mobility value chain can be divided into three stages between the origin and the point of destination: "storage and handling", transport execution" and "distribution/unloading". The value chain is dominated by the execution stage, which globally represents revenues of €2.3 trillion for a total world market of €2.7 trillion. Road transport represents the biggest part of this segment at €1.4 trillion. Sea transport ranks second with €312 billion in revenue (€199 billion for the container, €60 billion for tanker and €51 billion for bulk).[239]

Figure 49 Transportation and mobility – value chain



Source: Three steps logic from L.E.K., other elements from author's elaboration.

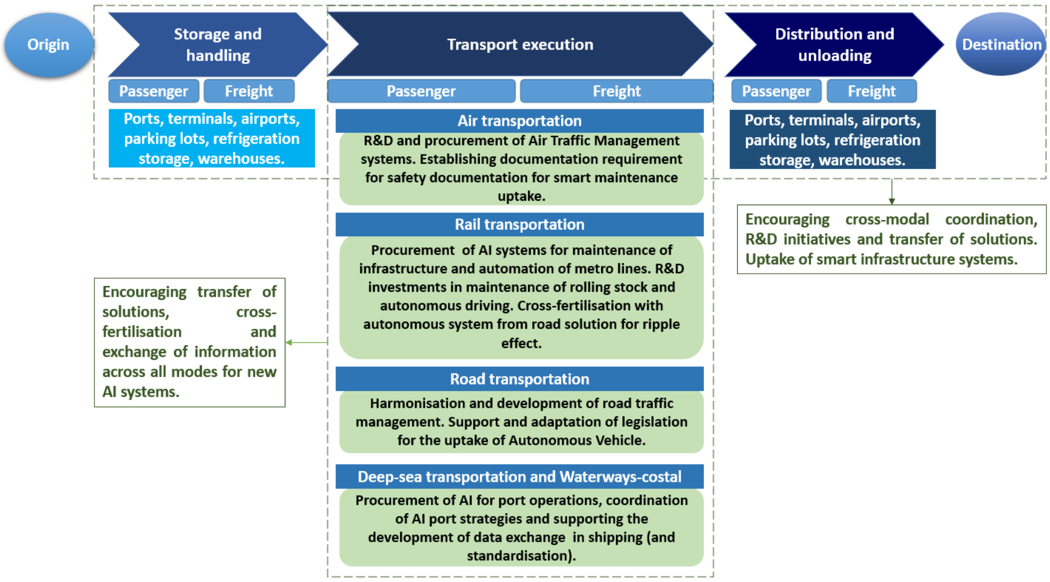
Equally important is the modal split for the organisation of the transportation & mobility industry. Road, airway, railway and maritime transport face very different challenges and realities. Furthermore, the competitive nature and type of players operating differ across transportation modes. Maersk, for example, is a very large and important company for sea transportation but has virtually no operation in the land and rail segment. Consequently, the analysis examines each mode separately. For each mode, infrastructure and vehicle fleet will be looked at separately. Closely linked, these two elements face different challenges and are also operated by different types of operators. The state typically plays a much more important role on the

[238] Drive Sweden (2020) "AI Aware": https://www.drivesweden.net/en/project/ai-aware

[239] In a "T&L (Transportation & logistics) perspective, the postal segment would have to be added. BCG, 2016, *Transportation and logistics in a changing world*, https://www.bcg.com/publications/2016/corporate-development-finance-value-creation-strategy-transportation-and-logistics-in-a-changing-world.aspx

infrastructure side (funding, organising, or directly owning them)[240]. The different opportunities and recommendations presented in this section are displayed in the figure below.

Figure 50 Summary of conclusions for value chain analysis.



Source: Three steps logic from L.E.K., other elements from author's elaboration.

Road transportation

Road transportation is the segment that displays the most potential for AI applications with rapid progress being made even though the uptake of AI solutions is focused mostly on vehicle fleets.

Indeed, AI systems for road transportation already exist and represent attractive opportunities for operators and companies: "AI systems applied in the transport sector can already now detect patterns in a large volume of data and model complex solutions that enable increased efficiency in decision making and better resource allocation. For example, AI technologies are used for 'real-time or predictive matching of supply and demand for rides or goods, predicting traffic speeds or dangerous road segments and behaviours, and managing supply chains".[241]

Most expectations and efforts to develop AI in road transportation are focused on autonomous vehicles and the deployment of smart traffic management systems. Consequently, most of the initiatives and projects led by the EC are focused on enabling the deployment of CAVs (Connected and Autonomous Vehicles), e.g.,

[240] In T&L, infrastructure is the first stage on which the rest of the T&L pyramid is built and it is also the most asset-intensive one. The second stage includes the logistics execution players, which entails relatively important asset-intensity as it requires owning and operating a transportation fleet. The third stage includes the freight forwarder and the contract logistics. Contract logistics providers usually cover all the T&L activities while freight forwarders cover the steps ranging from picking up to delivery, thus leaving aside warehousing and other services. The freight forwarder and contract logistics allow their customer to outsource a larger share of their T&L activities, however, they do not directly own assets but rather rent or subcontract them. The fourth and final stage is advisory services that require only regular offices and a very low asset-intensity. These players are focused on optimising and outsourcing activities but not on directly operating T&L processes or owning assets. BCG, 2016, *Transportation and logistics in a changing world,* https://www.bcg.com/publications/2016/corporate-development-finance-value-creation-strategy-transportation-and-logistics-in-a-changing-world.aspx

[241] European Parliament, January 2021, *Artificial Intelligence in Road Transport cost of non-europe report*, https://www.europarl.europa.eu/RegData/etudes/STUD/2021/654212/EPRS_STU(2021)654212_EN.pdf

updating and developing cooperative intelligent transport systems (C-ITS), including digital traffic management systems.[242]

However, greater effort is needed to address the "EU-level liability on AI and on enhancing the trust of users of AI in the road no further action is taken at the EU level on liability in AI and on enhancing the trust of users of AI in road transport could amount to between €231 097 and €275 287 million, were none of the gaps and barriers analysed addressed. This EU action would be also beneficial for employment and could create between 5,181 and 6,147 million jobs".[243] Aside from autonomous vehicles, several other main areas for the uptake of AI solutions can be identified in the Road transport segment:[244]

- Truck platooning;
- Road traffic management;
- Automated traffic lights;
- Sharing ride platforms;
- Automated vehicles and last-mile delivery;

As public authorities do not operate fleets or fleet management systems themselves, there is a limit in terms of what public authorities can achieve through direct procurement. Moreover, road transportation is a very competitive and dynamic market where investments from the private sector are already very important.[245]

Most efforts should therefore be concentrated on the legal framework, infrastructure modernisation and digital seamlessness. In that regard, numerous projects already exist in the field with Horizon funding and other initiatives such as the development of electronic freight transportation documents. [246]

An overhaul is necessary to revise existing liability legislation, cybersecurity, and ethical framework for trustworthy AI and to develop a "common approach to liability rules and insurance for connected and autonomous vehicles"[247] Acceleration of the adoption curve of CAV generated by revised EU liability framework could generate around €148 billion in added-value. "EU joint legislative action on ethical standards for AI systems could 'boost the internal market and establish an important strategic advantage" representing a potential gain of "€294.9 billion in additional GDP and 4.6 million additional jobs by 2030." [248]

[242] Autonomous vehicles could increase EU's GDP by 5.3% for the 2016-2050 period and generate €17 trillion of income for the same period. Most of the gains would come from improvements of internal processes and overall functioning of the transportation sector. Moreover, CAVs could generate reduction in fuel consumption, CO2 emissions (by 1.2% annually) and improve road safety. Optimisation of transportation grid could generate savings of approximately €100 billion annually by improving traffic congestion. European Parliament, January 2021, *Artificial Intelligence in Road Transport cost of non-europe report*, https://www.europarl.europa.eu/RegData/etudes/STUD/2021/654212/EPRS_STU(2021)654212_EN.pdf

[243] European Parliament, January 2021, *Artificial Intelligence in Road Transport cost of non-europe report*, https://www.europarl.europa.eu/RegData/etudes/STUD/2021/654212/EPRS_STU(2021)654212_EN.pdf

[244] European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[245] The total global investment in autonoumous vehicle only already exceded $200 billion in 2022. Forbes, 14/02/2022, *Autonomous vehicles and their impact on the economy*, https://www.forbes.com/sites/forbestechcouncil/2022/02/14/autonomous-vehicles-and-their-impact-on-the-economy/?sh=53f9202f60de

[246] European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[247] European Parliament, January 2021, *Artificial Intelligence in Road Transport cost of non-europe report*, https://www.europarl.europa.eu/RegData/etudes/STUD/2021/654212/EPRS_STU(2021)654212_EN.pdf

[248] European Parliament, January 2021, *Artificial Intelligence in Road Transport cost of non-europe report*, https://www.europarl.europa.eu/RegData/etudes/STUD/2021/654212/EPRS_STU(2021)654212_EN.pdf

Efforts are already granted for the deployment of smart national road infrastructure systems. However, cross-borders interoperability and cross-model interoperability are still missing. Furthermore, most efforts are focused on B2G exchanges and leave aside B2B, which represents both more data and more market potential for new applications.

Rail

Passenger and freight segments of railway transportation are displaying different dynamics. Passenger traffic is growing on average by 1.7% per year while freight volume still hasn't fully recovered from its 2009 drop. The railway is an energy-efficient mode of transportation and only accounts for 2% of the total EU energy consumption in transport and only 0.5% of CO2 emissions. Contrastingly, rail transported 12.2% of all freight and 6.6% of all passengers in 2016. [249]

The main challenge for the rail business model is the competition from road transportation and the pressure it represents on its competitiveness and prices. Indeed, rail freight is more expensive than road freight. Furthermore, the revenue generated by passengers decreased with the number of kilometres. [250] In addition, the sector suffers from a lack of competitiveness caused by the lack of interoperability and cross-border cooperation between rail operators.[251]

Consequently, railway operators must focus on cost leadership strategy without jeopardizing quality, something that AI systems can contribute to.[252][253] However, railway operators also have to simultaneously address the congestion of their network in the context of growing traffic. Aware of these difficulties, public authorities have increased their investment in railway infrastructure, rising from €29 billion in 2011 to € 50 billion in 2015 (for both maintenance and improvement of infrastructure). The European Fund for Strategic Investments represented €3.5 billion of that sum.[254] Nonetheless, European rail infrastructure tends to be much older than in other regions, leading to more important costs and difficulties in fully modernising them.[255]

AI can apply to each process involved in operating railways, including chatbot to assist customers, smart ticketing for demand forecast, robotics in railway and maintenance (e.g., drone for track monitoring and automated inspection), predictive maintenance, warehouse robotics, etc. However, despite the potential represented by AI to address

[249] European Commission, February 2019, *Sixth report on monitoring development of the rail market,* https://transport.ec.europa.eu/system/files/2019-02/staff_working_document_-_6th_rmms_report.pdf

[250] Rail passenger remains domestic and its share in all modes grew from 7% in 2007 to 7.6% in 2016 — even though personal care remains above 80% of all transport. Freight volume remains important at 17% but show some decline compared to road. Track access charges represent 80% revenues for railway operators, this represents less than €3 per train-kilometre in average in the EU. Shift2Rail, 8/12/2021, *Summary of existing relevant projects and state-of-the-art of AI application in railways,* https://www.researchgate.net/publication/352440235_RAILS_Project_Deliverable_D12_Summary_of_existing_relevant_projects_and_state-of-the-art_of_AI_application_in_railways

[251] European Commission, February 2019, *Sixth report on monitoring development of the rail market,* https://transport.ec.europa.eu/system/files/2019-02/staff_working_document_-_6th_rmms_report.pdf

[252] UIC, March 2021, *Artificial Intelligence case of the railway sector,* https://uic.org/IMG/pdf/artificial_intelligence_case_of_the_railway_sector_state_of_play_and_perspectives.pdf

[253] Shift2Rail, 8/12/2021, *Summary of existing relevant projects and state-of-the-art of AI application in railways,* https://www.researchgate.net/publication/352440235_RAILS_Project_Deliverable_D12_Summary_of_existing_relevant_projects_and_state-of-the-art_of_AI_application_in_railways

[254]Typically, public authorities currently focus their efforts on public service obligations followed by international passenger's flow and freight services. European Commission, February 2019, *Sixth report on monitoring development of the rail market,* https://transport.ec.europa.eu/system/files/2019-02/staff_working_document_-_6th_rmms_report.pdf

[255] Interview with a representative from a standardisation body in railway.

the challenges met by railway operators, there is a lack of market uptake for these solutions.[256]

Mainly, two areas can be identified as especially attractive for railways: "Intelligent train automation" (ATO) and predictive maintenance. ATO transfers train control responsibilities from the driver to the computer (with different levels of attribution based on the level of automation). To deploy ATO on a larger scale in Europe, the development and deployment of European rail traffic management systems (ERTMS) aimed at harmonising rail control systems is an absolute prerequisite.[257] However, more R&D is necessary to make these systems applicable in open areas and not solely in the closed metro environment.[258]

Predictive maintenance is another promising field for AI applications in Railways. Especially on the infrastructure side. [259] Rail infrastructure is more mature with a higher level of digitalisation meaning that data are already there to implement AI-led predictive maintenance applications. Rolling-stock, however, is less mature and requires more R&D development (for instance, to create a solution to identify wheel tread defects).[260] [261]

One uniquely European difficulty for wider uptake of AI solutions is the fragmentation of its rail market causing a lack of interoperability. Operators sometimes have to "guess" what systems and standards are used in another country as each operator has its ticketing systems, applications, etc. This is a very important challenge as AI systems require a high volume of good-quality data to be efficient. Without this, Machine Learning and AI applications are impossible. Consequently, the Shift2Rail initiative was therefore launched to develop a common interoperability framework at the European level. [262]

The competitive dynamics within the railway sector also cause difficulties in encouraging wider uptake. Railway operators are competing with road transportation rather than with other railway companies. Consequently, investing more efforts in achieving higher interoperability and sharing data is sometimes perceived more as an expensive and complex administrative burden. Developing new incentives to

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[256] UIC, March 2021, *Artificial Intelligence case of the railway sector,* https://uic.org/IMG/pdf/artificial_intelligence_case_of_the_railway_sector_state_of_play_and_perspectives.pdf

[257] European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[258] "*In addition to ensuring technical compatibility between national rail systems, the ERTMS combined with ATO can reduce rail operators' costs and energy consumption, and increase rail speed (up to 500 km/h), punctuality, safety and line capacity*." European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[259]Upgrade and maintenance of infrastructure should focus on switches which "are the most critical part of the rail infrastructure, causing approximately 20% of infrastructure-related delay minutes [of the trains] and costing €12bn a year globally to maintain and replace". UIC, March 2021, *Artificial Intelligence case of the railway sector,* https://uic.org/IMG/pdf/artificial_intelligence_case_of_the_railway_sector_state_of_play_and_perspectives.pdf

[260] UIC, March 2021, *Artificial Intelligence case of the railway sector,* https://uic.org/IMG/pdf/artificial_intelligence_case_of_the_railway_sector_state_of_play_and_perspectives.pdf

[261] For example, SNCF in France started to use predictive maintenance to pantographs and enable to forecast 80% of all catenaries incidents (the piece that supply electricity to the train) and reduce incidents related to train switches by around 30%. Ongoing project are developing the possibility for train to transmit "health diagnostic" to the fleet supervisor. We can also mention Devices for long-term assessment of asset performance and development of digital twins (e.g., the Rete Ferroviara Italiana developed digital twinning for its network). European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[262] CARSA et al, 02/12/2021, *Industry agreements in current value chain*, https://op.europa.eu/en/publication-detail/-/publication/8c021023-53ee-11ec-91ac-01aa75ed71a1/language-en

encourage Door2Door logistic competitiveness would be the key to encouraging more uptake from railway operators. [263]

Railway infrastructure remains mainly state-owned and 70% of investment in infrastructure still comes from national budgets. [264] Furthermore, train operators face "Public Service Obligations" for their operations while the state-owned or formerly owned company still represent the main operator in most countries (100% of market operation in France for example).[265] This situation leads to low competitive intensity in the market. Public authorities will have to play the leading role in purchasing, installing and deploying AI solutions for rail. ATO and predictive maintenance are the most interesting areas to focus investments and acquisitions. More R&D efforts are needed to tackle specific barriers such as the lack of technical solutions for the maintenance of rolling stock and implementation of ATO in open areas. [266]

To generate a greater ripple effect and potentially decrease costs, the development of cross-modal collaboration and development has to be explored. Few examples exist yet the railway industry could benefit from solutions developed in road transportation for autonomous vehicles. Joint research efforts and transposition of these solutions in the rail sector is an interesting lead to explore, especially for cross-modal barriers to AI such as in cybersecurity, modular warehousing robotics, workforce upskilling, etc. [267]

The fragmentation of the European market is a barrier to business competitiveness and the deployment of AI solutions. Greater interoperability is a key prerequisite for the development of new AI applications in the railway. Legislation on the B2B and B2G side of data exchanges and interoperability is needed. These legislations should focus on making exchanges and interoperability mandatory while leaving aside the technical question to railway operators. [268] Data sharing however also involves the question of data sovereignty. Something that could be protected, for example, through the development of a data space specific to railway operations or if the operator (data owner) is left in charge of sorting who can access and use their data.

Maritime

Sea trading represents 76% of Europe's external trade. Some 90% of all of the goods consumed were shipped at some point in their value chain and the EU shipping industry represents a total of €147 billion.[269] These figures highlight the importance taken of maritime transportation for all industrial sectors and the European economy as a whole.

As for other transportation modes, shipping vessels have turned into data factories with the deployment of new digital solutions such as radar, electronic navigation

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[263] CARSA et al, 02/12/2021, *Industry agreements in current value chain*, https://op.europa.eu/en/publication-detail/-/publication/8c021023-53ee-11ec-91ac-01aa75ed71a1/language-en

[264] European Commission, February 2019, *Sixth report on monitoring development of the rail market,* https://transport.ec.europa.eu/system/files/2019-02/staff_working_document_-_6th_rmms_report.pdf

[265] McKinsey, October 2019, Navigating the EU rail-market liberalisation, https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/navigating-the-eu-rail-market-liberalization and McKinsey, July 2019, *The liberalisation of the EU passenger rail market*, https://www.mckinsey.com/~/media/mckinsey/industries/travel%20logistics%20and%20infrastructure/our%20insights/navigating%20the%20eu%20rail%20market%20liberalization/the-liberalization-of-the-eu-passenger-rail-market-vf.pdf

[266] improvement of asset geolocalisation is necessary for automation of trains. Improved sensors have a range of 50-70 meters while shorter range of 1-5 meters are needed to roll in opened area (currently under development by the SNCF and the French Space Agency). European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[267] European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[268] Interview with a representative of a European public railway company.

[269] ECSA, 2019, *European Shipping sets ambitious goals for its next chapter*, https://www.ecsa.eu/sites/default/files/publications/ECSA%20-%20Priorities%202019-2025.pdf

charts, autopilot systems, wave radars, oil-spill detectors, and high-accuracy sensors.[270]

Pressured by the fear of protectionism and the lasting consequences of the 2008 crisis on their profitability, shipping actors have ramped up their efforts in increasing the digitalisation of their value chain and operations mainly to achieve greater cost-efficiency and increasing competitiveness.[271]

However, several important differences with other sectors can be observed. For instance, automated shipping is of low interest to shipping companies as it would involve developing a new business model. Instead, shipping companies are especially interested in the development of AI for data utilisation for smart shipping to optimise operations, and onboarding and increase cost-efficiency.[272] [273]

This strategy led to the development of cooperation initiatives for the development of common standards and sharing ecosystems (E.g., the Blockchain in Transport Alliance). However, technology uptake greatly varies between countries and shipping companies. Non-EU European countries, for example, have a much lower uptake of distributed ledger and less modern ICT systems.[274] This fragmentation, in turn, creates a lack of interoperability and difficulty for B2G and B2B data exchanges (something necessary to enhance data utilisation).

Automatic Identification Systems (AIS) have been developed to streamline B2G and infrastructure to vessel data exchanges (including data about the ship's identification number, position, course, speed and destination). Datasets that represent the important potential for analytics and that are still under-used so far.[275] On the infrastructure side, the "smart port" concept has arisen for the digitisation and organisation of activities on the port (including loading and unloading). In total, the port call optimisation platform (such as the one implemented in Rotterdam) can use AI to reduce waiting times by 20%. However, challenges remain for wider implementation stemming from low data quality and quantity (erroneous data from human or sensor mistakes).[276]

Similarly, port activities could benefit from greater automation and standardisation. However, there is a lack of market demand for these solutions and no genuine Europe-wide coordination. Most efforts and investments are done at the port level and then coordinated through port alliances or cooperation. Most of the discussions on the matter still take place at a high level while there is still a lack of implementation and understanding of what field applications could achieve for the industry. [277]

[270] European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[271] This however does not mean that AI-support to pilots won't be created. But full automation is not the focus of shipping companies. Ichimura Yuki et all, March 2002, *Shipping in the era of digitalisation, https://www.sciencedirect.com/science/article/pii/S2666954422000023*

[272] Ichimura Yuki et all, March 2002, *Shipping in the era of digitalisation, https://www.sciencedirect.com/science/article/pii/S2666954422000023*

[273] We can however name the NOVIMAR and MUNIN projects in Europe for the development of "shipping vessel platooning" and autonomous ships. European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[274] Kapidani Nexhat et all, 15/09/2020, *Digitalisation in developing maritime business environments towards ensuring systainability*, https://www.mdpi.com/2071-1050/12/21/9235

[275] Initiatives were also launched to simplify exchange of information between ships and port for electronic freight transport information and cross-border operations. Advanced use could help to gain in energy efficiency, detection of anomalies, navigation optimisation, predictive maintenance, traffic congestion and forecasts for bunker needs. European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[276] European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[277] CARSA et al, 02/12/2021, *Industry agreements in current value chain*, https://op.europa.eu/en/publication-detail/-/publication/8c021023-53ee-11ec-91ac-01aa75ed71a1/language-en

In general, despite genuine intent, the level of digitalisation of the shipping industry (infrastructure and vessels) remains limited. The shipping industry business model relies on secrecy. Disclosing information (e.g., availability of shipping capacity, the exact position of ships) would change the bargaining power to the detriment of shipping companies. Big players also have such a large reach that they prefer to develop and keep their internal solutions and tend to not use APIs enough. Despite discourse about collaborating practices, most cases for standardisation take place bilaterally or even internally.[278]

Nonetheless, large shipping companies are already engaged in standardisation and digitalisation efforts while ports tend to lag. The impact of AI systems on port automation is especially important and interesting to decrease the consumption of fuel. This is especially important in the context of rising prices and stricter regulations to make the industry greener. [279]

Public procurement can play an important role in the implementation of AI solutions in port activities. It would represent an important gain in operational efficiency and fuel savings. Greater purchases, coordination at the European level and development of pilot projects could generate replications efforts. [280] Authorities could play a role in making specific data (either B2B or B2G) exchanges mandatory. This could address the lack of exchange between ports to vessels and encourage the development of sharing practices. [281]

European collaboration in the matter is very limited as activities are left to port operators. European-scale coordination for the acquisition, implementation and standardisation of AI systems for port operations could give a competitive advantage to the EU. Implementation of these solutions could generate replication efforts from the industry. [282]

Air

Recent decades have seen tremendous progress in the uptake of AI solutions in air transportation. For example, the development of private data spaces for analytics and machine learning (e.g., Skywise from airbus) or the use of digital twinning for the design of aeroplanes.

However, many areas remain lowly digitalised and represent important opportunities for increased use of AI. For instance, the use of AI systems in air traffic control and air fleet management is still in its infancy.[283] There is still a lack of initiative to improve air traffic management and ensure a high degree of seamless air-ground integration.[284]

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[278] Shipping contracts can be done based on route length or used bunker. Consequently, shipping companies are discouraged to optimise their routes and can sometimes purposedly prolong a trip. This leads to higher bunker consumption, inefficiency and greater waiting time for port operations because of miss-communications. Interview with a representative from a startup in platform for port operations.

[279] CARSA et al, 02/12/2021, *Industry agreements in current value chain*, https://op.europa.eu/en/publication-detail/-/publication/8c021023-53ee-11ec-91ac-01aa75ed71a1/language-en

[280] CARSA et al, 02/12/2021, *Industry agreements in current value chain*, https://op.europa.eu/en/publication-detail/-/publication/8c021023-53ee-11ec-91ac-01aa75ed71a1/language-en

[281] CARSA et al, 02/12/2021, *Industry agreements in current value chain*, https://op.europa.eu/en/publication-detail/-/publication/8c021023-53ee-11ec-91ac-01aa75ed71a1/language-en

[282] CARSA et al, 02/12/2021, *Industry agreements in current value chain*, https://op.europa.eu/en/publication-detail/-/publication/8c021023-53ee-11ec-91ac-01aa75ed71a1/language-en

[283] European Parliament, March 2019, *Artificial Intelligence in Transport*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635609/EPRS_BRI(2019)635609_EN.pdf

[284] For example INTUIT to explore the potential of machine learning and visual analytics: COP>TRA on trajectory prediction. MALORCA speech recognition to encore in recognition software for human to machine and ground to air coordination.

For aeroplane fleets, Smart Maintenance is the most interesting area for the development of new impactful AI solutions. Maintenance has already been digitalised by many MROs (Maintenance and Repair Organisations) internally using "Electronic Maintenance Records".[285] However, information remains siloed and kept in-house. The developed data space platforms in the field lack cross-platform interoperability. SMEs are especially affected by this problem as they face more challenges in accessing these tools. Furthermore, maintenance is mandated by law, but the way it is documented is not. This leads to inconsistent reporting of maintenance information and difficulties to implement automation.[286] Air Traffic Management (ATM) is the area where public procurement would be the most impactful. Public procurement of modules, systems and support for an R&D project for Air Traffic Control (e.g., for developing explainability of AI systems) could transform ATM.[287] This would represent gains in operational efficiency, and ground-air connectivity and encourage the deployment of on-board solutions to exploit new opportunities opened by enhanced connectivity with ground operations. The development of standards requirements for safety and maintenance would encourage standardisation and uptake of automated smart maintenance systems.

2.3.3 Main drivers and barriers

The table below presents a PESTEL analysis of the uptake of AI technologies in public procurement in the e-government sector.

[285] Fernadnez Antonio, 16/02/2019, How Blockchain could enhance aircraft maintenance, https://datascience.aero/blockchain-enhanceaircraft-maintenance/

[286] CARSA et al, 02/12/2021, *Industry agreements in current value chain*, https://op.europa.eu/en/publication-detail/-/publication/8c021023-53ee-11ec-91ac-01aa75ed71a1/language-en

[287] Degas AUgustin et all, December 2022, *A survey on artificial intelligence and explainable AI in air traffic management*, https://www.mdpi.com/2076-3417/12/3/1295

Table 5 PESTEL analysis of the uptake of AI technologies in public procurement in the mobility and transport sector

Criteria	Drivers	Barriers
Political	• The promise of establishing a niche in the market related to AI in transport, especially in areas such as AI-driven Autonomous Vehicles technology deployment. • The adoption of AI in mobility and traffic monitoring can play an important role in the decision-making of public organisations to leverage the implementation and development of new or existing public transport services, mobility infrastructures, etc.	• Lack of harmonised rules and regulations in the adoption and integration of AI in mobility and transport across Europe. • Need for the inclusion of urban AI in EU research programs addressing data exchange, communication networks, and policy on mobility.
Economic	• The ability of AI solutions to reduce costs and significantly lower public spending: Deciding whether to build a new road, how much money should be allocated to maintenance and rehabilitation activities and which road segments or bridges to maintain, and whether to divert traffic to an alternative route in an incident situation. • AI can also help to manage and utilize large amounts of data and help to plan, design and control road transport networks. It can also help optimize movements to maximize efficiency contributing to significant cost reduction for instance in terms of logistics, public transport or traffic management.	• A major constraint on the growth and development of AI in the transport market is the high cost of some AI systems.

	• The new market for automated and connected vehicles is expected to grow exponentially and large economic benefits are expected.	
Social	• Safety: Road safety for both drivers and pedestrians are a major public health issue. While inadequate infrastructure—in particular, poor roads and vehicles without modern safety equipment—plays a role in the high death toll, human error is an important contributor. • Potential to enhance personal autonomy, especially for people with impaired driving abilities. Additionally, it can contribute to providing timely and accurate transit travel time information, which can attract ridership and increase the satisfaction of transit users. • AI is helping to take the personalization of the mobile user experience to the next level. Personalization is increasingly relevant as mobility systems evolve toward greater human centricity and sustainability.	• Sharing data and changing the rigid transport business models in separate modes towards a more dynamic network that joins technological platforms, mobility providers and customers, is a difficult task. Establishing commitment from top management to drive the cultural and process change required is a current barrier. • Concerns over loss of jobs including delivery and heavy truck drivers, bus drivers, taxi drivers, and chauffeurs. AI is likely to accelerate the transition toward a service economy, upending established economic development models by speeding up job losses for low-skilled workers in many fields, including transport.
Technological	• The introduction of AI enables the improvement of vehicle efficiency in terms of minimising fuel consumption. Additionally, it presents the opportunity to invest in research of alternative fuels. • Empowering electrical vehicles, as the application of AI technologies in transport presents opportunities to further develop aspects such as battery research and	• For any AI use, the collection, quality, coherence and volumes of data available are paramount. Some data quality and quantity issues arise with transportation data collected by sensors and data acquisition systems. Missing or incomplete data and subpar accuracy and availability of data directly impact the quality and trust in urban AI systems. • In several trials and pilots over recent years, some limitations of current technologies have arisen and they will need to process even more

	development, battery energy management, vehicle-to-grid algorithms, etc. • Opportunity to create a unified mobility model, in which there is open data sharing leading to the generation of reliable, robust and high-quality data sets and unified governance across all mobility modes, which allows going far beyond traditional solutions.	data to realize the expectations in the years ahead. • Demand for AI experts has grown over the last few years in developed countries and EMs where AI investment is increasing. A lack of skilled AI talent has been widely cited as the largest barrier to AI adoption in developed countries. When it comes to AI within local authorities, the implementation is often outsourced towards commercial parties providing tailored AI as a service. However, digitalisation and AI-related expertise are necessary for local governments to adequately assess internally or externally developed AI on their aspects of trustworthiness.
Environmental	• Management of traffic proactively with data-driven insights; to automatically detect incidents for faster response; to more efficiently and effectively manage bottlenecks on the road; and to identify and target traffic violations. This results in smoother traffic, reduced congestion and carbon emission. Therefore, it directly contributes to the reduction of greenhouse gas emissions, pollution and noise related to traffic. • Better management of urban space and reclaiming specific urban areas for residents.	• Lack of clear cost-benefit analysis for the entire set of AI solutions. Environmental analysis is usually focused on the gain and positive aspects, while negative impact, such as the implementation of larger server farms, is usually left aside. Therefore, the positive impact might be backfired on the real and global view environmental impact of AI.
Legal	• Development of an updated and harmonised EU-wide liability framework for connected and autonomous transport.	• The regulatory requirements for AI are difficult to predict, especially when it comes to who would ultimately be held liable if an AI-powered service were to cause an accident, harm, or fatality. Setting out the responsibilities of

	• Build and maintain a balanced regulatory environment, based on existing applicable regulations, that enables and stimulates future technological innovation and evolution.	manufacturers, operators and drivers depending on the level of automation is another important common challenge, to finding appropriate answers to new legal issues concerning liability and ethics. • Asking users to opt-in and provide more personal data for machine learning requires robust privacy laws. These laws must be balanced against the benefit of having more data in a telecommunications network.

Source: Authors' elaboration based on the challenges and the value chain analysis.

Figure 51 Strengths, Weaknesses, Opportunities and Threats of the uptake and public procurement of AI-technologies in the mobility and transport sector

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Better quality of life for citizens – Adoption of AI in transport has the potential to improve life quality of all citizens by: increasing road safety for both drivers and pedestrians, enhancing personal autonomy especially for people with impaired driving abilities and personalizing the mobility user experience.

Growing market - The new for automated and connected vehicles is expected to grow exponentially and large economic benefits are expected. The automated vehicles market has propelled a significant shift in automation and connectivity and the integration of advanced technologies, including AI, is taking place to help and automate driving operations in different means of transport.

W

Rigid business models – Mobility and transport sector presents rather rigid business models. Therefore, reluctancy towards data sharing, more dynamic technological platforms and application of AI technologies is considered a barrier that needs to be treated in order to change the current cultural and process paradigms.

O

Efficient decision making – AI provides the opportunity to significantly improve decision making in several aspects such as deciding whether to build a new road, how much money should be allocated to maintenance and rehabilitation activities and which road segments or bridges to maintain, and whether to divert traffic to an alternative route in an incident situation.

Environmental improvements - AI in mobility present vast opportunities to detect several aspects of traffic and mobility, such as incidents, bottlenecks, etc. that can be quickly and efficiently treated to guarantee smoother traffic, reduced congestion and carbon emissions, with a direct impact in the environment.

Growth of urban areas – AI enables a better management of urban space and promotion of specific urban areas for residents together with leverage the implementation and development of new or existing public transport services, mobility infrastructures, etc. that will enhance the development of cities and towns.

T

Job loss – Part of the society believes that the adoption of AI will lead to job loss, as machines will replace humans.

Privacy concerns - Asking users to provide more personal data for machine learning requires robust privacy laws and the existence of a balanced regulatory environment and liability frameworks.

Source: Authors' elaboration based on the challenges, value chain and PESTEL analysis.

2.3.4 Case Study: The Mobility Data Space (Germany)

Key Actors

The MDS initiative already encompasses 200 stakeholders coming from multiple different parts of the mobility industry. These members can be split into the following categories:[288]

- Data users and providers: science, business, and public administration.
- Founder and coordinator: the Acatech National Academy of science and engineering.
- Co-partners to support the coordinator (since October 2021): Caruso, Deutsche Bahn, Deutsche Post DHL, HERE, HUK-Coburg Versicherung, Mercedes-Benz as

[288] The Mobility Data Space, initiative's website, https://mobility-dataspace.eu/

well as BMW via the BMW Intec Beteiligungs GmbH and Volkswagen via Volkswagen Group Info Services AG.

- Managing body: the "DRM Datenraum Mobilität GmbH". Created as a sponsoring company (non-profit limited liability company). The states of North Rhine-Westphalia and Baden-Württemberg are co-shareholders since 2022. MDS is a member of the IDSA as well as it is the first operating project of Gaia-X.

Goals

The development of a Mobility Data Space (MDS) was instigated as an initiative of the German federal "Concerted Action on Mobility Committee" in 2019. The objective of the initiative was to create one common data space for mobility data (a one-stop shop). Quickly gaining traction, the German initiative has now reached a European scale.

Description

The MDS acts as a marketplace and builds on the architecture and principles defined by Gaia-X and IDSA. The MDS provides a secure architecture that acts as an intermediary to put data buyers and providers in contact. The initiative does not have any centralised data lake. Instead, the system is organised around a series of "connectors". These connectors are not large "pipes" where data can transit and instead data remains warehoused on the participants' servers. These connectors are closed environments where data from other members can be accessed through a system of API.[289]

Up and running, the MDS already generates added value for participants. With this safe and trusted ecosystem for data sharing, participants have access to the data they need for new use cases and AI applications. Even though the initiative remains somewhat immature in terms of business model, the promise it holds in terms of use case, in breaking data silos and bringing together private and public players already makes it a shining example in Europe. The initiative provides template licence agreements for data exchanges. Furthermore, the connectors have a built-in system to monitor activities and verify compliance by partners to terms and agreements.[290] However, data exchange has to be agreed upon bilaterally. Participants have to contact each other to agree on the terms of the exchange. There is no standard in terms of data format, content, quality or volume. Participants also have to agree on the temporality of the exchange: i.e., access to data can be provided for a specific period (one month, 2 weeks, etc) or even with regular updates (e.g., new data sets will be provided each month). Similarly, price and valuation mechanisms are left to the participants. They can decide to provide data for free, decide bilaterally on the price or proceed to barter. [291]

Such a decentralised network requires a "central directory in which data sources and services are published and which can be searched either manually or automatically by data users. With different operator and business models, one or more central components for the data space can be offered":[292] The directory is therefore a repository that provides a list and description of the data available on the data space, their characteristics, formats, etc.

AI use case. The connector system does not place any limit on the use that can be made for the data acquirer. These limitations have to be defined by the partner before

[289] Ibid. Also see Fraunhofer, March 2021, *Mobility Data Space*, https://cefic.org/app/uploads/2022/01/Cefic-position-on-transport-and-logistics-digital-collaboration-and-data-sharing.pdf

[290] Second interview with a representative of the Mobility Data Space.

[291] First interview with a representative of the Mobility Data Space.

[292] Ibid

the exchange takes place. Participants can use connectors as closed and safe environments to run their algorithms and machine learning systems. Mainly, four types of data are shared on the MDS:[293]

- **Weather data:** to link with mobility data such as traffic jams;
- **Infrastructure data:** e.g., e-mobility infrastructure, smart traffic light, etc;
- **Road safety data**: data on hazards as identified and analysed by the vehicles to adapt traffic management and warn users);
- **Environmental data:** a combination of environmental information with other data (e.g., road utilisation) to generate positive environmental externalities.

As the initiative acts as a marketplace, the possibilities opened to AI depend on the creativity of the participants, and their ability to conclude data exchange agreements. However, the main use case is related to **autonomous driving**. To be efficient, an autonomous vehicle needs to be able to connect and exchange with other vehicles and the smart infrastructure. For example, in poor weather conditions, a vehicle can have difficulties identifying if the light is red or green. Accessing the data from the infrastructure to identify under what condition (e.g., level of brightness), these signals can be correctly identified can help manufacturers in improving their systems.[294] In addition, we can also identify **other potential use cases** that will grow in the future for traffic management, improvement of embarked electronics and preventive maintenance.

Successes and Key Lessons

- **Breaking Data Silos in the mobility ecosystem** which had been noted as a barrier in both the public and private spheres[295]. Until then, dataspace initiatives were mainly developed at the regional and local level for smart cities, smart traffic management systems and similar types of initiatives. [296] Similarly, the MDS was set to absorb the Mobility Data Marketplace initiative launched in 2017. The MDM is a marketplace for data exchange in the mobility industry. [297] Indeed, the MDS was launched to build an integrated data ecosystem bringing SMEs, start-ups, public authorities and OEMs together to restore German competitiveness against the US tech giants. [298]
- **The federal government played an important role in** driving the development of the MDS and in convincing industrial partners to get on board. The federal government for example granted €18 million for the development of the MDS[299] and €3 million for the development of the preceding initiative, the Mobility Data Marketplace.[300] In addition to this **financial support,** the government was **active in convincing large OEMs** — without which the

[293] Ibid.
[294] Second interview with a representative of the Mobility Data
[295] Next-mobility, 17/01/2022, *Datenraum mobilität: wie Europa sich gegen die US-Tech-Giganten rüstet,* https://www.next-mobility.de/datenraum-mobilitaet-wie-europa-sich-gegen-die-us-tech-giganten-ruestet-a-1088354/
[296] Mobility Data Space, sin dato, *Connection of data platforms,* https://www.mobility-data-space.de/en/connection.html
[297] Next-mobility, 17/01/2022, *Datenraum mobilität: wie Europa sich gegen die US-Tech-Giganten rüstet,* https://www.next-mobility.de/datenraum-mobilitaet-wie-europa-sich-gegen-die-us-tech-giganten-ruestet-a-1088354/
[298] Next-mobility, 17/01/2022, *Datenraum mobilität: wie Europa sich gegen die US-Tech-Giganten rüstet,* https://www.next-mobility.de/datenraum-mobilitaet-wie-europa-sich-gegen-die-us-tech-giganten-ruestet-a-1088354/
[299] Handelsblatt, October 2020, Merkel Drängt autokonzerne: BMW, Daimler und VW sollen Datenschatz teilen, https://www.handelsblatt.com/politik/deutschland/autogipfel-merkel-draengt-autokonzerne-bmw-daimler-und-vw-sollendatenschatz-teilen/26308418.html?ticket=ST-1376973-6msjtMrmiOfcreSP5PK1-ap2
[300] APCO Worldwide, 7/12/2020, Has Germany set the European Transport sector on the path to a digital transformation?, https://apcoworldwide.com/blog/has-germany-set-the-european-transport-sector-on-the-path-to-a-digital-transformation/

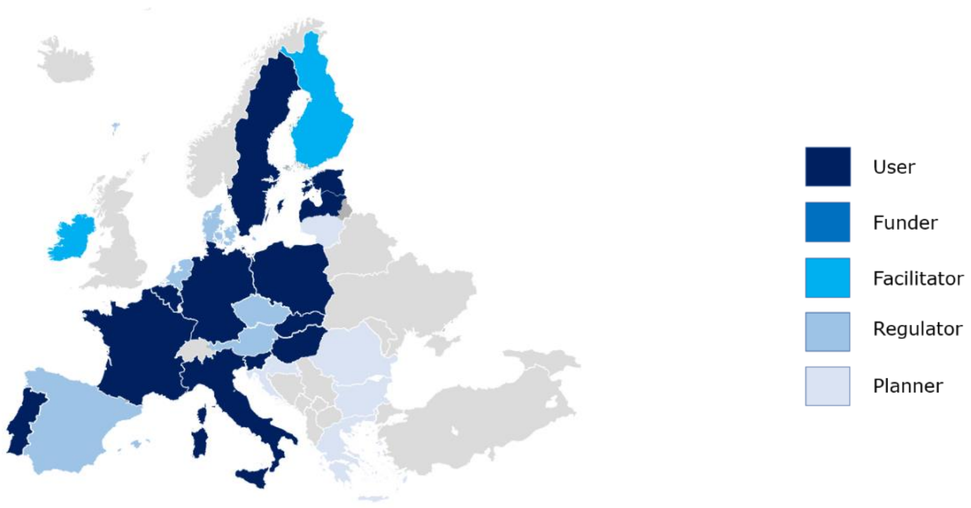
initiative would have little sense — to embark on the digital journey This was achieved through public statements held by the then Chancellor Angela Merkel, participation in public events and fair by officials and dissemination of a covenant to be signed by joining partners.[301]

- **Another important step to build trust** between private and public players was the selection of the Federal Academy for Science and Engineering (Acatech) as a Trust Anchor to develop and launch the initiative. Responsibilities that the Academy partially transferred to the organisation created for the occasion, the "LLD DRM Datenraum Mobilität GmbH".[302] Up and running, the MDS already generates added value for participants. With this safe and trusted ecosystem for data sharing, participants have access to the data they need for new digital innovative business cases, which solve problems of the current through data solutions. The GmbH already reached a sufficient level of maturity with the implementation of concrete use cases. By breaking data silos and bringing together private and public players, the MDS already is a best practice in Europe.

2.3.5 Economic analysis

Despite its enormous promise, the number of real-world use cases of AI in mobility in the public sector is still relatively few with *uses* often in localized settings such as single cities or smaller transport networks. Therefore, large datasets across multiple locations are not yet available. This makes an economic analysis which compares the performance of users and non-users of AI in the public using data frames built around member states impossible. As the use of the technology in cases like transport system management becomes more widespread, future research could use metrics like congestion data and safety statistics to test the theory, but with the novelty of the technology in the public sector, this approach is not currently possible.

Figure 52 Mobility & AI: Member state classification (Malta and Cyprus are categorized as "planners")



[301] APCO Worldwide, 7/12/2020, Has Germany set the European Transport sector on the path to a digital transformation?, https://apcoworldwide.com/blog/has-germany-set-the-european-transport-sector-on-the-path-to-a-digital-transformation/
[302] The Mobility Data Space, initiative's website, https://mobility-dataspace.eu/

2.4 Health

In a 2020 survey, 18 European Member States designated healthcare as the sector which should be prioritized the most going forward in terms of accelerating AI uptake[303]. The speed and severity of the COVID-19 pandemic have undoubtedly expedited technological innovation in a sector that has been searching for solutions to structural challenges such as ageing populations. Few subjects have received more attention and expectation as potential solutions for both the short- and long-term issues facing the health sector than Artificial Intelligence (AI). From Natural Language Processing to image analysis and predictive analytics, AI is used in multiple areas of healthcare including care management, diagnosis, medical diagnostics, clinical decision support and many more[304]. Beyond patient-centric delivery, AI is also being deployed to revolutionize health system management with secure patient data at its heart.

Yet despite its promise, reticence at the user level, a lack of skills, governmental coordination and incentive models[305] have meant that healthcare is the third most advanced sector in terms of businesses using AI behind ICT and education. This has been particularly acute at the European level where a cloistering of data and failure to make use of its significant advantages[306] has meant that the EU is yet to fulfil its considerable potential as a high-skilled powerhouse of AI innovation in health.

The health sector incorporates multiple subsectors and units of analysis, each with its dynamics, considerations and relationship with AI. From a patient at home receiving advice from a chatbot to a hospital overhauling its administrative system and a national government´s drawing up its regulations, AI has a multidimensional role to play in health. According to a joint EITHealth and McKinsey report, in the short term, AI will increasingly take over operational and administrative tasks while in the medium and long term, AI will facilitate a rebalancing of care between hospitals and homes, easing the burden on health systems, and becoming an increasingly integral part of clinical trials and by extension clinical practice. Commercially, the healthcare sector in the EU has seen Venture Capital AI investment of around 5 billion EUR annually, reaching 13% of global Venture Capital (VC) investments around the world behind the US and China[307]. While this share looks to be increasing, there is still a large disconnect between the highly touted goals of national AI strategies and the everyday use of AI technologies in health. A 2020 Survey found that only 44% of respondents working in enterprises in the health sector are using AI technology in any form with a 50-50 split between those that are planning to use AI in the future and those that are not[308].

The policy landscape: Health and AI

A clear signal of intent from the raft of national strategies on AI that were released at the start of the 2020s was the importance that most member states placed on healthcare as one of a few critical areas for AI growth[309].

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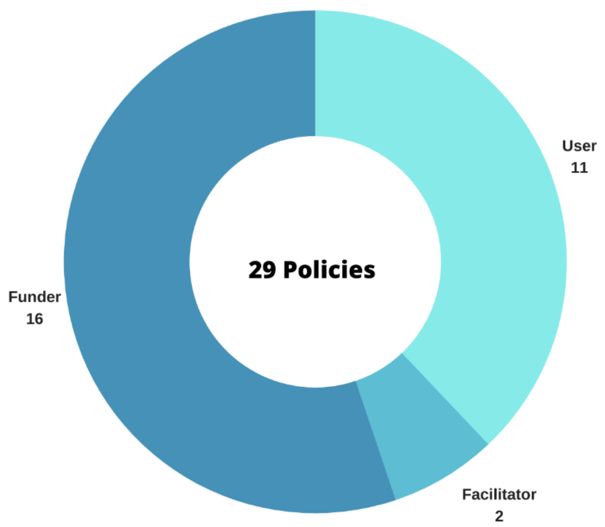
[303] Misuraca, G., and van Noordt, C., (2020) Overview of the use and impact of AI in public services in the EU, Publications Office of the European Union, Luxembourg
[304] EIT Health and McKinsey, 2020. ´Transforming healthcare with AI´: https://eithealth.eu/wp-content/uploads/2020/03/EIT-Health-and-McKinsey_Transforming-Healthcare-with-AI.pdf
[305] PWC Netherlands (2017) Adoption of artificial intelligence in healthcare
[306] PWC Netherlands (2017) Adoption of artificial intelligence in healthcare
[307] AI Watch (2021) ´How can Europe become a global leader in AI in health´: https://knowledge4policy.ec.europa.eu/sites/default/files/JRC123420_AI_health_Policy%20Brief_FINAL_0.pdf
[308] European Commission, Directorate-General for Communications Networks, Content and Technology (2020) *European enterprise survey on the use of technologies based on artificial intelligence : executive summary*, Publications Office, https://data.europa.eu/doi/10.2759/40940
[309] AI Watch (2020) National strategies on Artificial Intelligence: A European perspective, 2022 edition, , EUR 31083 EN Publications Office of the European Union, Luxembourg,2022, ISBN 978-92-76-52910- 1, doi:10.2760/385851, JRC129123.

As a part of and in addition to the strategies and plans published throughout the EU, the strategic procurement of AI technologies and investment in the organization that produce them in the health sector is increasingly common. This has never been more evident than with the success of BioNTech, the company behind the world´s first vaccine against COVID-19, which benefited from several EU R&D programmes[310]. The BioNTech vaccine was evidence of how collaboration between the public and private sectors can create extraordinary health benefits as well as commercial success. One of these support mechanisms that assisted BioNTech´s work was a European Research Council Grant[311] in 2018, a funding model that some member states have subsequently applied at a national level.

Figure 53 Health and AI – breakdown by policy type



Source: Authors' elaboration.

Similar programmes include France´s "Breakthrough innovation challenge on AI in health"[312] Germany´s "Research on AI technologies in Health"[313] and Lithuania´s National Research Programme for Healthy Aging.

Alternatively, Denmark and the Netherlands have used their Innovation Fund and National Growth Fund as investment vehicles to assist areas such as regenerative medicine and health data infrastructure. However, the public sector is also developing its initiatives such as Portugal´s CCM-SNS Verification of medical prescriptions, Sweden´s Analytic Imaging Diagnostic Arena and the Datakalab in France which permitted COVID-19 mask-wearing detection in some French cities (France). On a regional level, bodies such as Belgium´s Brussels and Flanders have launched their boutique AI strategies (with Health as a focal point) albeit with an inevitably smaller scale. The Brussels region´s AI policy for example, through the regional innovation agency Innoviris, is emblematic of the different forms that public procurement and financing of AI technology. As part of a series of funding mechanisms, the organization has financially supported two start-ups focused on the "from the therapeutic medicine to preventative medicine: Prediction, Prevention, Identification" involved in genomics

[310] https://researchprofessionalnews.com/rr-news-europe-horizon-2020-2021-1-biontech-chief-eu-r-d-funds-helped-develop-covid-19-vaccine/

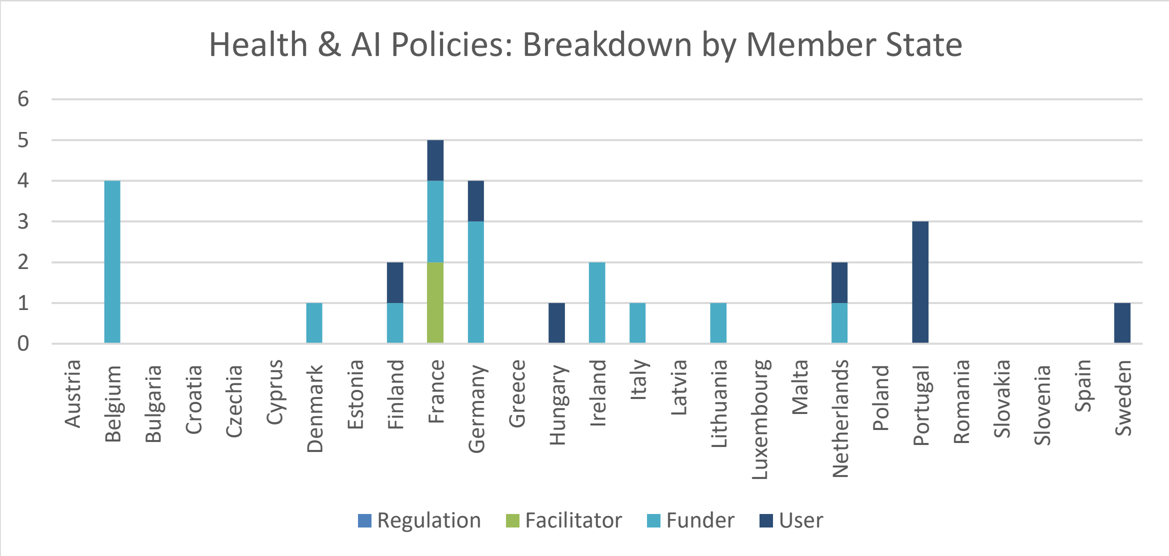
[311] Research Professional News, BioNTech chief : EU R&D funds helped develop Covid-19 vaccine, 2021:https://researchprofessionalnews.com/rr-news-europe-horizon-2020-2021-1-biontech-chief-eu-r-d-funds-helped-develop-covid-19-vaccine/

[312] Hoppen (2022) "The digital health acceleration strategy explained" https://www.hoppen.care/strategie-dacceleration-sante-numerique/

[313] German Research Centre for AI - https://www.dfki.de/en/web

and radioactive medicine[314]. In addition to these projects, which received 500,000 euros each, Innoviris is also responsible for HubBrussels, a MedTech accelerator which provides start-ups in the sector with support and access to expertise. Nevertheless, these programmes are certainly outliers rather than indicative of similar programmes throughout Europe. While adoption may be sluggish thanks to the unique idiosyncrasies of the health sector, these programmes at the European, national and local levels might be a blueprint to be replicated by other (sub)national governments.

Figure 54 Health and AI policies – breakdown by Member State



Source: Authors' elaboration.

2.4.1 Challenges and AI solutions/applications in the health sector

Healthcare systems around the world are facing the structural challenges of demographic changes as populations and public spending on healthcare balloon along with higher expectations of the quality of healthcare. In the short, medium and long term, AI is well placed to address the daunting challenges of the health sector from resolving the low-hanging fruit of improving operations to boosting R+I and even shifting healthcare to a more continuous and proactive model rather than one that is based on mitigation and ex-post treatment.

Figure 55 Summary of challenges and AI solutions for health

Public sector challenge	*Improve medical decision-making*	*Make administrative work and procurement more efficient*	*Improve understanding deeper medical science*	*Mitigate surges in admissions, staff shortages*
AI value drivers	Computational assistance for medical decision-making	Improving operations	Strengthening innovation	Improving population-health management

[314] https://innoviris.brussels/brussels-city-innovators

AI Applications	AI-assisted diagnostics, triage and diagnosis, clinical decision support	AI-assisted procurement AI-software for back-office work	Disease state and target understanding, lead selection and optimisation, clinical dose and endpoint selection, therapeutic tailoring and portfolio management Drug Discovery	Prediction of staff shortages Identification of risk of unplanned hospital admissions
AI Techniques	SaMDs Dual-layered neural networks	NLP and machine learning	Machine learning to help design protocols	AI-powered models based on clinical data from a large population

Improved medical decision-making

The more recent interest surrounding the topic of Artificial Intelligence (AI) in healthcare delivery hides the fact that computational systems to support medical decision-making are not new. Computational technologies already existed using probabilistic models to rationalise decision-making (e.g., QMR-DT) such as a system to support the diagnosis of abdominal pain was already created and tested in Leeds in the 1960s. However, applications are harnessing a new generation of tools and solutions using larger data sets, web-based technologies (e.g., ADM or Dxplain models) and recent advances in machine learning (ML) and AI.[315] [316]

The potential held by new systems is both promising and varied. This includes imagery recognition for faster diagnoses and the development of IBM Watson for co-diagnostic or automatic robots for surgical procedures. Taken together, these innovations could change virtually all stages of the delivery of healthcare to patients. It would help health practitioners to have a more comprehensive approach to diagnosis, facilitate the presentation of options to patients and make more accurate drug-prescription — especially for rare diseases. [317]

A joint EIT-Health and McKinsey report identified 6 patient-facing impact areas in which AI is set to transform healthcare:

- Self-care/prevention/wellness
- Triage and diagnosis
- Diagnostics
- Clinical decision support
- Care delivery
- Chronic care management

[315] Souhir Ben Souissi, 15/01/2018, *Vers une nouvelle génération d'outils d'aide à la décision s'appliquant à la prévention des risques lors de la prescription des antibiotiques : combinaison des technologies web sémantique et de l'aide multicritère à la décision*, *https://tel.archives-ouvertes.fr/tel-01684761/document*
[316] Cairn, February 2001, *Les systems d'aide à la décision médicale*, https://www.cairn.info/revue-les-cahiers-du-numerique-2001-2-page-125.htm
[317] PwC, june 2017, *Why AI and robotics will define new health*, https://www.pwc.com/gx/en/industries/healthcare/publications/ai-robotics-new-health/ai-robotics-new-health.pdf

Use case: Medical Decision-making[318]	
Derm.AI	Researchers from Fraunhofer Portugal AICOS (FhP-AICOS) have developed a digital solution to make the process of referencing skin lesions more efficient. The technology that results from the Derm.AI project consists of two components: a mobile application and Artificial Intelligence (AI) software. "In recent years, clinicians at the National Health Service (SNS) have been increasingly concerned with spotting skin cancer early. However, in Portugal, with the reduced number of dermatology specialists in the SNS, it is important to improve the referral process, ensuring that the information collected is of good quality and helping to prioritize the referred cases", adds the researcher.

Improving operations

The ageing of the European population translates to a larger need for medical care while keeping operations high quality and costs down.[319] Even though replacing a doctor or healthcare professional with a health bot is neither feasible nor desirable, innovative solutions have started to emerge such as AI-powered virtual nurse assistants (other dimensions related to support to decision-making are detailed in the next section) to increase the productivity of the existing workforce.[320]

Similarly, the digitalisation of back-office activities (e.g., administration) in health can produce important financial and productivity gains. As with other sectors, automation of administrative tasks would reduce the administrative burden for the workforce and free up valuable resources for a budgetarily stressed healthcare system.[321]

However, the possibilities opened by AI in healthcare are still not fully clear and are often met with resistance from the ecosystem. Indeed, the analyses of the gain from AI in healthcare typically set aside the implementation cost, while implementation of AI systems is costly and work-intensive. Furthermore, these gains must be tempered as the acquisition of AI systems needs to be assessed on a case per case basis, taking into consideration the running costs and the benefits from other technologies.[322]

Use Case: Health Operations[323]	
Qventus	Qventus is an AI-based software platform that solves operational challenges that occur in the hospital. Delays or cancellations of surgeries plague hospitals and can result in worse clinical outcomes, ineffective use of healthcare resources (e.g., theatres, anaesthetist time) and higher costs per patient The software detects unexpected orders and late-start risks during the preoperative phase and optimises the block

[318] https://www.aicos.fraunhofer.pt/en/news/archive/2022/dermai.html
[319] EC, sin dato, *Public Health,* https://ec.europa.eu/health/health-workforce/overview_en
[320] Harvard Business Review, May 2018. *Promising AI applications in healthcare,* https://hbr.org/2018/05/10-promising-ai-applications-in-health-care
[321] Harvard Business Review, May 2018. *Promising AI applications in healthcare,* https://hbr.org/2018/05/10-promising-ai-applications-in-health-care
[322] Wolf Justus et al (2022) The economic impact of artificial intelligence in Health Care: systematic review, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7059082/
[323] Transforming healthcare with AI The impact on the workforce and organisations

	schedules in real-time. It helps hospital teams prioritise, for example, by identifying high-priority actions and nudging the teams to resolve issues.

Artificial Intelligence can also benefit the public procurement process itself. Public procurement in healthcare can be a difficult and complex task that could be simplified by an AI system with the automation of repetitive tasks, enabling better-decision making, avoiding tender duplication, lowering costs and increasing transparency. [324]

This is especially the case in health with important transaction costs that can arise when the acquisition is surrounded by uncertainties about the product's qualities, asset specificity and frequency. Similarly, the acquisition of pharmaceuticals and health goods requires checking safety and compliance.[325]

This complexity leads to a series of concrete and damaging consequences for the health sector. For example, a group of UK hospital trusts collected and standardised manufacturers and price data for generic products (e.g., exam gloves) usually bought by individual trusts. The study identified that more transparent and centralised procurement would represent cost-cutting opportunities ranging between 15 and 50% compared to the current best prices paid by the National Health System. In addition, the need to relax checks and procedures to meet the emergency caused by the COVID outbreak led to an increase in the circulation of suboptimal drugs and even corruption scandals. The inflexible nature of the safety rules did not allow for rapid adaptation and transparent procedures that were needed in a time of emergency. [326]

According to Pettersen Inger et al, automation of public procurement implies moving to a new paradigm of "transactional contracts" (contracts being summarised as a mutually profitable exchange). However, the authors warn that the approach is not necessarily optimal in the context of healthcare where "relational exchanges" grant more important to human and social controls — two important dimensions to control public procurement in healthcare.[327]

More concretely, relational contracts are driven by efficiency criteria such as scientific, costs, price, etc. Relational exchanges allow us to consider ethical and intersubjective elements. In other words, transactional contracts using automated solutions can generate important gains in efficiency-driven fields and areas. In other words, it is unwise to generalise the use of an automated public procurement system. However, these warnings coined by Petterson Inger et al. are based on one case study. Mapping efforts taking into consideration qualitative and human factors are needed to confirm these intuitions as well as to identify areas where transactional and relational logic is the most suited.

Human and social controls based on "relational exchanges" are important security factors in the acquisition of sensitive healthcare goods (pharmaceuticals, etc). The number of activities that can be automated in public procurement of healthcare will therefore be more limited.

[324] EC, sin dato, Emerging technologies in public procurement, https://ec.europa.eu/growth/single-market/public-procurement/digital-procurement/emerging-technologies-public-procurement_fr

[325] EC, 2020, Expert panel on effective ways of investing in health (EXPH), https://op.europa.eu/en/publication-detail/-/publication/0fa5efff-b138-11eb-8307-01aa75ed71a1/language-en

[326] Kohler Clare Jillian, September 2020, The urgent need for transparent and accountable procurement of medicine and medical supplies in times of COVID 19 pandemic, https://joppp.biomedcentral.com/articles/10.1186/s40545-020-00256-w

[327] Pettersen Inger et al (2020) *Public procurement performance and the challenge of service complexity*, https://www.researchgate.net/publication/342649253_Public_procurement_performance_and_the_challenge_of_service_complexity_-_the_case_of_pre-hospital_healthcare

Advanced and enhanced public procurement would greatly benefit from the development of an inclusive health data ecosystem across the health value chain. This involves the modernisation and connectivity of hospitals' digital platforms and the development of health data spaces.

Strengthening innovation

As explained in further detail in the subsequent section on the health AI value chain, AI is being taken up by large pharmaceutical companies in the area of R+D[328]. The promise of AI stems from its ability to "both collect high-quality data from each patient and connect it to data from large pools of patients for analysis with artificial intelligence-based algorithms"[329]. Furthermore, large big pharma players such as AstraZeneca and Bristol-Myers Squibb are entering into partnerships with AI companies with objectives such as acceleration of drug discovery and designing protocols for precision treatment. Other early applications include:

- Disease state and target understanding
- Lead selection and optimization
- Clinical dose and endpoint selection
- Therapeutic tailoring
- Portfolio management

However, per the CEO of Novartis Vas Narasimhan, "a lot of talks and very little in terms of actual delivery of impact"[330] and the bulk of recent investment had focused on data-related projects that will provide the foundation for future R+D and applications.

Use Case: Strengthening Innovation	
Astra Zeneca Data and AI: Drug Discovery	AstraZeneca teamed up with BenevolentAI for collaboration on the drug discovery of two novel targets to enter its drug portfolio, for chronic kidney disease (CKD) and idiopathic pulmonary fibrosis (IPF)[331]. BenevolentAI and AstraZeneca scientists collaborate using the Platform and Knowledge Graph to interrogate underlying disease mechanisms, frame and test hypotheses and rapidly identify novel targets. New knowledge generated through the disease programmes is also fed back into the Platform, improving the quality of future drug target predictions.

Improving population-health management

Beyond the frontline of healthcare delivery, AI can improve the overall health of populations over time. With access to real-time data from sufficiently large populations, AI models can be deployed for early detection of trends. By extension, AI can be a tool for early prevention and give systems early warning systems valuable time to distribute resources in the case of scenarios such as a surge in hospital

[328] EIT Health & McKinsey (2020) Transforming healthcare with AI
[329] EIT Health & McKinsey (2020) Transforming healthcare with AI
[330] EIT Health & McKinsey (2020) Transforming healthcare with AI
[331] BenevoltentAI (2022) "BenevolentAI achieves further Milestones in AI-enabled target identification with AstraSeneca": https://www.benevolent.com/news/benevolentai-achieves-further-milestones-in-ai-enabled-target-identification-collaboration-with-astrazeneca

admissions, staff shortages or epidemiological events. These can also better inform understanding of longer-term events such as demographic patterns and immunity.

Use Case: Population-health management[332]	
Risk prediction for hospital emergency admissions	Mount Sinai's Department of Population Health has been using machine-learning algorithms to mine data that identifies patients who are at risk of an unplanned admission among the system's 500,000 patient population health programme and develop predictive modelling features[333]. This shifts the working patterns of practitioners from reactive care to proactive care. To adequately address the risk, practitioners and social workers need to understand how the model identified the patient and which factors may need to be addressed to mitigate the risk

2.4.2 Value chain analysis

The Health Value Chain can be defined as "the chain of suppliers, producers, distributors, healthcare providers and dispensers that provide clinicians with the drugs and supplies they need to care for patients and patients."[334]

Highly complex, the health value chain includes external players which can quickly become influential through the provision of innovative technologies. This is the case of Apple's wearables that serve as tools to measure health signals used by insurance companies to incentivise their customers to remain healthy through a system of rewards.[335] Furthermore, each link that composes the health value chain has undergone important changes over the years. This can be attributed to the increased use of digital solutions and the growing importance given to achieving cost efficiency.[336]

The importance of digital solutions in the modern health care industry is better understood through the representation of an R&D and a Digital Value chain, plugged into the traditional value chain. These two "side value chains" are where the potential

[332] EIT Health & McKinsey (2020) Transforming healthcare with AI
[333] EIT Health & McKinsey (2020) Transforming healthcare with AI

[334] TraceLink, sin dato, *The future of the healthcare value chain*, https://www.tracelink.com/agile-supply-chain/healthcare-value-chain#:~:text=What%20is%20a%20healthcare%20value,care%20for%20patients%20and%20patients.

[335] Another example is a joint venture between Amazon, J.P Morgan Chase and Berkshire Hathaway, which established an independent health care company, Haven, for their more than one million employees. The objective of the establishment of the company was to improve health care services and cost efficiency for the employees. Another example is the Amazon-introduced line of private label over the counter medicines and selling point for medical supplies to doctors, dentists and health institutions. Deloitte (2019), 2019 Global health care outlook: Shaping the future, https://www2.deloitte.com/global/en/pages/life-sciences-and-healthcare/articles/global-health-care-sector-outlook.html.

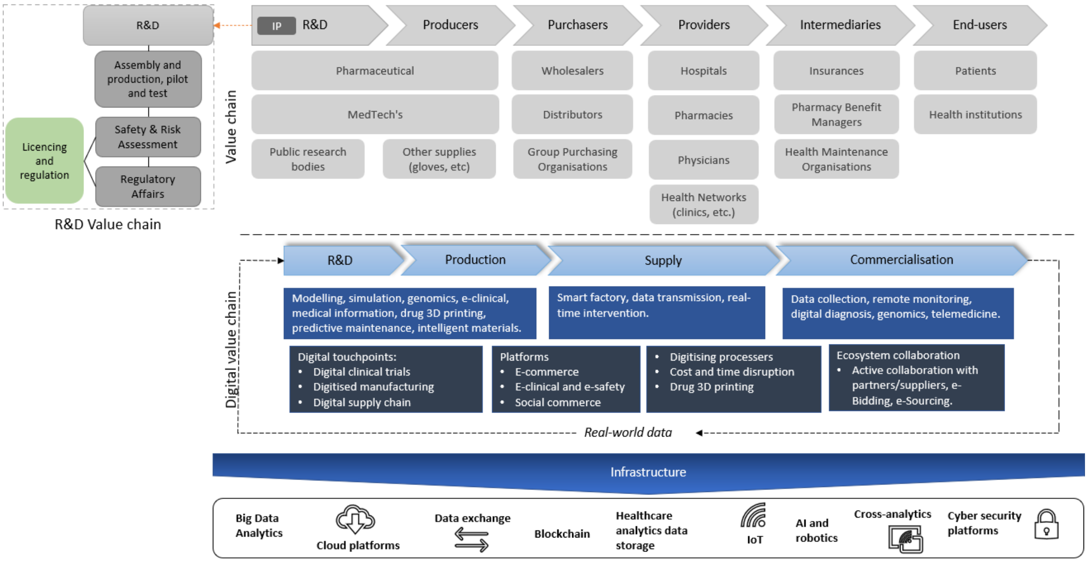
[336] Sarah Collins (2015), Analyzing value cgain business models: medical devices industry, https://marketrealist.com/2015/11/analyzing-value-chain-business-models-medical-device-industry/

for Artificial Intelligence arises, such as automated robotics for lab experiments, virtual twinning or digital experiments. [337] [338] [339]

Another key element of the European Health Value Chain is the central role played by the State. For example, in 2019 the government schemes and compulsory schemes and saving accounts represented 79.7% of all health expenditures in Europe.[340] This importance of public authorities has a decisive influence on both the competitive dynamics and the role that public procurement can play in influencing the AI market in healthcare. [341]

The value chain links will be analysed together to identify synergies and centre the analysis on potential state intervention and potential for AI solutions. An additional sub-section on the impact of Covid will be added as the pandemic had a decisive influence on the data and digital value chain of the health sector.

Figure 56 Health sector value chain



Source: Four elements of the digital value chain were taken from Bain & Company[342] and further elaborated by CARSA, in 2019. The T&L function will not be analysed in this value chain section. It is an important enabling function but it is not central to the delivery of health value for this study.

The value chain analysis has four sub-sections:

- R&D and production
- Purchasing and intermediaries

[337] Healthcare Industry BW (2016), Industry 4.0 in the medical technology and pharmaceutical industry sectors, https://www.gesundheitsindustrie-bw.de/en/article/dossier/industry-40-in-the-medical-technology-and-pharmaceutical-industry-sectors

[338] Rhenu Bhuller (2018), Beyond the pill pharma takes a stake in digital health, https://pharmaboardroom.com/articles/beyond-the-pill-pharma-takes-a-stake-in-digital-health/

[339] Bain & Company (2015), Getting the Dose Right: A Digital Prescription for the Pharma Industry, https://www.bain.com/insights/a-digital-prescription-for-the-pharma-industry/

[340] Eurostat, sin dato, *Analysis of current healthcare expenditures, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Analysis_of_current_healthcare_expenditure,_2019_(%25).png*. Comparatively, in 2011, public authorities, government and mandatory schemes represented 48% in the US and 56% in China EMERGO, 2021, *Europe – Overview of Medical Device industry and healthcare statistics, https://www.emergobyul.com/resources/europe-overview-medical-device-industry-and-healthcare-statistics*

[341] European Observatory on Health Systems and Policies Series, 2005, *Purchasing to improve health systems performance*, https://www.euro.who.int/__data/assets/pdf_file/0004/98428/E86300.pdf

[342] Ibid

- Health providers and end-users
- COVID impact

Research & Development and Production

R&D and production stages are closely intertwined as these tasks are usually undertaken by the same group of companies. In turn, these stages can be segmented into a series of 3 key players: Medtech, pharmaceuticals and public research bodies (public research bodies will be analysed concerning their contribution to MedTech and pharmaceuticals).

"MedTech, or medical technology, is every product, service, or solution using medical technology to improve people's health by preventing, diagnosing, monitoring, and treating disease."[343] An important link in the modern health value chain, Medtech includes a range of different players, from SMEs to tech giants and research centres.

MedTech is an innovation-driven field with strategic and economic importance for the EU. The EU MedTech market represents around €140 billion, 760,000 employees and 27.6% of the world market (second after the USA). Furthermore, the sector represents an economic surplus of around €8.7 billion for the EU and [344] 95% of European MedTech companies are SMEs.[345]

In addition to this economic importance, the European MedTech market is a dynamic and innovative field. In 2020 only, 14,200 patent applications were filled at the European Patent Office (EPO) compared to 8,500 applications filled for the pharmaceutical sector. These figures mean that Medtech represents 38% of all patent applications at the EPO.[346]

With a share of 70% of all MedTech purchases[347] in Europe, public procurement can play a key role in supporting the uptake of AI-driven MedTech. So far, the uptake of AI-driven MedTechs and solutions is concentrated in large hospitals and large cities. This represents an unexploited potential for larger adoption through the harmonisation of capacities.[348]In many cases, the lack of utility of the AI solutions comes from a lack of complementary solutions to enable the use/uptake of AI MedTechs (e.g., digital medical records require new integration software and platforms).[349]Risk-capital from

[343] The scope of MedTech corresponds to the scope defiend by the Medical Defice Directive. See Obelis group, sin dato, *Scope under the Medical Device* Directive, https://www.obelis.net/industries/medical-device-directive-scope-under-the-medical-device-directive/ and AKRNconsulting, 01/06/2020, *What is MedTech*, https://akrnconsulting.com/what-is-medtech/#:~:text=MedTech%2C%20or%20medical%20technology%2C%20is,%2C%20monitoring%2C%20and%20treating%20disease.

[344] MedTechEurope, 21/06/2021, *Facts and figures*, https://www.medtecheurope.org/about-the-industry/facts-figures/

[345] This further stresses the importance taken by R&D in medtech: "*The average global R&D investment rate (R&D spend as a percentage of sales) is estimated to be around 8% in the medical technology sector. Products typically have a lifecycle of only 18-24 months before an improved product becomes available*." MedTech expenditure in Europe represented €265 per capita in 2020. MedTechEurope, 2021, *The European Medical Technology Industry in Figures*, https://www.medtecheurope.org/wp-content/uploads/2021/06/medtech-europe-facts-and-figures-2021.pdf

[346] MedTechEurope, 2021, *The European Medical Technology Industry in Figures*, https://www.medtecheurope.org/wp-content/uploads/2021/06/medtech-europe-facts-and-figures-2021.pdf

[347] MedtechEurope, sin dato, Value-based procurement, https://www.medtecheurope.org/access-to-medical-technology/value-based-procurement/

[348] Brooking institute (2022) *Why is adoption in Health Care lagging?*
https://www.brookings.edu/research/why-is-ai-adoption-in-health-care-lagging/

[349] Brooking institute (2022) *Why is adoption in Health Care lagging?*
https://www.brookings.edu/research/why-is-ai-adoption-in-health-care-lagging/

public bodies is needed to target the development of complementary solutions in an emerging market.[350]

Furthermore, pharmaceutical companies are diverse and range from SMEs (they account for 65% of all European pharmaceutical companies[351] [352]) to chemical giants synthesising molecules or academics contributing to research & development. In total, in 2019, the European pharmaceutical sector represented a production of €275 billion a positive trade balance of €140,000 million and a total workforce of 795,000 employees.[353] The European pharmaceutical market represents around 23.9% of the world market with an expected CAGR growth of 4.5% over the 2021/2025 period.[354]

While the range of applications for AI solutions in pharmaceuticals is very wide, its most potent and important impact is on speeding up the drug discovery process.[355] To contribute to the greater uptake of AI solutions and generate economic gains in drug-discovery, better integration, new standards for molecule representation and solutions for data continuity in cognitive factories are needed.[356]

Through its system of tax incentives, a network of research bodies, and subsidies, the State already represents a crucial source of funding in Pharmaceuticals, paving the way for the reallocation of these fundings to support the development of AI solutions.[357]

AI solutions require standardised molecule representation for data exchange (within the company or across value chains). This is often prevented by the lack of computable and standardised molecule representation thus preventing the use of new AI solutions for digital twinning, digital trials, etc. This barrier requires the development of large public-private partnerships bringing together pharmaceuticals, academics and chemical companies.[358]

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[350] JRC (2021) *How can Europe become a global leader in AI in health?*, https://knowledge4policy.ec.europa.eu/sites/default/files/JRC123420_AI_health_Policy%20Brief_FINAL_0.pdf

[351] Based on Eurostat figures. SMEs are companies under 50 employees and large companies are above 50. Figures for number of companies were available for 2018. However, the total number of pharmaceutical manufacturers was only available for 2016. The final rate is therefore only an approximation based on existing data. Eurostat, sin dato, Industry by employement size, https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

[352] SMEs are extremely important for pharmaceuticals as 42% of the medicines developed by SMEs address orphan disease with a success rate of medicine development between 75% and 68% for all drug developed by SMEs. European Medicine Agency, 11/05/2016, *Supporting Innovative SMEs as major drivers of new pharmaceutical developments*, https://www.ema.europa.eu/en/news/supporting-innovative-smes-major-drivers-new-pharmaceutical-developments

[353] EFPIA (2020) *The Pharmaceutical Industry in figures, https://www.efpia.eu/media/554521/efpia_pharmafigures_2020_web.pdf*

[354] Statista (2021) *Pharmaceutical industry in Europe – Statistics & Facts*, https://www.statista.com/topics/8631/pharmaceutical-industry-in-europe/#dossierKeyfigures

[355] National Library of medicine (2021) *Artificial Intelligence in Drug Discovery*, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7577280/ and Biospace, 14/03/2022, *AI in Pharmaceuticals*, https://www.biospace.com/article/ai-in-the-pharmaceutical-market-size-to-worth-around-usd-9-24-bn-by-2030/#:~:text=The%20AI%20in%20pharma%20market%20segmented%20by%20based%20on%20application,is%20accounted%20highest%20market%20share.

[356] These points are detailed in CARSA et al. (2021), *Study on technological and economic analysis of industry agreements in current and future value chains*, https://op.europa.eu/en/publication-detail/-/publication/8c021023-53ee-11ec-91ac-01aa75ed71a1/language-en

[357] European Parliament (2021) *European Pharmaceutical Research and development, https://www.europarl.europa.eu/RegData/etudes/STUD/2021/697197/EPRS_STU(2021)697197_EN.pdf*

[358] These points are more detailed in CARSA et all, 02/12/2021, *Ibid.* The report provides a framework based on 3 industry agreements to efficiently tackle these challenges.

The uptake of AI solutions in pharmaceuticals is often impeded by the lack of data quality, quantity and interoperability. News standards are required to harmonise systems and foster digital continuity in cognitive factories (e.g., integration of production systems with R&D function for automated return on experience to speed-up drug-discovery process).[359]

Purchasers and intermediaries

The number and type of organisation (e.g., local government, central health fund) involved in the intermediation and purchasing of health supplies varies for each European country. However, the European market is characterised by the domination of the purchasing and intermediation stages by public players.[360]

According to the European observatory on health systems, competition is absent at these stages of the value chain. Even though private actors exist, they are surrounded by legislative frameworks and rules to monitor and frame their activities. Consequently, private bodies simply do not enter into direct competition with public authorities that dominate and organise intermediation and purchasing activities. [361]

Consequently, the purchase of health supplies is mainly done by public authorities. In Europe, public procurement represents 70% of all MedTech purchases.[362] The payment of pharmaceuticals by compulsory health insurance systems and national health services (ambulatory care only) represented a total of €135,485 million in 2018.[363] If we divide this by the total production figures for the pharmaceutical sector, this means that the State represents around 49% of all pharmaceutical payments in Europe[364]. The domination of public bodies in intermediations stages means that uptake and adoption of AI solutions will only be achieved if the state plays the leading role in investing, purchasing and implementing innovative solutions. The state can also play the role of an enabler in the development of new solutions. This requires the development of horizontally integrated platforms and data spaces for the exchange of standardised information.

Providers and end-users

As for other links in the health value chain, public authorities again play a central role in the provision and usage stages. The state is the main source of funding for patients regarding medical services and goods: "massive predominance of public funding in inpatient curative care: even if part of the total health expenditure is always funded by private insurance and out-of-pocket payments, almost the entire amount of inpatient health expenditure is publicly financed."[365] Similarly, the majority of hospitals and hospital beds are managed by public organisations while private bodies have to

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[359] These points are more detailed in CARSA et al. (2021) *Ibid.* The report provides a framework based on 3 industry agreements to efficiently tackle these challenges.

[360] European Observatory on Health Systems and Policies (2005) *Purchasing to improve health systems performance*, https://www.euro.who.int/__data/assets/pdf_file/0004/98428/E86300.pdf

[361] For example, in Germany, private health insurance schemes have to adopt a non-for-profit status.European Obervatory on Health Systems and Policies (2005) *Purchasing to improve health systems performance*, https://www.euro.who.int/__data/assets/pdf_file/0004/98428/E86300.pdf

[362] MedtechEurope, sin dato, Value-based procurement, https://www.medtecheurope.org/access-to-medical-technology/value-based-procurement/

[363] EFPIA, 2020, *The Pharmaceutical Industry in figures, https://www.efpia.eu/media/554521/efpia_pharmafigures_2020_web.pdf*

[364] In Europe, in 2020, medtechs represented 7.6% of all health expenditures, pharmaceuticals 14.9% and inpatient/outpatient care accounted for 77.6%. MedTechEurope, 2021, *The European Medical Technology Industry in Figures*, https://www.medtecheurope.org/wp-content/uploads/2021/06/medtech-europe-facts-and-figures-2021.pdf

[365] European Hospital and Healthcare Federation (2018) *Hospitals in Europea Healthcare data*, https://www.hope.be/wp-content/uploads/2018/07/2018_Hospitals-in-EU-28-Synthesis-final-for-publication-002.pdf

respect painstakingly defined rules and regulations.[366] As for other segments of the value chain, this gives the state and public authorities a driving role in the development of the IT architecture and infrastructure to enable the development of new AI solutions. The development of a health data space would indeed have to start at the service delivery and usage stages. Artificial intelligence is as good as the data it is fed with. Consequently, the development of AI solutions for health requires increasing the quantity, quality, interoperability and availability of health data.[367] This involves generalising the use of standardised Electronic Digital Health Records (for patient data). This stage represents great opportunities and potential for the development of new AI solutions at almost all stages of the value chain. IT platforms to manage public hospitals are another precious source of health data for procurement, use of materials, needs, etc. The heterogeneity of the platform landscape is partially addressed by initiatives from public hospitals to develop common solutions. However, more efforts are needed (especially to develop truly European coordination and standardisation).

The impact of COVID: data spaces, cross-border exchanges and new opportunities for AI

COVID highlighted the vulnerabilities of the European health sector caused by globalisation. Indeed, with the closure of borders, many key supplies were in critically short supply for both basic needs (masks) and even the production of pharmaceutics and MedTech. [368]However, despite its tragic costs in terms of human life, the COVID outbreak also accelerated a series of positive trends in the digital space: cross-border exchange of information, tracing apps, vaccine development and the development of health data spaces.

In April 2020, the European Commission launched the Covid-19 Data Sharing Platform for rapid cross-borders data exchanges related to COVID-19. The initiative could build on prior initiatives that developed the groundwork for rapid deployment of IT architectures and standardisation of data.[369] In other words, the crisis contributed to accelerating the deployment of the data and IT architecture necessary for the development and uptake of new AI solutions. However, more efforts are necessary to build on this legacy. Standardisation and interoperability of data sets and platforms remain important limitations for cross-border exchanges. Furthermore, the suspension of the French Health Data Hub initiative in January 2022, showed that ethical and legal concerns are still a central obstacle to the development of sustainable health data spaces in Europe. [370] To turn these temporary gains into long-terms infrastructure, more involvement is necessary from all stakeholders which are part of the value chain, mainly from the end-user side. A governance structure designed by the stakeholder's ecosystem is necessary to turn data spaces into successful and sustainable initiatives leading to the development of new AI solutions.

[366] WHO, sin dato, *Hospital beds*, https://gateway.euro.who.int/en/indicators/hlthres_28-beds-in-publicly-owned-hospitals-total/ For just France in 2019, 45% of all hospitals were public institution and 22% were not-for-profit private organisations. Gouvernement français, sin dato, *Vue d'ensemble*, https://drees.solidarites-sante.gouv.fr/sites/default/files/2021-07/Vue%20d%27ensemble.pdf

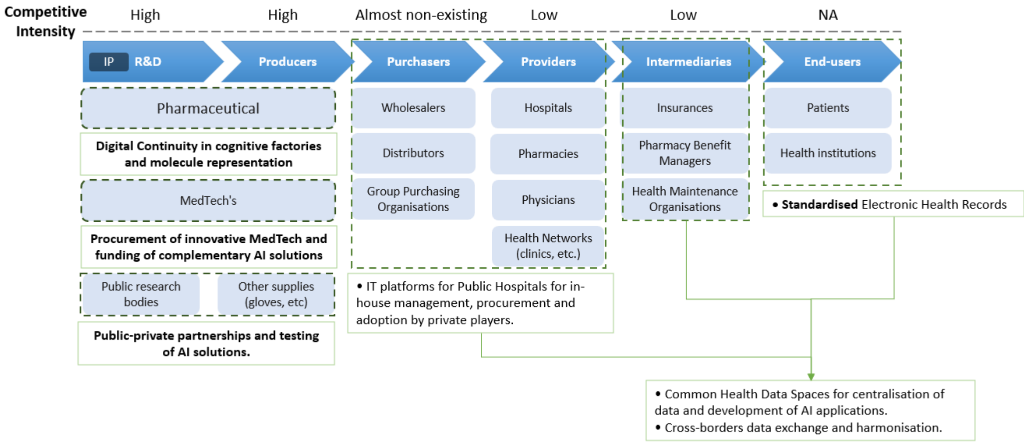
[367] These points are more detailed in CARSA et al (2021) *Ibid.*

[368] MedTechEurope (2021) *The European Medical Technology Industry in Figures*, https://www.medtecheurope.org/wp-content/uploads/2021/06/medtech-europe-facts-and-figures-2021.pdf

[369] EC, April 2020, *Coronavirus: Commission launches data sharing platform for researchers*, https://ec.europa.eu/commission/presscorner/detail/en/IP_20_680

[370] L'usine Digitale (2021) *Où en est le Health Data Hub ?*,

Figure 57 Summary of key intervention areas for public authorities and public procurement along the health value chain.



Source: CARSA, 2022.

2.4.3 Main drivers and barriers

The table below presents a PESTEL analysis of the uptake of AI technologies in public procurement in the e-government sector.

Table 6 PESTEL analysis of the uptake of AI technologies in public procurement in the Healthcare sector

Criteria	Drivers	Barriers
Political	• The successful management of healthcare systems is a key political issue. With more public policies promoting the use and adoption of AI in healthcare, uptake is increasing. • Due to its importance, strategic public procurement can drive demand for pharmaceuticals and healthcare technologies for the benefit of the citizen.	• The adoption of AI systems and technologies by the public healthcare system will need to open tendering processes which might extend the adoption time significantly. • Institutional reticence to reform healthcare systems due to its difficulty and cost.
Economic	• By examining data patterns, AI technologies can help healthcare organizations make the most of their data, assets and resources, increasing efficiency and improving the performance of clinical and operational workflows, processes, and financial operations. • AI is accelerating operations to save productivity hours, so AI has the potential to save costs.	• It is crucial to determine the best place/process to implement AI solutions and technologies to decrease, and not increase, the overall cost of healthcare systems. • The adoption of AI systems requires the support of external expertise to assess each situation and propose, produce and implement the most suitable AI systems for each case.
Social	• Optimisation of diagnosis and treatments through AI solutions has the potential to improve people’s life quality. AI has a high potential to improve the speed and accuracy of diagnosis and detection. • AI helps streamline procedures, automate functions, instantly share data and organize operations, all of which help relieve medical professionals of juggling too many tasks and	• A misconception among medical practitioners that AI will replace doctors in the coming years. The doctors and practitioners believe that skills such as empathy and persuasion are human skills, and thus, technologies cannot completely rule out the presence of a doctor. • Lack of understanding of the capabilities of AI technologies in the public healthcare sector. Responsible AI principles within an organisation

	increase the quality of the work environment for overstretched healthcare professionals.	can guide how to operate and exploit AI systems fully, responsibly and ethically using effective internal communication and training.
Technological	• The need to develop more simple technologies such as data storage and computing power that allow data collection, storage, movement and transformation that will afterwards support intelligent decision-making (AI). • The need to develop common and high-quality Health Data Spaces for the centralisation of data and development of AI applications. • Improvement in sensitive data protection and treatment, as well as cybersecurity aspects.	• Doubts about the capabilities of AI solutions in terms of accurately diagnosing patient conditions. • Lack of required talent, as AI adoption in healthcare, needs staff with interdisciplinary knowledge both from technological and medical disciplines. Specific investment in educating and reskilling healthcare workers is required to truly take advantage of the implementation of AI solutions. • Difficulties working with unstructured data, such as medical imaging, represent a large share of relevant data in healthcare. This means that the AI system still needs to be complemented by the experience of human doctors. • Lack of interoperability is a limiting factor to be considered in terms of AI adoption by the healthcare sector. With hospitals, specialists and clinics working with diverse Electronical Medical Record platforms, it is challenging for one entity to be able to access a patient's full record as systems are not compatible and interoperable. This limits the information that AI can see and causes incomplete analysis of the medical record.
Environmental	• Alongside quality workwear clothing for healthcare workers, sanitary PPE, and limiting	• The energy use and emissions associated with training AI models have indicated the wider

	human contact, AI can automate processes that may have required human labour. These automated processes reduce human action, and the waste involved with ensuring environments are clean for healthcare standards. • In terms of sustainability, savings can be seen in energy and time. Lower energy use links directly to a lower environmental impact from electricity generation.	consequences of this rapid development. These emissions are largely associated with the upfront development and training of AI algorithms while the tuning and adaptation are potentially less costly.
Legal	• Accelerate the development of policy frameworks to build trust and foster the adoption of AI in healthcare. • Build and maintain a balanced regulatory environment, based on existing applicable regulations, that enables and stimulates future technological innovation and evolution. • Speed up the regulation of AI in the market through a shared official definition in the market of what AI technology is.	• No shared official standards in the industry for how AI can be used by organisations nor how its performance should be evaluated, leading to uncertainty on the legitimacy of the use of AI by hospitals. • Lack of rules of accountability in the use of AI for decision-making. As AI technology replaces parts of the decision-making process traditionally carried out by humans, there is no regulation on how to include non-human actors in the legal accountability system.

Source: Authors' elaboration based on the challenges and the value chain analysis.

Figure 58 Strengths, Weaknesses, Opportunities and Threats of the uptake and public procurement of AI-technologies in the healthcare sector

S

Increase workplace productivity - Rather than spending hours of manpower on menial, repeatable tasks, employees can configure AI to manage it instead. AI allows to manage a multitude of tasks more efficiently and improving performance of clinical and operational workflows, processes, and financial operations.

Better quality of healthcare – Adoption of AI in healthcare has the potential to improve life quality of all citizens making high quality care more accessible and affordable, as well as improving working conditions of health professionals.

Great applicability range – AI can be used and adopted by a variety of industries, including healthcare. The type and sophistication of the AI required depends on the tasks to be performed and the range of potential applications in healthcare is broad, having examples such as early and accurate diagnosis, development of medicines, Streamlining Patient Experience or Mining and Managing Medical Data.

W

Artificial intelligence remains inhuman - skills such as empathy and persuasion are human skills that technologies cannot replicate. Therefore, AI is a tool that can communicate, but it can't communicate emotionally. And so, although it can use information, it won't be able to grasp or react to the complexities of human emotion.

O

Combing AI with newer forms of tech – The combination of AI with "lower" technologies provides the opportunity of crating new AI based technologies capable of responding to numerous necessities alongside the healthcare value chain.

Less strain on employees – A large amount of tasks, such as administrative issues, can be handled thanks to the adoption of AI technologies, which lessens the workload of medical professionals. Therefore, the sensitive adoption of AI enables lowering the stress levels of professionals and improve their quality of life

T

Job loss – Part of the society believes that the adoption of AI will lead to job loss, as machines will replace humans.

Trustworthy AI -The need for doctors to interact with a machine for critical decision-making poses an issue of trust, particularly in a field such as healthcare, where face-to-face interaction between patients and doctors is so important.

Source: Authors' elaboration based on the challenges, value chain and PESTEL analysis.

2.4.4 Case study: Developing the next generation of bionic prostheses for low-limb amputees (Belgium)

Key Actors

Innoviris: The Brussels Region´s Innovation Agency

Axiles Bionics: A Spin-off from the Vrije Universiteit Brussel

Type of policy

This use case of AI in health was driven by the Innovative Starters Award (ISA) programme carried out by Innoviris to provide funding for ambitious start-ups and scale-ups. In the words of Barbara Trachte, the State Secretary for Economic Transition and Scientific Research: "The Innovative Starters Awards is a spearhead programme of Innoviris to spotlight and financially support start-ups and scale-ups to further develop their innovative ambitions. I am pleased that ecological and social criteria were used this year. After all, Brussels-based companies have many ideas for acting positively towards the planet and its inhabitants[371]. The winner of the 2021 edition, Axiles Bionics, will receive €500,000 in funding to further realise their strategic innovation plan over the next 3 years.

Goals

The goal is to create a cloud-based data collection platform with information from every prosthesis in use. Currently, nothing is connecting the human brain with a prosthesis which makes mobility more difficult. Incorporating another form of intelligence through technology, the current disconnect between what happens naturally and how a prosthesis should react to stimuli can be diminished[372].

Description

Axiles Bionics, co-funded by Innoviris, is seeking to develop an "innovative technical solution that can be applied to any medical device that would benefit from patient-specific self-learning capabilities, such as prostheses, orthoses and wheelchairs, among others". This will be the company´s first application and its first flagship product, demonstrating the necessity of the initial public investment. In addition to the biomechanics of prostheses used in everyday mobility, the solution also includes reinforcement learning whereby the devices will be able to learn autonomously using the data from the cloud-based platform mentioned above.

Data can be submitted to the cloud every night by recharging and connecting the prosthesis while the amputee is sleeping. This can then be used to improve the daily functioning of the prosthesis through user-specific data which are sent back when the person is awake and active[373].

Successes and key lessons

- **Competitions with social considerations produce solutions with social utility.** For the 2021 edition of the ISA, a competition that had been running since 2010, there were social and ecological criteria in its assessment[374]. This was the first time that these had been included and were introduced as part of the 2021-2027 Regional Innovation Plan. While previous winners of the award had a significant social impact, the inclusion of more altruistic criteria helps to create incentive structures and produce solutions akin to Axiles Bionics, a project with significant social impact that this kind of project has for people with reduced mobility and the improvement of their daily life. In terms of key lessons to be replicated, although it seems obvious, explicit criteria in the very popular funding mechanism of research calls help condition the results.

- **Regional clustering with universities and public funding agencies to maximize potential.** Formed from the Vrije Universiteit Brussel and funded by the Brussels region innovation agency, the story of Axiles Bionics is grounded in the local AI ecosystem. Using networks, local expertise and support beyond finance to maximise outputs and progress is essential and a model that other regional authorities can look to replicate. In the words of Pierre Cherelle (the CEO), "We are very grateful for the continued trust and support of both Innoviris, in our team and our vision,". Nevertheless, with the funding totalling 500,000 euros over 3 years, this type of procurement model can be easily

[371] Innoviris.brussels (2021) "Axiles Bionics and Tapio win an innovative Starters Award 2021" https://innoviris.brussels/news/axiles-bionics-and-tapio-win-innovative-starters-award-2021
[372] Innoviris.brussels (2021) "Piere Cherelle Axiles bionics" https://innoviris.brussels/stories/pierre-cherelle-axiles-bionics
[373] Ibid
[374] Innoviris.brussels (2021) "Axiles Bionics and Tapio win an innovative Starters Award 2021" https://innoviris.brussels/news/axiles-bionics-and-tapio-win-innovative-starters-award-2021

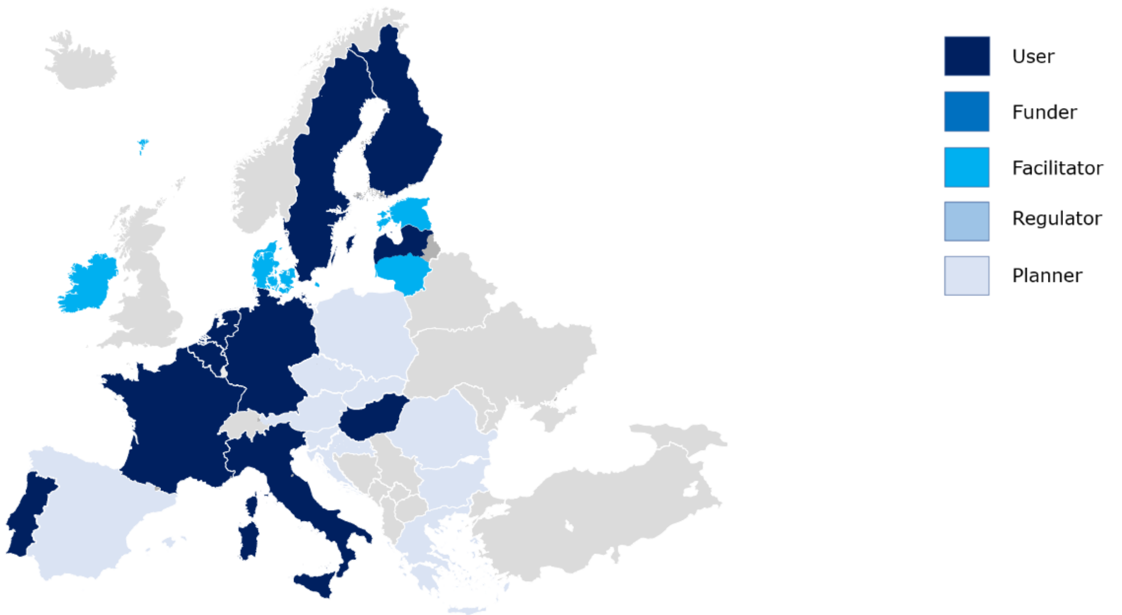
exported to the entirety of the EU and help foster local AI ecosystems and clusters.

2.4.5 Economic analysis

A large part of public sector activity in the health sector has been in the area of research and innovation with the belief that more funding will unlock better uptake of AI in health. Subsequently, the first model estimates the relationship between healthcare research and policy modes. As discussed above, another touted benefit of AI in health is its ability to improve the "low-hanging fruit"[375] of the administrative side of the healthcare system which is reflected in the second model.

Figure 59 Health & AI – Member state classification

N.B Cyprus is categorized as a Facilitator and Malta as a planner



To measure research in AI, model 1 uses the OECD´s AI Research database and takes the number of publications per member state in 2021 by "healthcare Institutions"[376]. The hypothesis would be that those countries already using AI have a more sophisticated AI ecosystem including research output on AI in health. Similarly, those countries funding programmes in AI in health should produce more than those not. The second indicator is taken from the DESI´s eHealth section in the form of "seeking health information" – a measure of the digitalization of a country's health system[377]. This selection draws on the theory that AI improves policy delivery, public services and citizen-government interaction[378]. In healthcare administration, can "enhance

[375]EIT Health & McKinsey (2020) Transforming healthcare with AI

[376]OECD.AI (2022), visualisations powered by JSI using data from MAG, version of 31/12/2021, accessed on 27/6/2022, www.oecd.ai

[377] Eurostat (2022), Table isoc_bde15cua: Internet use and activities

[378] AI Watch (2022) Road to the adoption of Artificial Intelligence by the Public Sector: A Handbook for Policymakers, Public Administrations and Relevant Stakeholders, EUR 31054 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-52131-0, doi:10.2760/693531, JRC129100.

existing service interfaces through applications that are more usable, and thus decrease barriers to use". The second model looks to test that theory.

Figure 60 Regression table - Health

	AI Research by Health Institutions	**Seeking Health Information**
User	224.37	70.24
Funder	-87.17	-3.05
Planner	-204.23	-6.32
R^2	0.22	0.07
Observations	27	27

- **Research:** *User* countries are correlated with the largest research output by health institutions with 87 more publications per year on AI than *funder* countries and 204 more than *planner* countries.
- **Information:** Similarly, of the 3 categories, *planners* have the lowest percentage of citizens seeking health information online at around 63%, 3% less than *funder* countries and nearly 6.5% than *developers.*

2.5 Education

In the words of educationalist and academic Anthony Seldon, AI in education is not "a passing innovation like the introduction of photocopying or smart boards, but a once-in-five-hundred-year revolution"[379]. AI is set to transform education for learners, teachers and the ecosystem as a whole. Broadly speaking, the consensus is that AI will have a differentiated effect on different areas of education both supporting existing capabilities and creating cognitive capabilities that would not be possible without technology and reducing the importance of some human cognitive capabilities or making them obsolete[380]. From improving special needs education through the detection of conditions such as dyslexia to the generation and assessment of tests, the potential use cases in schools and early learning are highly varied if not yet currently especially common.

However, more than a tool to improve the provision of education, AI is also a prevalent subject of learning around the world as governments try to educate citizens from all age-groups Thanks to its relationship with labour and employment, the predicted structural changes caused by AI to jobs through increased automation will have a drastic impact on education. Traditional educational institutions, employers and

[379] Baker, Toby and Laurie Sue Smith (2019) "Educ-AI-tion Rebooted ? Exploring the future of artificial intelligence in schools and colleges."
[380] European Commission, Joint Research Centre, Tuomi, I.,(2019) The impact of Artificial Intelligence on learning, teaching, and education, Punie, Y.(editor), Vuorikari, R.(editor), Cabrera, M.(editor), Publications Office

individuals will need to ensure what they are learning remains relevant to avoid being left behind.

Even in the nearer term, adult learners must be provided with the means to prosper in an ever-changing world as other previous skills become less useful. AI as a subject is increasingly common with online learning and Massive Online Open Courses (MOOCs) are seen as an effective strategy for the dissemination of awareness and understanding of AI, even for policymakers themselves. In the words of an EIT report, "Policymakers and employers must also create pathways for non-near AI talent to eventually upskill to AI talent, for instance creating a learning pathway from business operations analyst into a data scientist, and then finally into an AI worker".[381]

The policy landscape: Education and AI

As with the other sectors, supporting the growth of AI in education requires a comprehensive picture of the current activity in the research sphere and broader market of AIEd[382]. Featuring every published National AI strategy, education or "human capital" is a significant priority for the EU´s member states. Nevertheless, the majority of policies are focused on learning about AI rather than learning with AI with a particular focus on adult learning and upskilling (see figure below). However, this uniform signal of intent has not translated into meaningful policy platforms particularly procurement of AI technologies for use in the education system. While there is considerable variety in national approaches and the nuances of the policies themselves, it is possible to construct a broad typology of policies both in what role they perform and who they target. Indicative of the focus on upskilling and adult education that defines AIEd for many, the largest focus on policies is on industry and professional training also in the form of a "course" (which is longer than a "workshop" and has more restricted access than a MOOC). These can be relatively open like Slovakia´s Kinit.sk or have a sector-specific focus such as Slovakia´s AI courses for the public sector or Belgium´s EluciDATA lab which is marketed towards individuals already working in the technology sector.

The educational initiatives on AI can be broken down broadly into 5 categories:

- **Workshop**. A short-term introductory session which will teach the learner the basics of AI or demonstrate a particular use case
- **Course**. A medium to long/term learning programme typically takes several weeks after which the learner will receive a qualification/certificate.
- **MOOC**. Similar to a course except with free and universal access
- **Portal/Platform**. The infrastructure upon which a user can host AI education content or interactions between EdAI and Edtech companies.
- **Centre**. A multidisciplinary setting which combines many of the categories above and provides research, short- and long-term learning opportunities.

[381] EIT Health (2021) Analysis of the educational activities available in the area of Artificial Intelligence: https://eit.europa.eu/sites/default/files/analysis_of_the_educational_activities_available_in_the_area_of_ai_crosskic_deliverable_1.pdf

[382] Baker, Toby and Laurie Sue Smith. "Educ-AI-tion Rebooted ? Exploring the future of artificial intelligence in schools and colleges." (2019)

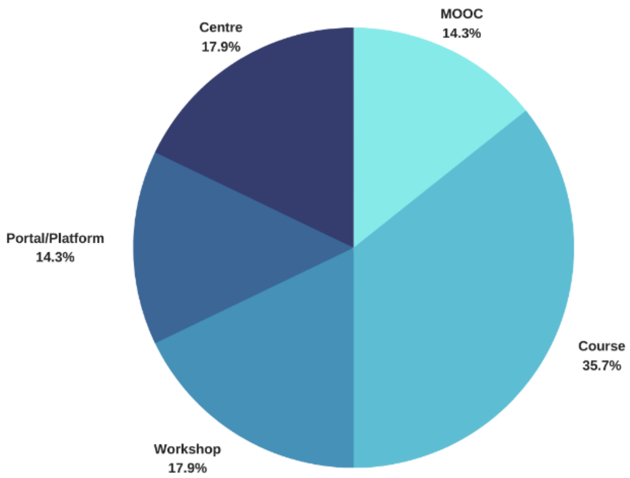


Figure 62: Breakdown per policy type

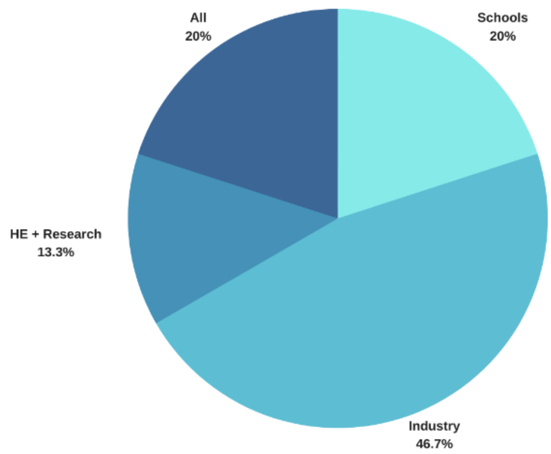


Figure 61: Policies per education level

Among the member states, Belgium leads the way with 10 policies which range from project grants for edtech companies in the SmartEducation@schools initiative to the "i-learn" portal and courses. Choosing the multidimensional approach of investment in *centres*, France and Germany have established the interdisciplinary Institutes of AI and the AI campus respectively. Without the financial clout for such large investments, smaller member states such as Malta are also innovating. The country has helped set up the AI Family Challenge and the AI Olympiad, which hones in on schools and specifically Early Childhood and Care (ECEC) while most states are focusing on later stages of education. As Nesta notes, this is still quite far away from the paradigm shift in education and there are no systemic applications of AI to education although many satisfy the EIT´s list below:

The EIT´s 10 actionable suggestions to become a leader in the European AI education landscape[383]

- Focus on European applied topics like language and culture in the courses.
- Complement the hard skill education in AI with AI-related soft skills.
- Market AI programs specifically to a female audience to foster diversity.
- Strengthen collaboration with universities and facilitate the offering of accredited courses.
- Create the first European open platform for online courses.
- Offer students AI courses free of charge and early in education.
- Help professionals in specific industries solve current problems with applied AI workshops.
- Educate and enable managers to create pragmatic AI governance.
- Facilitate courses for decision-makers to understand the potential of AI.
- Strengthen courses for policymakers to understand the ethics of AI.

[383] EIT Health (2021) Analysis of the educational activities available in the area of Artificial Intelligence: https://eit.europa.eu/sites/default/files/analysis_of_the_educational_activities_available_in_the_area_of_ai_crosskic_deliverable_1.pdf

2.5.1 Challenges and corresponding AI solutions/applications in the education sector

As with all economic sectors, education is being redefined and profoundly transformed by societal and technological challenges that have materialised over the past decades. A UNESCO paper on AI in education divides these into 4 principal focus areas where AI application can be found[384]:

- Lifelong learning (Student facing)
- Learning and assessment (Student-facing)
- Empowering teachers and enhancing teaching (teacher-facing)
- Education management and delivery (system-facing)

These different challenges will be briefly introduced as well as the AI techniques to address them. However, one can already highlight that most of these techniques are at a very early stage in terms of Technology Readiness Level (TRL). In reality, despite some lighthouse projects, AI in education has few concrete examples of implementation and most solutions are still at the R&D stage.

Figure 63 Summary of challenges and AI solutions for education

Public sector challenge	*Ensure relevant skills in the population*	*Improve learning outcomes*	*Prepare teachers for the digital age*	*Increase efficiency in education systems*
AI value driver	Lifelong learning	Learning and assessment	Empowering teachers and enhancing teachers	Education management and delivery
AI Solutions	AI-driven lifelong learning companions AI-enabled continuous assessment AI-enabled record of lifelong learning achievements	Intelligent tutoring systems Dialogue-based tutoring systems Exploratory learning environments Automated writing evaluation AI- supported reading and language learning Smart robots Teachable agents Education virtual and augmented reality Learning network orchestrators	AI-driven discussion forum monitoring AI-powered teaching assistants	Educational chatbots Predictive algorithms

Lifelong learning

In the current age of rapid technological change, lifelong learning has become a requirement for education systems to ensure their citizens remain competitive.

384 UNESCO, 2021, *AI and Education: Guidance for policy-makers*, https://unesdoc.unesco.org/ark:/48223/pf0000376709

With the fast rate of obsolescence of knowledge and skills, teachers and students need to constantly acquire new abilities and update their knowledge. The skills demanded from the workforce are constantly changing, with more and more emphasis being placed on STEM fields. "For example, 54 per cent of American workers who responded to a Pew Research Centre survey in 2016 indicated that they thought they would need further upskilling during their careers, and 39 per cent of large-company executives surveyed by Deloitte expressed difficulty in finding the talent their companies required. Many of the skills shortages lie in STEM fields."[385]

Over the years, the interest in AI and Lifelong Learning has converged, with the hope that new AI techniques could simplify and increase the impact of LLL on workers' skillset. [386] In total, 3 main types of applications of AI for LLL can be identified:[387]

Even though LLL and e-learning are dynamic and high-upside markets,[388] the use of AI in lifelong learning remains, so far, very limited. Indeed, most technologies in the field have not reached the level of technological maturity needed for large-scale implementation. Many projects are still underway, not just to develop these techniques, but also to understand their potential and to assess their risks.[389] In addition, important ethical concerns are being raised regarding the risks of "Lifelong Learning" turning into "Lifelong Tracking" with the use of AI techniques.[390] [391]

In addition, criticisms were voiced against the very concept of LLL itself. Indeed, some advocate that the replacement of "Lifelong Education" with "Lifelong Learning" indicates the utter domination of economic-driven interest and the corporate world in this sphere. This involves a series of risks such as the confinement of developed materials to economically-driven topics and the exclusion of low-income or unemployed people from most interesting initiatives.[392]

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[385] UNEVOC – UNESCO, 2021, *Understanding the impact of artificial intelligence on skills development*, https://unevoc.unesco.org/pub/understanding_the_impact_of_ai_on_skills_development.pdf

[386] Rebecca Eynon et al, January 2021, *Methodology, legend, and rhetoric: the constructions of AI by academia, industry, and policy groups for lifelong learning*, https://journals.sagepub.com/doi/pdf/10.1177/0162243920906475

[387] UNESCO, 2021, *AI and Education: Guidance for policy-makers*, https://unesdoc.unesco.org/ark:/48223/pf0000376709

[388] GlobeNewsWire, 21/05/2021, *The e-learning market size is expected to grow at a CAGR of over 13% during 2020-2026*, https://www.globenewswire.com/news-release/2021/05/21/2233971/0/en/The-e-learning-market-size-is-expected-to-grow-at-a-CAGR-of-over-13-during-2020-2026.html

[389] For example: OxfordInternetInstitute, sin dato, *Understanding the potential of AI in Lifelong learning: A critical perspective*, https://www.oii.ox.ac.uk/research/projects/understanding-the-potential-of-ai-in-lifelong-learning-a-critical-perspective/

[390] Solidar Foundation, 2020, *Position paper*, https://www.solidar.org/system/downloads/attachments/000/001/142/original/SOLIDAR_Foundation_AI_Position_Paper.pdf?1592215657

[391] Regarding the ethical risks for AI in education, the reference is the "International conference on artificial intelligence and education" (Beijing, 16/05/2019). Participants adopted the "Beijing Consensus on Artificial Intelligence". Declares a humanistic approach for usage of AI in education:

The Consensus details the policy recommendations on AI in education in five areas:

1. AI for education management and delivery;
2. AI to empower teaching and teachers;
3. AI for learning and learning assessment;
4. Development of values and skills for life and work in the AI era; and
5. AI for offering lifelong learning opportunities for all.

It also elaborates recommendations corresponding to four crosscutting issues:

1. Promoting equitable and inclusive use of AI in education;
2. Gender-equitable AI and AI for gender equality;
3. Ensuring ethical, transparent and auditable use of education data and algorithms; and
4. Monitoring, evaluation and research.

UNESCO, 2019, *The Beijing Consensus on Artificial Intelligence and Education*, https://unesdoc.unesco.org/ark:/48223/pf0000368303

[392] Poquet Oleksandra et al, 2021, *Developing Capabilities : Lifelong learning in the Age of AI*, https://www.researchgate.net/publication/351700209_Developing_capabilities_Lifelong_learning_in_the_age_of_AI

Generally, three main stakeholders are involved in AI for LLL: governments, industrial players and academia. However, academia-designed-solutions are only rarely applied in a real-life setting and tend to be complex and confined to the academic world and are yet to become a mainstay of the business world.

Policy-makers could support the development of AI in LLL in three ways:

- The low maturity of the technology in the field requires more investment in R&D. The technology still requires investments in R&D projects and would benefit from support funds and research projects from public authorities in the three fields: learning companions, continuous assessment and certification.
- To develop a more ethical approach, the "Ethical Committee" could be developed to involve third parties, including citizens, governments, academia and industry-players. These committees would be involved in the design and monitoring of AI in LLL to avoid lifelong tracking.
- Public authorities can increase the uptake of market solutions and speed-up development of new AI in LLL by procuring and pilot-testing these techniques on their Lifelong Learning platforms (e.g., the "EAD" platform (Éducation à Distance") managed by the unemployment office in the south of Belgium).

Lifelong Learning		
Type	**Description**	**Maturity**
AI-driven lifelong learning companions	• Development of an AI companion based on the skills, needs and experience of the learner •	• So far, only research projects at an early TRL stage exist in that field.
AI-enabled continuous assessment	• This type of application already exists for basic assessment (e.g., using scripted answers to answer basic questions).	• This type of application already exists for basic assessment (e.g., using scripted answers to answer basic questions).
AI-enabled record of lifelong learning achievements	• With the increase in workers engaging in LLL, the need to make these learning achievements valuable in the work market or with traditional educational institutions is symmetrically rising. An AI-enabled record of LLL would track all achievements, certificates and courses taken to develop a personalised portfolio that could be shared with an employer.	• As for other AI solutions in LLL, this remains an R&D project with no concrete examples. •

Learning and assessment

The area which has received the most attention thus far, for better and for worse, is AI In learning and education. Particularly pervasive thanks to the pandemic, AI-enabled education seeks to provide access to "high-quality, personalized and ubiquitous" learning[393].

New technologies, global competition and even the rise of AI itself mean that curriculum must be constantly improved to integrate new technological-driven knowledge. Indeed, education with AI does not simply mean using AI for educational purposes. It also means preparing workers to learn about AI and also use AI in their future work.[394]

With the rapid rise in the demand for new skills, education institutions, students and workers face difficulties in maintaining employability. Similarly, employers have difficulties finding the correct profile for the tasks at hand. This mismatch is already well-known. AI can help resolve these difficulties by helping to raise awareness about employability and helping individuals to develop a career path: [395]

"*Helping to develop self-awareness about choices and develop career paths*

- AI experimental solution for eye tracking and scanning that can assess personality
- AI games that let people express and identify their knacks (traits and abilities)
- AI-powered Chatbots that advise people about their career path and exploration options and resources

Learning and skills building

- AI educational solutions that adapt and personalize the learning experience
- AI-powered augmented reality solution that builds interactive visual material
- AI virtual learning assistant
- Speech-to-text AI learning solutions

Qualification assessment and matchmaking:

- AI virtual assistants for profile building, resume review and ATS compatibility
- AI-powered neuroscience games to match candidates to the best-fit jobs
- AI search engines that sort and categorize jobs from a wide range of job sites
- AI chatbots for job recommendations
- AI matchmaking platforms that use different forms of personal and qualification assessments"

Unfortunately, AI for employability is dominated by foreign companies. The US companies represent 52% of innovations in the domain, followed by the group made of Israel, Canada and the UK (25%), followed by Europe (11%) and China and India (around 8% combined). Combined, African companies represent 4%.[396]

Nonetheless, this remains a promising field for further research. AI for higher employability would reduce friction in the work market and recruitment processes. Furthermore, research in the development of AI techniques is, in itself, a way of creating new jobs [397] Chatbots and other AI systems can half the matchmaking process time for recruitment. 74% of candidates dropping from a candidacy process

[393] UNESCO, 2021, *AI and Education: Guidance for policy-makers*, https://unesdoc.unesco.org/ark:/48223/pf0000376709
[394] Brookings (2018) *The role of AI in education and the changing US workforce*, https://www.brookings.edu/research/the-role-of-ai-in-education-and-the-changing-u-s-workforce/
[395] Marwan Akram (2020) *Impact of artificial intelligence on education for employement: learning and employability framework*, https://fount.aucegypt.edu/cgi/viewcontent.cgi?article=1839&context=etds
[396] Ibid
[397] Ibid

made that decision out of "frustration" because of a complex or unclear procedure — something that could be greatly simplified thanks to AI techniques. [398]

To help support these techniques, it would be recommended that:

- The curriculum should be updated to include skills that are important in new economies. Legislation and policy-makers should support the development of partnerships between schools and their ecosystem to support workforce development partnerships (involving educators, internships, etc). [399]
- The development of gamified AI to improve self and market awareness among young people can help to decrease the mismatch between job offers and demand. [400]

Student-facing AI		
Type	**Description**	**Maturity**
Intelligent tutoring systems	• Provides step-by-step tutorials individualised to each student on structured topics (e.g., IT and mathematics). However, this solution is based on ignoring other learning assumptions (e.g., Productive Failures). Furthermore, this approach prescribes content instead of encouraging students' agency. • There is only limited evidence of these solutions' effectiveness.	• Most mature field with some concrete applications cases. Also generated interest from the private world with ongoing investments. Sometimes implemented in Learning Management Systems (e.g., Khan Academy). • 60 commercial ITS available, the main ones are Alef, ALEKS, Byjus, Mathia, Qubena, Riiid, and Squirrel AI.
Dialogue-based tutoring systems	• AI uses natural languages to simulate a spoken tutor-student dialogue. Encourages students to co-create explanations to have a deeper understanding.	• Low maturity. • Research project with a heavy focus on application in ICT. Examples: Watson tutor and AutoTutor.
Exploratory learning environment	• Students are encouraged to explore their learning environment to build their path and curriculum. The role of AI is to provide automated guidance and avoid cognitive overload	• Only research projects exist. • Examples are ECHOES, Fractions lab and Betty's Brain.

[398] Ibid
[399] Brookings (2018) *The role of AI in education and the changing US workforce*, https://www.brookings.edu/research/the-role-of-ai-in-education-and-the-changing-u-s-workforce/
[400] Marwan Akram (2020) *Impact of artificial intelligence on education for employement: learning and employability framework*, https://fount.aucegypt.edu/cgi/viewcontent.cgi?article=1839&context=etds

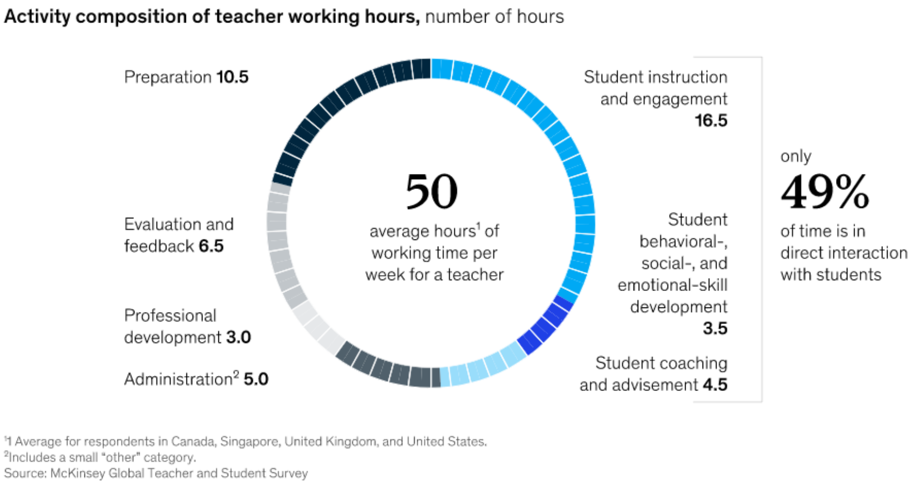
	leading to students giving-up.	
Automated writing evaluations	• Automated techniques to provide feedback on writings to help a student improve writing or to facilitate (and automate) scoring of students' works.	• Already used in an education context with programs: WriteToLearn, e-Rater and Turnitin.
AI-supported reading and language learning	• Includes speech recognition used to compare students' productions with a recorded sample of native speakers. Also includes automatic translation to read learning materials in other languages.	• Varying level of maturity. Genuine AI solutions are still in the early research stage. Some simpler versions are already in use, eg: AI teacher, Amazing English, Babbel, and Duolingo.
Smart robots for social inclusion	• Speech-enabled humanoid robots created for learners on the autism spectrum provide mechanical interaction more reliably than human ones. Or telepresence robots for sick or absent students.	• Already some examples of applications in Asia. Examples: Nao and Pepper (kindergarten robot in Singapore) used to introduce kids to STEM and programming.
Teachable agents	• AI acts to simulate another student that can be taught by the learner. This helps and encourages the active acquisition of knowledge.	• Only at a research stage, the "Betty" project is the main existing example.
Educational virtual and augmented reality	• VR and AR-assisted learning to increase learners' engagement.	• Already been used for some specific learning activities in geology or biology (e.g., simulating being inside a human womb or volcano). • Examples: Blippar, Eon reality, Google Education, Neobear, and VRMonkey.
AI-enabled collaborative learning	• Enhancing learning outcomes through the creation of a collaborative environment. Help to coordinate activities between learners and between learners and teachers.	• No concrete examples, only a research project at this stage.

Empowering teachers and enhancing teaching

The same considerations of needing to keep the skills and knowledge base in the population no only applies but is even more acute with Europe´s teachers and educators. Most EU countries face the dual challenge of an ageing work force and a general shortage of teachers. For example, in Italy, 53% of teachers are aged 50 or older.[401]

Artificial Intelligence can help tackle these obstacles in two different ways. Firstly, AI can drive the apps and systems to personalise and automatically adapt training offers (by creating learning pathways and automatically adapting the classes and courses to the student). [402] Secondly, AI can automate repetitive work thus sparing time for teachers to focus on key tasks.

Together, these solutions represent an important gain in teaching times. According to the University College London, teachers in England work, on average, 47 hours a week, and less than half that time is dedicated to teaching tasks.[403] These findings match the results from the study carried out by McKinsey:



Source: McKinsey[404]

According to McKinsey: "Our current research suggests that 20 to 40 per cent of current teacher hours are spent on activities that could be automated using existing technology. That translates into approximately 13 hours per week that teachers could redirect toward activities that lead to higher student outcomes and higher teacher satisfaction. In short, our research suggests that existing technology can help teachers reallocate 20 to 40 per cent of their time to activities that support student learning."[405]

[401] European Parliament (2020) *Teaching careers in the EU*, https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/642220/EPRS_BRI(2019)642220_EN.pdf

[402] Some concerns are raised about the potentiality of AI to really empower the workforce/student. See for example: Akhras Fabio et al, June 2011, *First workshop on Artificial intelligence in Education to support the social inclusion of communities*, https://www.researchgate.net/publication/251401277_First_Workshop_on_Artificial_Intelligence_in_Education_to_Support_the_Social_Inclusion_of_Communities_AIEDSIC

[403] Financial Times (2020) *How AI eases teachers' heavy workloads, https://www.ft.com/content/da3a9bac-3e0a-11ea-b84f-a62c46f39bc2*

[404] McKinsey (2020) *How Artificial Intelligence will impact K-12 teachers*, https://www.mckinsey.com/industries/education/our-insights/how-artificial-intelligence-will-impact-k-12-teachers

[405] McKinsey (2020) *How Artificial Intelligence will impact K-12 teachers*, https://www.mckinsey.com/industries/education/our-insights/how-artificial-intelligence-will-impact-k-12-teachers

Even though the exact time spent on each task might differ for European countries, the general lessons' conclusions and logic still apply to the European context. Policy-makers can support the development of these solutions in the following way:

- Investments should be targeted on solutions that are mature and easy to implement to accustom and upskill the teacher workforce. Teachers' and school leaders' capacity to harness new technologies should be strengthened. [406]
- Development and implementation of these techniques should be done inclusively, involving all key stakeholders: school directors/leaders, technology companies, governments, teachers and learners. [407]

Empowering teachers and enhancing teaching		
AI-driven discussion forum monitoring	• Monitor discussion forums (where students can respond to tasks, and ask questions about materials, classes, etc). AI can answer simple questions (about schedules for example), triage questions and identify the relevant teacher or even use sentiment analysis to identify non-productive emotions (e.g., aggressivity).	• Successful pilot projects conducted in the US face important ethical criticisms. The Assistant Jill Watson developed at Georgia Tech in the US was used to send assignments deadlines and other basic information by email. However, the program was criticised for emulating to be a human by delaying answers and even using humour.
AI-Human "dual teacher" model	• Instead of replacing humans to carry specific tasks, this paradigm relies on developing a mix human-AI approach. • The AI could help the human teacher with many tasks, including providing specialist expertise or professional development resources, collaborating with colleagues, both within and outside the particular setting, monitoring the students' performance, and tracking progress over time.	• Research project. Mostly developed in China for remote areas. Existing programmes use videos to have experienced teachers giving classes to remote locations where they are assisted by local and less experienced teachers. The Le Waijiao AI classroom is developed to replace the long-distance teacher with an AI to support the local teacher.

[406] McKinsey (2020) *How Artificial Intelligence will impact K-12 teachers*, https://www.mckinsey.com/industries/education/our-insights/how-artificial-intelligence-will-impact-k-12-teachers

[407] McKinsey (2020) *How Artificial Intelligence will impact K-12 teachers*, https://www.mckinsey.com/industries/education/our-insights/how-artificial-intelligence-will-impact-k-12-teachers

AI-Powered teaching assistants	• As mentioned, many technologies are designed to relieve teachers of time-consuming activities such as taking attendance, marking assignments and answering the same questions over and over again	• Some research on these has been undertaken, but many technical and ethical issues need to be overcome before they can be harnessed in real settings

Education management and delivery

In addition to supporting students and teachers, AI holds great promise when applied to education systems on a broader level. At the school-level, AI can be used for expediting organizational tasks and "learning analytics":

Simplification and automation of administrative tasks (e.g., naturally written language recognition and automatic grading for basic tasks[408]; sending automated reminders for students about homework and other information).

Forecasting and Efficiencies (e.g., enhanced planning for future administrative and directorial tasks, avoiding waste and generating savings).

Real-time data: dashboards and systems to track and provide educators with information about students (e.g., identification of students at risk of dropping-out). Some school districts in the US already use this type of system.[409]

Furthermore, AI and big data can offer valuable insights at the system-wide level where data from multiple educational institutions can be aggregated and analysed to improve educational policy itself.

Education management and delivery [410]		
Educational Chatbots	• Chatbots are online computer programs that use cloud-based services and AI techniques to hold simulated conversations with people. The human user types or speaks a question, and the chatbot responds, providing information or undertaking a simple task.	• With varying levels of maturity, most solutions are at a research or pilot stage. The most promising examples (are basic chatbots replying using pre-programmed scripts); advanced chatbots using natural language recognition and machine learning to generate unique responses.

[408] "*Century Tech's system marks each student's work automatically, collecting the data for teachers so they can identify who understood the lesson and who struggled. Funded by angel and social impact investors, it charges £5 a year per pupil, and invests revenues into research*." Financial Times, 09/03/2020, *How AI eases teachers' heavy workloads, https://www.ft.com/content/da3a9bac-3e0a-11ea-b84f-a62c46f39bc2*

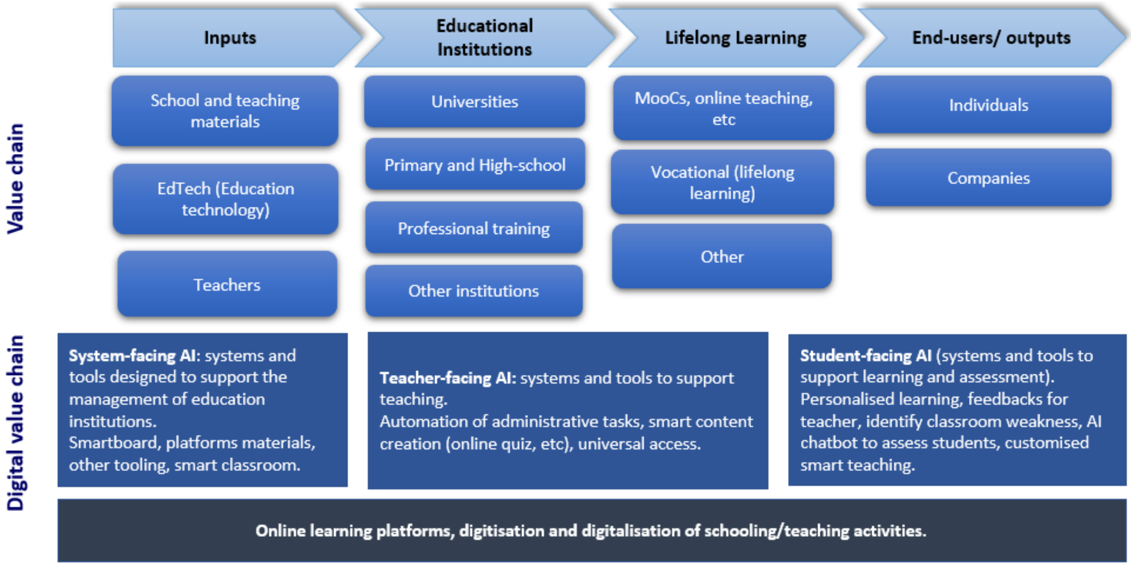
[409] EDSEMBLI, sin dato, *How can AI help educators redirect time to what matters most?* https://www.edsembli.com/ai-and-workload-management-for-teachers/

[410] Most of these solutions are already mapped in the section about "Changing demography". Also see: UNESCO, 2021, *AI and Education: Guidance for policy-makers*, https://unesdoc.unesco.org/ark:/48223/pf0000376709

2.5.2 Education value chain analysis

While not as well-suited as with other sectors, the value chain approach can still help to structure and guide the analysis. Indeed, it gives an idea of the different steps needed to deliver education services. The figure below provides an elaboration of a value chain and digital value-chain representation for the education sector.

Figure 64 Education value chain



Source: Authors' elaboration.

This representation clarifies the different steps involved in the delivery of education services. However, from the perspective of implementing AI solutions, these steps are too intertwined to be analysed separately. Consequently, this graph should be seen as an overview of the education sector and the digital functionalities that exist in the sector. This section will investigate the three following points:

- The COVID-19 outbreak's impact on the digitalisation of the educational sector;
- AI in the EdTech industry;
- AI for the delivery of education services.

The COVID-19 outbreak's impact on the digitalisation of the educational sector

With the closure of schools and the impossibility to deliver organise in a physical format, the COVID crisis acted as an accelerator for the digitalisation of the educational system, contributing to a year-to-year increase of 21% in the EdTech market in 2021.[411]

While this increase is substantial, many elements highlight that these changes were not as profound as originally expected or even hoped for. In reality, once able to "go back to normal", most schools abandoned the use of digital tools to revert to original

[411] Forbes (2022) *Five trends the EdTech industry should pay attention to in 2022*, https://www.forbes.com/sites/forbesbusinesscouncil/2022/03/10/five-trends-the-edtech-industry-should-pay-attention-to-in-2022/?sh=17fa884a5a4a

teaching methods. Overall, the desire to maintain a mixed-teaching methodology incorporating digital solutions seems to be lacking throughout Europe. [412]

More profoundly, even though digital solutions were key to maintaining learning activities, they fell short of the initial objective of maintaining a similar level of quality. An impact study from the Netherlands concluded that the use of Digital schooling during the crisis led to lower learning gain and increased inequalities. On average, Dutch high-school students lost between 0.06-0.2 points in reading and between 0.13-0.33 in mathematics. The greatest learning losses were observed in lower-income and lower-education households. [413]

In reality, most countries already launched ex-post remedial plans to compensate for the learning losses. Many hopes surrounded the use of AI during the crisis but also in the context of these remedial plans. However, concrete achievements and the use of AI are very limited. In reality, the majority of measures were focused on setting-up emergency solutions to reach all students. Neither curricula nor teaching methods were adjusted to incorporate AI or other advanced digital techniques. Similarly, only a few efforts were made in monitoring the acquisition of learnings and measuring results.[414]

In the same order of ideas, in the UK, 86% of the technologies introduced in the primary school system during the crisis were learning platforms used to send and received pupils' work. In high-school, 89% of the digital systems implemented served to enable live remote sessions and learning remotely.[415] Comparatively, the use of advanced technologies and AI systems was very modest, with only 16% of high schools and 5% of the primary school mentioning making use of AI[416]: "Use of other technologies was significantly lower. Assistive technology was the most commonly used, followed by learner analytics and secondary schools were significantly more likely to use these technologies compared to primary schools. A minority of schools used any artificial intelligence (AI), virtual reality (VR) or augmented reality (AR) technologies. Use of accessibility features built into mainstream devices and software was particularly low in primary schools."[417]

Despite optimistic claims, the main achievement of the crisis regarding educational AI was to increase positive attitudes toward AI technologies in education, but with limited impact in terms of actual implementation and use.[418]

Nonetheless, several measures could help societies to reap the benefits of the COVID crisis in the education sector:

- The COVID crisis acted as a large-scale experiment for testing digital systems in educational institutions. However, there is a lack of impact studies on the matter. Research efforts are needed to map digital strategies; identify what

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[412] Vegas Emiliana (2022) *Education technology post-COVID-19: a missed opportunity?*, *https://www.brookings.edu/blog/education-plus-development/2022/03/11/education-technology-post-covid-19-a-missed-opportunity/*

[413] Haelermans Carla et al, (2022) *Sharp increase in inequality in education in times of the COVID-19 pandemic*, https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0261114

[414] WorldBank (2022) *Remote Learning During the Global School Lockdown: Multi.country lessons*, https://documents1.worldbank.org/curated/en/668741627975171644/pdf/Remote-Learning-During-the-Global-School-Lockdown-Multi-Country-Lessons.pdf

[415] UK Department of Education (2021) *Education Technology (EdTech) Survey 2020-21*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1057817/Education_Technology_EdTech_Survey.pdf

[416] However, this figure is not detailed enough in the report. It is therefore unclear if these were genuine AI-systems or not. Furthermore, AI applications can include chatbot to answer to student's questions about schedules.

[417] UK Department of Education (2021) *Education Technology (EdTech) Survey 2020-21*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1057817/Education_Technology_EdTech_Survey.pdf

[418] Pantelimon Florin-Valeriu et al (2021), *The evolution of AI-driven Educational Systems during the COVID-19 Pandemic*, https://www.mdpi.com/2071-1050/13/23/13501/pdf?version=1638844186

exact solutions were used; identify best-practices; identify clear failures and mistakes to avoid. Based on these elements, a roadmap for digitalisation and implementation of AI in the education sector could be developed.[419]

- The "back to normal" scenario seems to highlight that the changes made during the COVID crisis were superficial (no changes in curriculum, measures were mostly focused on organising classes using videos, etc) with no explorations of the possibility to develop mixed-methodologies. Identifying the reasons behind this fact could help to develop a clear and substantiated understanding of what are the exact barriers and solutions for the uptake of AI in education.[420]

AI and the European EdTech industry

The expected benefits for the education sector from the wider use of EdTech are widely acknowledged and accepted. For example, in the UK, 88% of headteachers and 84% of teachers agree that these technologies already deliver benefits and will continue to do so, especially in terms of reducing workload and saving time to help teachers focus on key tasks.[421]

Simultaneously, many optimistic assessments and statements highlight the market potential for EdTech. [422] The World Bank, for example, expects Education AI to reach $6 billion by 2024.[423] Marketsandmarkets assess the global AI in the education market to reach USD 3.68 billion by 2023 at a CAGR of 47%.[424] Similarly, the e-learning market size is expected to rapidly grow at a CAGR of 13% during the 2020-2026 period.[425]

However, EdTech is a complex market that includes different technologies and solutions including blockchain for administrative documents (e.g., digitalised degree ensuring traceability), big data, gamification, platforms, etc. [426]

In reality, the importance of Artificial Intelligence in the existing business model of EdTech companies is much more limited than sometimes advertised. [427] "Answering [the question of implementing AI in education] and similar questions is challenging due to the unstructured market, lack of evidence, and topic-specific complexity. Moreover, the market is growing much more slowly than other markets are with the

[419] For example, the initiative in Peru to ask daily reports from teacher using the digital platform led to increasing the workload and causing burnout in the educational personnel. WorldBank, 30/03/2022, *Remote Learning During the Global School Lockdown: Multi.country lessons*, https://documents1.worldbank.org/curated/en/668741627975171644/pdf/Remote-Learning-During-the-Global-School-Lockdown-Multi-Country-Lessons.pdf

[420] Vegas Emiliana (2022), *Education technology post-COVID-19: a missed opportunity?, https://www.brookings.edu/blog/education-plus-development/2022/03/11/education-technology-post-covid-19-a-missed-opportunity/*

[421] UK Department of Education, (2021), *Education Technology (EdTech) Survey 2020-21*, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1057817/Education_Technology_EdTech_Survey.pdf

[422]"*Investors generally continue to be enticed by education technology companies such as Century, with venture capital funding for the sector surpassing $8bn in 2018, according to Holon IQ, a market intelligence agency. Think and Learn, the Indian company behind learning app Byju, was recently valued at $8.2bn following fresh funding of $200m from US private equity group General Atlantic*." Financial Times, 09/03/2020, *How AI eases teachers' heavy workloads, https://www.ft.com/content/da3a9bac-3e0a-11ea-b84f-a62c46f39bc2*

[423] UNESCO (2021) *AI and Education: Guidance for policy-makers*, https://unesdoc.unesco.org/ark:/48223/pf0000376709

[424] Marketsandmarkets, May 2018, Ai in Education market, https://www.marketsandmarkets.com/Market-Reports/ai-in-education-market-200371366.html

[425] GlobeNewsWire, 21/05/2021, The e-learning market size is expected to grow at a CAGR of over 13% during 2020-2026, https://www.globenewswire.com/news-release/2021/05/21/2233971/0/en/The-e-learning-market-size-is-expected-to-grow-at-a-CAGR-of-over-13-during-2020-2026.html

[426] Which can lead to complete overestimation of the market, such as Globant estimating the market to reach 7 trillion dollars by 2027. Globant, 2021, The Next Wave of EdTech, https://reports.globant.com/wp-content/uploads/2021/12/Whitepaper_EdTech-1.pdf

[427] Nazaretsky et al, 2021, An instrument for measuring teacher's trust in AI-Based Educational Technology, https://dl.acm.org/doi/abs/10.1145/3506860.3506866

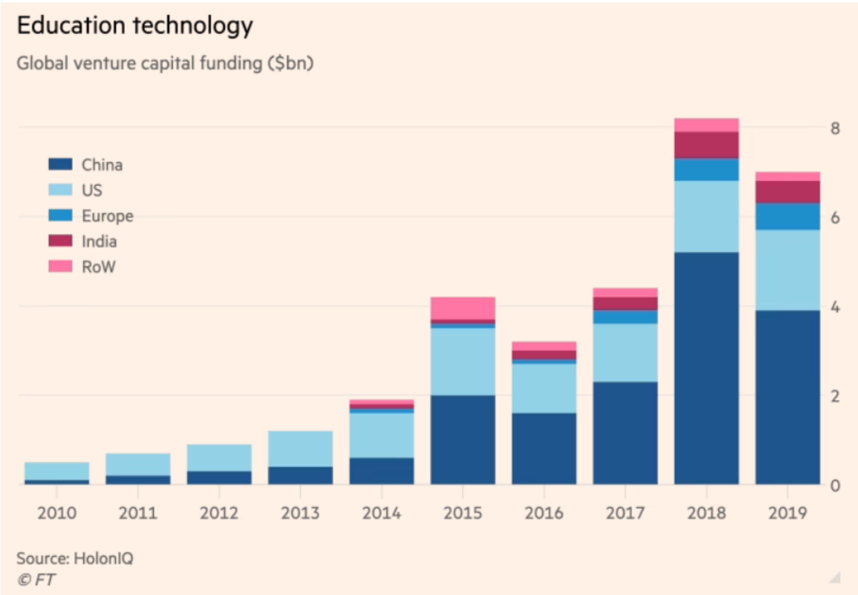
dynamics of digital transformation" thanks to the diversity of actors involved in the market." [428]

Concrete use cases of AI applications in education exist such as the DreamBoxLearning program for mathematics developed by the Netflix group in the US to enable personalised learning using AI and adaptative intelligent learning systems. There is also the Knewton solution to analyse user data to establish success prognoses and identify learning profiles; the use of IBM's Watson supercomputer to provider 365 days of feedback to students at Deakin University in Australia; the use of Degree Compass by Austin Peay State University to establish probabilities for students to pass courses; the eAdvisor solution used by Arizona State University. [429]

However, most of these are flagship initiatives with little progress in terms of replication or large-scale implementation. In reality, there are very few examples of successful implementation of AI solutions in education settings. Many cases that are advertised as AI solutions, once investigated, turn-out to not be data-driven AIs. [430] [431]

In addition, in a European context, it is extremely difficult to identify similar flagships and initiatives leading to more difficulties to encourage replication. Moreover, Europe tends to lag in the development of AI solutions and is also showing a lack of investment in the Education Technology market compared to China and the US.

Figure 65 Comparison of venture capitals in Education Technology for China, the US and Europe



Source: FT.

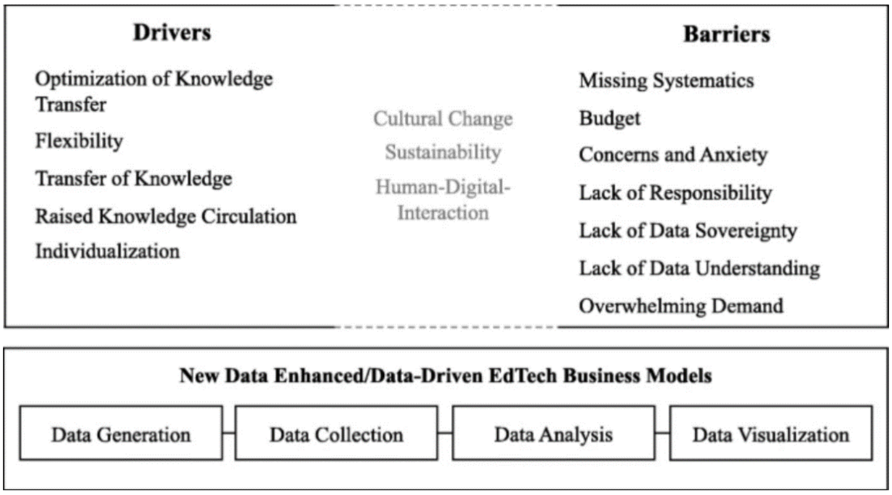
In reality, even if most EdTech companies offer some AI services, most of them are limited and lack a data-led business model. While there is evidence of the production

[428] Renz André et al, 24/02/2020, Prerequisites for artificial intelligence in further education : identification of drivers, barriers, and business models of educational technology companies, https://educationaltechnologyjournal.springeropen.com/articles/10.1186/s41239-020-00193-3#:~:text=While%20the%20desire%20for%20flexibility,solutions%20at%20the%20same%20time.
[429] Renz André et al, 24/02/2020, Prerequisites for artificial intelligence in further education : identification of drivers, barriers, and business models of educational technology companies, https://educationaltechnologyjournal.springeropen.com/articles/10.1186/s41239-020-00193-3#:~:text=While%20the%20desire%20for%20flexibility,solutions%20at%20the%20same%20time.
[430] Renz André et al, 24/02/2020, *Prerequisites for artificial intelligence in further education : identification of drivers, barriers, and business models of educational technology companies*, https://educationaltechnologyjournal.springeropen.com/articles/10.1186/s41239-020-00193-3#:~:text=While%20the%20desire%20for%20flexibility,solutions%20at%20the%20same%20time.
[431] Financial Times, 09/03/2020, *How AI eases teachers' heavy workloads,* *https://www.ft.com/content/da3a9bac-3e0a-11ea-b84f-a62c46f39bc2*

of interactive whiteboards, educational software as a service, hosting of educational data, etc, there is a lack of genuinely mature products already available on the market. [432]

Educational institutions are in a make-or-acquire dilemma situation. Institutions have to decide whether to develop the solutions they envision or acquire them. Furthermore, EdTech companies can act as competitors with education institutions as EdTech companies tend to become education service providers for AI solutions and systems.[433]The market is thus at a very early stage with low maturity, low demand and limited offer. One of these powerful barriers is the lack of acceptance of AI solutions in an educational setting.[434] [435]

Figure 66 Drivers and barriers to the uptake of AI in education



Source: Renz André et al[436]

Policy-makers can undertake several actions to encourage the development of the educational AI market:

- Tax incentives and other fiscal measures to encourage greater investment of venture capital in the development of educational AI.

[432] Renz André et al, 24/02/2020, *Prerequisites for artificial intelligence in further education : identification of drivers, barriers, and business models of educational technology companies*, https://educationaltechnologyjournal.springeropen.com/articles/10.1186/s41239-020-00193-3#:~:text=While%20the%20desire%20for%20flexibility,solutions%20at%20the%20same%20time.

[433] Nazaretsky et al, 2021, *An instrument for measuring teacher's trust in AI-Based Educational Technology, https://dl.acm.org/doi/abs/10.1145/3506860.3506866*

[434] Renz André et al, 24/02/2020, *Prerequisites for artificial intelligence in further education : identification of drivers, barriers, and business models of educational technology companies*, https://educationaltechnologyjournal.springeropen.com/articles/10.1186/s41239-020-00193-3#:~:text=While%20the%20desire%20for%20flexibility,solutions%20at%20the%20same%20time.

[435] To highlight this reluctance from the educational institutions, we can mention the position taken by The "European Trade Union Committee for Education" (ETUCE). The organisation released a position paper about the EU regulation of Artificial Intelligence. According to ETUCE, the classification of AI tools in education requires stricter regulations to mitigate risks. Furthermore, the union demands to forbid AI tools aimed at replacing or de-professionalising teachers and education personnel. Furthermore, ETUCES claims that transparency should be ensured and solutions developed in partnership with education personnel as co-creators of AI tools in education. Education social partners should therefore be engaged in the upcoming "Artificial intelligence Board". Finally, greater AI and technology literacy of the education personnel must be ensure. ETUCE, 15/06/2021, *Artificial Intelligence in education must not undermine the professional role of teachers*, https://www.csee-etuce.org/en/news/education-policy/4474-artificial-intelligence-in-education-must-not-undermine-the-professional-role-of-teachers

[436] Renz André et al, 24/02/2020, *Prerequisites for artificial intelligence in further education : identification of drivers, barriers, and business models of educational technology companies*, https://educationaltechnologyjournal.springeropen.com/articles/10.1186/s41239-020-00193-3#:~:text=While%20the%20desire%20for%20flexibility,solutions%20at%20the%20same%20time.

- Listing, mapping and assessing existing European flagships initiatives to encourage replication, identify best practices and disseminate results.
- Tenders and granting research funds and support to European companies active in educational AI to complement the lack of market dynamism in the field.
- Development of large pilot projects for the procurement and implementation of existing solutions as well as identifying key research needs and future pathways.

2.5.3 Main drivers and barriers

The table below presents a PESTEL analysis of the uptake of AI technologies in public procurement in the e-government sector.

Table 7 PESTEL analysis of the uptake of AI technologies in public procurement in the education sector

Criteria	Drivers	Barriers
Political	• There is a huge opportunity for a policy that supports innovative ecosystems to realize the opportunities of AI in the field of education, as educational institutions are aware of the necessity of AI adoption. • The adoption of AI in education has the potential to use data to facilitate and lower the effort on the assessment of the educational performance of regions, countries and Europe for the creation of reports and strategic plans for the future.	• A profound change in the education system requires a large amount of political capital due to the difficulty and time needed to implement solutions on a system-wide basis.
Economic	• The use of AI can help school leaders to predict issues before they arise. AI solutions can be used to lower energy costs, improve the management of staff optimise resource planning, etc. Education institutions can make advantage of AI to increase efficiencies and reduce the number of unforeseen events. • AI applications can reduce the administrative tasks of educators while freeing up time from repetitive tasks can have an impact on educator recruitment and retention. Additionally, it increases the efficiency, as well as the dedication of teachers to educational and student-oriented actions.	• A major challenge in the adoption of AI by educational institutions lies in planning and strategizing the school's budget. As some AI solutions and AI-powered technologies can have a considerable cost, understanding which AI-based learning tools are available and how they can benefit the students.
Social	• AI tools can help make impactful decisions in the classroom, which will enhance the learning	• Learning complex skills like developing perspectives, socializing in professional norms,

	process of students and their educational levels. Aspects such as determining which portions of the content need to be covered in greater depth and which resources are the best to use for a given unit and why along with providing the opportunity to cover more material will potentially improve each student's performance. • Personalization is one of the biggest contributions that AI can provide to students through a personalized approach to learning programs based on their own unique experiences and preferences. AI can adapt to each student's level of knowledge, speed of learning and desired goals so they are getting the most out of their education. • AI tools can be successfully trained to help any group of students with special needs, thus ensuring access to education for students with special needs. The adoption of innovative AI technologies can open up new ways of interaction with students with learning disabilities. • Universal 24/7 access to learning. Accessibility for all students, anytime and anywhere to learning can be guaranteed through AI-powered tools. It provides the possibility for each student to learn at their own pace, and 24/7 access makes it easier for students to explore what works for them without waiting on an educator.	feeling motivated, and mastering expertise requires the guidance of a human teacher. • Potential to increase the digital divide as the adoption of AI requires minimum technological characteristics (stable and reliable electrification, internet connection, hardware, etc.) which might be a barrier in less developed areas, regions or countries. • There is an important need to train and upskill all key stakeholders in AI including school directors/leaders, technology companies, governments, teachers and learners. Teachers will need to be trained in new teaching methodologies and tools, students will need to get familiar with AI technologies and make safe use of them; school leaders will have to understand the benefits AI technologies will provide to the educational centres to invest in them and technology providers will have to understand the needs of the educational environment and create efficient and trustworthy solutions.

Technological	• Potential to build large-scale data sets about the performance of students in a particular category across different regions, countries or the world. • AI allows the design and creation of Smart Content such as digital lessons (Digital learning interfaces with customization options, digital textbooks, study guides, bite-sized lessons, etc.), information visualisation (New ways of perceiving information, such as visualization, simulation, web-based study environments, etc.) and learning content updates. Textbooks can be digitized, and new learning interfaces are being created to help students of all academic grades and ages.	• Interoperability and the need for a complete tool that includes several functionalities and covers all the requirements of a classroom rather than various tools that are individually used for a singular purpose. The time it takes to transition between tools for different uses, and the static nature or lack of flexibility of some tools concerning how they are and can be used are considered a barrier in the educational processes. • Having highly reliable data is very sporadic, unevenly distributed, distorted, and limited in many other ways. Additionally, for the description of the learning process, other data such as the physical and emotional health of students, their socio-economic status, family situation or governmental policies can affect learning progress. • Technological linearity. To embed AI in Education, it is required that the technologies developed should be introduced early in conjunction with other digital tools so that its more widely accepted. • Low Technological Readiness Level. Most technologies in the educational field have not reached the level of technological maturity needed for large-scale implementation. There is a need to understand their potential and assess their risks, considering important ethical concerns and biases.
Environmental	• AI solutions can be used in educational institutions to lower energy consumption.	• The positive environmental impact can be shadowed by the negative environmental

	Accurate forecasts generated using machine learning based on historical patterns can ensure, for example, that heat and light are provided according to the actual demand. • The creation of Smart Leaning Materials can significantly reduce the number of physical materials used in educational institutions. Along the same line, de minimisation of physical material can translate into waste reduction.	impact, mainly in terms of energy consumption, of AI solutions, as well as other aspects such as the implementation of large server farms.
Legal	• The widespread adoption of AI solutions in education and other domains is a driver for the adoption of legislative adjustments required to properly and effectively address data handling issues.	• Attributing responsibilities. There is still uncertainty about who will take responsibility for the negative consequences that might occur from the usage of AI technologies, for example, if a bias is detected in an AI-based system that makes decisions about enrolment or grading. • Biases. If there is a bias in the initial dataset, machine learning algorithms will eventually incorporate it and proceed to make biased decisions. Therefore, guaranteeing aspects such as that the admission or grading process will be fair, is complicated.

Source: Authors' elaboration based on the challenges and the value chain analysis.

Figure 67 Strengths, Weaknesses, Opportunities and Threats of the uptake and public procurement of AI-technologies in the education sector

S

Educational institution management -AI solutions have the power to optimize the overall management of educational institutions in areas such as resource planning, energy consumption, staff management, etc. Adoption if Artificial Intelligence, together with other technologies such as IoT, are able to substantially increase efficiencies and reduce the number of unforeseen events.

Better engagement – AI adoption in education generates a positive impact in student engagement. A personal approach (through individualized schedules, custom tasks, interaction with digital technologies, Smart Contents and personal recommendations) helps students feel special, increasing their engagement and raising interest in studies.

W

Slow on the uptake related to legal and ethical aspects - Regulations and laws aren't keeping up with the rapid development of the technology.

Skilled teachers and students – Students and teachers should have adequate understanding and skills in the usage of AI technologies in order to make the most of the AI enhanced education. Although the adoption of digital skills appear to be commonplace, AI based solutions will require readjustments of people skills for the teachers and the students.

O

Universal AI assisted education – The general concern of educational institutions for improving and enhancing their learning processes through the application of digital technologies, including AI tools, presents the opportunity for the design and development of universal or standard AI powered educational platforms and technologies. Moreover, a standard platform would ensure educational interoperability at region, country and European level.

Student experience – Adoption of AI in educational institutions has the potential to personalise and, therefore, enhance the experience of each student. Student experience will be improved through a personalized approach to the learning program based on each student's characteristics, combined with the assistance that AI can provide to teachers when making impactful decisions.

Policy creation – Being education a common aspect for all European countries, there is a huge opportunity for the creation of policies at region, country or European level in order to overcome the specific necessities and generate solutions and guidelines to support AI adoption for the creation of a innovative educational ecosystem.

T

Digital gap– Although in European context digital gaps are not as noticeable as in a Worldwide context, there are still areas, regions or countries that are currently overcoming the digitalisation barriers.

Privacy concerns - Collection, storage, disclosure, processing, and dissemination of personal data is required to power AI based solutions in education. Additionally, as it comes to the education sector, most of the data concerns to underaged people.

Source: Authors' elaboration based on the challenges, value chain and PESTEL analysis.

2.5.4 Case study: Educating the world on AI: The elements of AI MOOC (Finland)

Key Actors

- University of Helsinki
- MinnaLearn (formerly Reaktor)
- The Finnish Ministry of Economic Affairs and Employment

Type of policy:

The initiative was funded from the budget of the Ministry of Economic Affairs and Employment and is estimated to have had a budget of EUR 1,679,000 (VAT 0%). This policy is associated with the areas of digital transformation, artificial intelligence, new skills, the transformation of work and sustainable development which Finland's Presidency was spearheading during its Presidency of the Council of the European Union with the help of the Ministry of Economic Affairs and Employment.

Goals

The initiative had three aims: Finland, as the then outgoing Presidency, wanted to invest in skills, increase EU citizens' practical understanding of the opportunities and nature of artificial intelligence and reinforce the digital leadership of the EU and thus increase its competitiveness.

A competitive and socially inclusive EU is one of the main priorities of the Finnish Presidency. Europe's competitiveness draws on skilled people and, increasingly, on the use of artificial intelligence and digital solutions.

Project description

Elements of AI is a Massive Open Online Course (MOOC) that is aimed at anyone interested in learning about artificial Intelligence. With the revolution that AI is destined to bring about, this MOOC helps teach the basics of the technological area in an accessible and well-designed manner. With its genesis in a shared building at the University of Helsinki, what started as a digitalized version of an entry-level computer science course at a single University now boasts over 750,000 users in 170 countries. Aimed at the entire population rather than a narrow band of those with high technological aptitude or interest, the course doesn't require basic programming skills or knowledge of advanced mathematics.

The core idea was to start by teaching 1% of the Finnish population about AI and build incrementally. However, with the arrival of Finland´s Presidency of the Council of the European Union, the MOOC was seen as the perfect vehicle for increasing the digital skills of the entire EU. Increasing inclusion and competitiveness of the EU were some of the main priorities of the Finnish Presidency and knowledge and uptake of AI are seen as a way to achieve these ends. With the investment made by the original partners and the Finnish Government, the MOOC was translated into every official EU language and more. In 2019, the course won the Massachusetts Institute of Technology´s global grand prize in the Inclusive Innovation Challenge[437].

Successes and Key lessons

- **Inclusion and accessibility** are building blocks for success. In the initial ideation period for the MOOC, which was an adapted University Course, the consortium took an initial version to be tested in high schools and reveal the overly technical parts. This base helped to create a final product that would be highly accessible regardless of age, reflected by the fact that over 25% of students are over the age of 45[438]. Furthermore, conscious of the considerable gender gap that exists in computer science[439] and STEM subjects[440], the team designed the course with a female as the principal user. This exercise allowed the team to think inclusively about key components such as the language used in the course, the UX and the UI. Subsequently, the course has seen a gender

[437] Datarooms rating (2022) Tech for Good prosperity workers: https://dataroom-rating.us/mitinclusiveinnovation/
[438] Minnalearn (2023) Elements of AI https://www.reaktor.com/?page_id=102694
[439] Texas Tech Today (2021) "Why is Computer Science Unpopular Among Women" https://today.ttu.edu/posts/2021/09/Stories/why-is-computer-science-unpopular-among-women
[440] American Association of University Women (2022) "The STEM gap: Women and Girls in STEM" https://www.aauw.org/resources/research/the-stem-gap/

split of 40% women which, although it is not full parity, outperforms its education sphere.

- **Strategic dissemination** is vital to scaling up. A huge part of the success and popularity of MOOCs is the dissemination actions around them. Making use of a synergistic consortium which saw private consultancy MinnaLearn take the lead on dissemination, the strategy leveraged Finland´s strengths to great effect. With the Finnish President in attendance at the first graduation of the course, the team also used the various social media accounts of Finnish Ministries to challenge their Swedish counterparts to take the AI challenge. Generating attention around what was then still a national initiative, the same process was carried out with other member states´ public sectors such as Germany. This scaling up both paved the way for and formed the base of the strategy behind the Finnish Presidency´s handling of the MOOC which would turbocharge the expansion worldwide.

2.5.5 Economic analysis

Building on the literature and the inventory of policies, the quantitative analysis is based on two sets of regression models focusing on the concentration of talent in a selection of sectors and the penetration of AI in higher education. Each set encompasses multiple indicators from reliable sources. This is undoubtedly unrepresentative of the overall education sector with the omission of schools and ECEC although both the lack of policies in the areas and married with the absence of indicators means that they are not included in the analysis. On a broad level, User countries are much more clustered with much larger variation in facilitator and planner countries, especially vocationally.

Indicators and variables

Each set of models relies on a particular database and set of indicators. For the labour aspect, the models use the OECD´s talent concentration dataset which gives both member-state and sector-level data[441]. More specifically, the observations are the percentage of LinkedIn members with AI skills or who perform an AI occupation (e.g. machine learning engineer) – per country and industry over the last year. The models focus on the following sectors: Education, software and IT services, finance, hardware and networking and manufacturing

Alternatively, for higher education, the models use data from the 2021 edition of the AI Watch Index and its societal dimension. Three categories are split into Bachelor and Master, and the indicators measure the AI programmes, places and intensity. The first[442] indicates the intensity with which AI is included in official curricula, as a proxy of the supply of AI capacities or the Proportion of programmes with AI content compared with the total number of programmes. The second[443], places, provides an estimation of the potential future workforce trained with AI skills in a specific AI

[441] OECD.AI (2022), visualisations powered by JSI using data from LinkedIn, accessed on 22/6/2022, www.oecd.ai

[442]Righi, R., López-Cobo, M., Alaveras, G., Samoili, S., Cardona, M.., Vázquez-Prada Baillet, M., Ziemba, L.W., and De Prato, G., Academic offer of advanced digital skills in 2019–20. International comparison. Focus on Artificial Intelligence, High Performance Computing, Cybersecurity and Data Science, EUR 30351 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76- 21541-9, doi:10.2760/225355, JRC121680. https://publications.jrc.ec.europa.eu/repository/handle/JRC121680

[443] Gómez Losada, Á., López-Cobo, M., Samoili, S., Alaveras, G., VázquezPrada Baillet, M., Cardona, M., Righi, R., Ziemba, L., and De Prato, G., Estimation of supply and demand of tertiary education places in advanced digital profiles in the EU. Focus on Artificial Intelligence, High Performance Computing, Cybersecurity and Data Science, EUR30377EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-22281-1, doi:10.2760/559530, JRC121683. https://publications.jrc.ec.europa.eu/repository/handle/JRC121683

domain. Definition Number of available places in university programmes with AI content by AI domain (ML, AI ethics, Robotics, Computer vision…). The final indicators[444] measure the size of the potential future workforce trained with AI skills, the Proportion of available places in university programmes with AI content in the total number of places in university programmes.

Vocation

Talent Concentration	**Education**	**Software and IT Services**	**Finance**	**Manufacturing**	**Hardware and Networking**
Intercept	4.46	3.33	0.95	0.69	1.45
Industry-focused AI courses	2.82	1.35	0.28	0.41	0.71
R^2	0.11	0.09	0.05	0.09	0.08
Observations	27	27	27	27	27

- **Countries with programmes** dedicated to vocational and industry-focused policies on AI education have **higher levels of AI talent concentration** in each of the 5 sectors than countries without any programmes.
- **The gap is largest in education** and software & IT services where there is 2.82% and 1.35% more talent in countries with adult learning AI courses.
- In finance and manufacturing, where even for countries with programmes the talent concentration is less than 1%, the gap is small (0.28% and 0.41 less respectively).

Higher education

AI in Higher Education	**BProgrammes**	**MProgrammes**	**BPlaces**	**MPlaces**	**BIntensity**	**MIntensity**
Intercept	5.86	9.44	18586.00	8720.41	5.10	6.52
Higher Education AI Support	0.21	0.47	17696.11	17550.48	0.69	0.59
R^2	0.01	0.01	0.05	0.16	0.01	0.01
Observations	23	27	23	26	23	26

[444] Gómez Losada, Á., López-Cobo, M., Samoili, S., Alaveras, G., VázquezPrada Baillet, M., Cardona, M., Righi, R., Ziemba, L., and De Prato, G., Estimation of supply and demand of tertiary education places in advanced digital profiles in the EU. Focus on Artificial Intelligence, High Performance Computing, Cybersecurity and Data Science, EUR30377EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-22281-1, doi:10.2760/559530, JRC121683. https://publications.jrc.ec.europa.eu/repository/handle/JRC121683

- The models confirm the hypothesis that countries with policies that support **AI in higher education have a higher number of programmes, places and intensity** at both the bachelor and master levels**.**
- However, with very low R^2 scores for the "programmes" and "intensity" models, the relationship between the two variables is very weak and unreliable. Nevertheless, the direction is still positive in favour of countries that have higher education AI policies in place.
- The most reliable models are the "places" where countries with policies are correlated with over 17500 more places, in both bachelor and master degrees containing AI learning, than those countries without.

2.6 Conclusions

While each sector is unique in its organization and dynamics, some common themes would likely apply across most areas beyond those addressed in this chapter. Artificial Intelligence has established a foothold in each of the 4 key sectors but has not yet left a distinguishable mark – at least in the everyday lives of ordinary citizens. In other words, the public sector has seen widespread surface-level integration of simpler AI solutions and some more advanced applications but the transformative change which AI has the potential to usher in is yet to materialize. Bringing about this change in the status quo and overcoming the substantial barriers to adoption and implementation described in the chapter will require a more emboldened public sector in both procurement and development as well as at the national and European levels.

In all 4 sectors, the utility of AI applications for increasing efficiency is well-established. Appropriately referred to as low-hanging fruit, these applications address simpler administrative and "back-office" tasks as they are relatively undisruptive, uncontroversial and cheaper than other solutions. An emerging paradigm that will likely continue is the growth of AI-assisted hybrid cases where a public actor, whether that be an administrator, teacher or healthcare professional, is supported by AI technology in a manner that might seem more advanced than other past technological assistance but not necessarily unfamiliar to the citizenry.

There are commonalities too between the 4 sectors with the more advanced AI cases. Undoubtedly, proof of concept exists for many hugely promising applications that have captured the collective imagination such as autonomous vehicles, AI-enhanced education or patient-care. Nevertheless, these are still limited to small pockets of their respective sectors and yet to become widespread. Furthermore, whether it's a hospital, a school or a transport hub, algorithmic prediction of real-time trends can help any public entity better deploy its resources. However, once again, the difficulty is to scale these proven applications into a smart and interconnected health or transport system, a considerable and multifaceted challenge which is yet to be conquered.

All 4 sectors showed that part of this challenge is inherently technical with a lack of data infrastructure and general interoperability combined with a public sector which is for the most part unfamiliar with the use and potential of AI. To this effect, what happens in the education sector is critical to the progression of other sectors as displayed by the need for public sector AI experts highlighted in the research of the other 3 sectors. Moreover, at a time of rampant inflation and stretched public finances, the considerable immediate set-up costs of adopting AI are an obstacle throughout the government despite the promise of savings in the future. Finally, given the considerable complexities and risks of AI, the socio-political dimension of AI reticence due to complexity and bias will need to be addressed if the technology is going to fundamentally change and improve society. This ties into some of the fundamental threats to the successful roll-out of AI throughout the public sector; a lack of trust, fears of trends like replacement in the labour market and concerns over privacy and data. A common theme throughout the chapter was that increased participation of the citizenry fosters greater understanding and increases the chances that the public will buy-in to AI projects.

Perhaps unsurprisingly, within the European Union, regardless of the individual sector, a group of larger and wealthier countries are leading the way in AI public policy. Countries such as Belgium, France and Germany already have a well-rounded repertoire of policy interventions including regulations, facilitating mechanisms, funding regimes and crucially development of AI uses and solutions in-house. Meanwhile, countries such as Croatia and Romania, which are yet to even publish an AI Strategy as of late 2022, are risking being left behind and would greatly benefit from increased public sector focus on AI and assistance from the European AI ecosystem.

Ultimately, the pace of development, use and scaling of AI applications will likely need to be turbocharged by a more entrepreneurial and less risk-averse approach from national governments and the EU if Europe is going to achieve its broader policy goals and the twin-transition.

For eGovernment, the main factors affecting the propensity of AI adoption were the technological and financial capacities of the institutions looking to use the technology in addition to specific, at times niche, specializations. With a few exceptions in local settings such as Plovidic in Bulgaria and Katernini in Greece, the main users of AI Govtech were those with high levels of prior digitalization such as the Nordics and Western Europe. On the implementation side, political impetus and an acknowledgement of the need for AI adoption ensured that there were few difficulties, legally and culturally, in establishing the technology in public sectors while a lack of skilled administrators in AI has held back progress. These trends were reflected in the case study of Mercé which took place in Barcelona, a city with a highly skilled workforce and innovative and well-funded public sector. The project itself, which was dependent on the participation of individual citizens submitting data, is emblematic of the necessary widespread public support and participation in AI projects such as this. In terms of measuring outcomes, the models showed that across all three indicators, countries using AI had better rates of use of eGovernment services and availability of information online.

For the mobility sector, uptake and use have been quite limited with most of the progress taking place in countries with highly developed transport industries although a majority of countries had passed regulations in the sector or were supporting it through funding or facilitating policies. AI in mobility is a proven solution to some of the current environmental issues and has a demonstrable track record of being economically viable. The mobility value chain was divided into the four transportation modes that exist: road, railway, maritime and air with the current lack of effort for cross-modal exchanges and fertilisation holding the sector back. Solutions developed for driverless cars could, for example, benefit the railway industry. Specific recommendations have been developed for each mode, including the uptake of smart road infrastructure to increase the uptake of driverless-cars, investing in smart maintenance and smart trackways using AI for railways, developing a common digital approach for the uptake of AI systems across European ports (which would give Europe a unique competitive advantage in the world) and encouraging the uptake of smart maintenance in aerospace. Nevertheless, the sector´s growth is being stifled by a lack of interoperability and harmonized rules not to mention very high access costs to the technology. However, the Mobility Data Space in Germany is a shining example of the potential for mobility AI once these barriers are overcome. With over 200 members, in a country with a highly sophisticated automotive industry, a collaboration of data has been the emphasis with the project also helping allay societal concerns such as safety and the environment.

For AI and health, the use cases are incredibly varied and touch every aspect of this diverse ecosystem, something which can likely be attributed to the pervasiveness of the policy of bottom-up funding programmes and the heterogeneity of actors in the sector. The health value-chain was also divided into 3 segments: R&D, purchasers and intermediaries, providers and end-users. Public authorities have a crucial role to play in health as they are considerably the largest acquirers of health products and services in Europe. The uptake and harmonisation of AI-enabled digital platforms for public hospitals could be a boon for European health providers but the current landscape is fragmented between different and sometimes incompatible platforms within nations and across borders. The harmonisation of exchange systems across borders and within national states could open many new opportunities for AI systems in health procurement, improving administration and treatment delivery. The relatively low uptake of AI-driven MedTech solutions highlights the role that public authorities could play in boosting the market (demand side). This is especially true as public authorities represent around 70% of all MedTech purchases in Europe. However, the acquisition of advanced systems should be carried out while keeping in mind the need to harmonise systems across European hospitals and healthcare. Furthermore, true AI-enhanced MedTech is rare and more R&D and large-scale pilots remain necessary to help the market reach full maturity (offer side). Spurred on by necessity amid the COVID-19 pandemic, data sharing and cross-border exchange are increasingly common while a lack of trust and doubts over the lack of familiarity and human components are holding this back. The case study of Innoviris and Axiles Bionics is emblematic of these trends with an open funding mechanism creating a transformative AI solution for what is still a non-central area of healthcare in prostheses.

In the education sector, uses of AI for delivery are still yet to become mainstream albeit despite a surge in its teaching as a subject through MOOCs, specializations and a mainstream subject at all levels of education. The promise of optimizing the experience of teachers and learners alike has been held back by valid legal and ethical concerns as well as a lack of familiarity of stakeholders with the technology. The main conclusion from the education value chain analysis was the relative immaturity of this sector for a larger uptake of AI solutions. The COVID-19 outbreak highlighted this by providing a worldwide large-scale experiment but truly AI-driven systems were only rarely applied or implemented during the outbreak. More research is necessary at the European level to identify the AI tools that were implemented in education and determine which were successful or lacking. This would be the first step to addressing the two main barriers to a higher procurement of AI systems in education: a lack of existing AI solutions and willingness from teachers to use AI solutions. Across the board, those countries which have enacted national policies of educating people on AI had higher concentrations of talent in five sectors (IT, finance etc). The "Elements of AI" course is a worthy example of how an educational tool can be used to bridge the digital divide and reduce unequal access to education about AI while also demonstrating how understanding AI can lead to more innovation in developing uses and solutions.

Finally, below is a short list of some **cross-cutting themes from the best practices of the case studies** in the report which could be beneficial for any public authority wishing to create policy in AI:

Inclusion breeds trust

Inclusion was a considerable part of both the Mercé and Elements of AI projects, the case studies in the eGovernment and education sections. With the former, the inclusion of the voice and feedback (and data) of residents ensured that the solution was specifically catered to addressing the everyday needs and concerns of the local population. Similarly, the Elements of AI MOOC was designed for accessibility from the very start of the project, testing the project in a school and using inclusive language and design for the interface. Involving the very people that are set to supposedly benefit from the technology from the start ensured that these projects were not expensive and unusable technological white elephants. Furthermore, participation breeds understanding which together builds trust – something which is paramount for public participation and AI technology to reach its potential.

Measuring success successfully

Similarly, Mercè also promoted the use of a new set of objectives and indicators for urban planning documents which could be accessed and scrutinized by ordinary citizens. As opposed to simply orthodox retrospective analysis, the Mercè project allows citizens to use real-time data for forecasting future trends. Meanwhile, in the health section as part of its award procedure, the Innovative Staters Award from Innoviris explicitly used social and environmental criteria in 2021 and awarded funding to winners with clear altruistic benefits. Beyond the technology itself, if the processes in the sphere of monitoring and evaluation have a focus beyond the simply economic, AI solutions should be constructed to also benefit humanity in other ways.

(Creative) collaboration

A very necessary element of the creation and operation of the Mobility Data Space in Germany, the only of its kind in Europe, was the collaboration between multiple types of stakeholders. The project had no fewer than six categories of actors including the founder, managing body, government bodies, co-partners, clusters and of course the data users and providers. This ground-breaking dataspace should be a model for others, both in the mobility space, other geographies and other sectors. The project demonstrated the diversity and balance of stakeholders needed to harness the power of data. Furthermore, the meteoric growth of the Elements of AI MOOC was partly driven by the positively opportunistic ways in which the organizers sought to collaborate. Initially calling on counterparts in government departments of other member states over social media, the project gained international status by harnessing the Finnish Presidency of the Council of the European Union to vault the status of the project with impressive results. Such is the complexity of AI procurement and adoption that well-conceived cooperation between the private and public sectors and different levels of government is paramount.

3 Chapter 3: Consultation of stakeholders' analytical, comparative report

3.1 Introduction

This chapter presents a comparative analysis of stakeholder consultations undertaken as part of this study. The consultations included:

- Four sectoral workshops, dedicated to exploring the challenges and measures in the uptake of AI by the public sector in the health, e-government, mobility/transport and education sectors.
- The policy workshop dedicated to identifying and exploring policy solutions and recommendations for the uptake of AI in the public sector.
- An online survey, dedicated to assessing the challenges and policy recommendations in the uptake of AI in the public sector.

The more detailed methodologies for these consultations can be found in the annex.

The chapter proceeds by providing analyses of the workshops, the analysis of the online survey, and the comparative analysis of all stakeholder consultations in the conclusion.

3.2 Health workshop

The health workshop took place on 26 September (10:00-12:30 CET) via Microsoft Teams, utilising the Mural board to conduct interactive exercises.

The workshop was attended by 19 participants in total, represented by 3 business associations, 6 AI providers, 2 NGOs, 3 national public bodies, and 2 research organisations.

The rest of this section provides an analysis of the results of the exercises undertaken during the workshop and the discussions that followed.

3.2.1 Exercise 1: Challenges affecting the uptake of AI by the public sector

In this exercise, participants were asked to write down challenges affecting the uptake of AI by the public sector concerning procurement process, data, sectoral and AI-specific technology, and organisational capacity challenges for industry and public sector, and indicate which ones are the most significant.

Procurement process challenges

For industry, the most significant procurement process challenges are the **lack of acceptability of real-world data and evidence in regulatory assessment**, the lack of integration into the medical protocol, **unclear/inconsistent pricing and reimbursement** guidelines, and the **lack of experts** in the European Medical Device Regulation[445], which is very relevant to procurement issues of AI in healthcare. Lack of expertise and limited knowledge was also raised concerning the policy setters.

Other procurement process challenges affecting the industry are the **lack of openness and transparency** in the procurement process. Lack of transparency in AI predictive models due to weak clinical trials affects the ability to build trust among stakeholders. There is also a **lack of funding** which is allocated to the procurement of digital health solutions, including AI products, and reimbursement challenges. There is

[445] More information available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017R0745

also the need to increase **support for SMEs**, including poor upfront engagement of key stakeholders within the receiving organisation, eg. In showing value, addressing concerns on risks, etc. Another major group of challenges relates to the **lack of clarity on regulation** and the need for sectoral-specific ethical guidelines since there is insufficient understanding of sector-specific applicability. There is an overall issue with the definition of what is AI, and what is and is not in the scope. There is also a problem of potentially differing regulations when dealing with multinationals and a lack of regulatory spaces for experimenting with AI and its impact.

For the public sector, the most significant procurement process challenges are **inadequate national IT and human capital strategies**. The public sector is not sufficiently competitive to hire IT specialists, partly due to the **lack of funding** for IT projects. There are also insufficient financial and human resources inside hospitals, including IT specialists and data managers.

There is also a **lack of regulation**, contributing to the **uncertainty** as to legal regime and implications of AI projects, especially in terms of who holds risks and the **blurring of responsibilities** between several public actors, such as governments, national health funds, regional health authorities, regional IT bodies, and hospitals. Other challenges raised are **variable procurement skills** on AI projects within many public sector organisations, lack of buy-in at Executive levels and a clear value proposition/business case to organisations. Relatedly, there is a challenge of how to promote the adoption of standards when there is not an immediate tangible benefit for hospitals and healthcare providers.

During the discussion, one AI provider pointed to the lack of clarity as to who bears the legal risks if something goes wrong. Clarification on legal responsibility is needed so that health professionals have more confidence in accessing AI products.

Another AI provider underlined the challenge of dealing with multiple different people with contradictory views, which creates complexity in the procurement process. Several stakeholders remarked on the lack of acceptability of real-world data and evidence in regulatory assessment and the need for interoperability. It is important to allow citizens to extract all the data from healthcare institutions, and hospitals to transfer to another. This involves getting regulators to agree on the quality of real-world data.

Data challenges

For industry, the most significant data challenges are the lack of **interoperability** and **uniform data quality**, which creates unclear, **unharmonised rules** for cross-border data flows. Data quality is variable due to fragmented data architectures and variable data standards (**lack of common standards**), patchy/incomplete data. Significant effort must be made in cleaning data to make it fit for purpose Consequently, the generation, **sharing and access** to representative datasets for target populations, and access to high-quality datasets are challenging.

Another set of challenges concerns **regulation**, in particular, differentiated GDPR implementation, concerns that regulation may require sharing of patient data at a level which could compromise patient **confidentiality** or violate patient consent. There is also a problem with the uncertainty of "**data ownership"**.

Finally, there are challenges concerning open AI Models to open black boxes and build trust, bias in management and noise in the data, and ensuring a lack of bias in data, and AI-derived from data.

For the public sector, the most significant data challenges concern data **quality**, data **interoperability**, and the lack of **standards** and **leadership**. There is a need to invest significant time upfront in stock-taking on data to be used and also understand user concerns on data of a specific type. This is compounded by **insufficient resources**. Another challenge is the **fragmentation of IT systems** between providers and the lack of unified health data space. Consequently, access to data remains difficult.

During the discussion, an AI provider noted that there is a lot of fragmentation in the public sector, and fragmentation of budgets with projects developing in parallel. "Data ownership" with the ability to create a synchronous view of the data for all healthcare establishments – the federated data platform (FDP) of the NHS is an effort in that direction.

A national public body noted that the national database in France has a single national database, the quality of which is fairly good. The question is the resources needed to exploit that data. Interoperability between the providers and lack of resources to exploit the data are key issues. A lot can already be done with the existing data, but there is a lack of resources to exploit the data. It is difficult and cumbersome to access the data. It is harder to train and keep data specialists in healthcare establishments.

Another AI provider commented on data quality and that they are putting in huge efforts to make data 'regulatory grade'. A key challenge is to generate a reward system to ensure investment in data quality. On patient confidentiality, there is a dichotomy of views on sharing of medical data in the public sphere – privacy vs. usefulness.

Sectoral and AI-specific technology challenges

For industry, one set of significant sectoral and AI-specific technology challenges is around the issues of **trust** in the application of AI solutions in medical decision-making. Building trust and education among practitioners and patients is needed. Users and patients need to receive a **better explanation** of what AI solutions do. There are also potential fears from health practitioners that AI solutions might replace practitioners. Positioning AI as support for experts rather than a replacement for experts is important. Thus, AI models for health should be **transparent**, openly accessible and not **black boxes**. Health professionals should know how a prediction is made. Relatedly, ensuring **patient safety and privacy** as ethical issues are important.

Another set of challenges is related to the problem of **skills**. There is a lack of deep tech talent in the health sector, and a gap in the skills required. Professional training is needed to overcome it and to empower healthcare professionals to make informed decisions concerning AI solutions. Finally, there are challenges concerning **bias** concerning gender data, lack of diversity in data science teams, or potential for discrimination based on AI results, for example in insurance policies. Thus, it is important to engage in bias management and ensure that society's current biases are not hard-wired in AI solutions.

For the public sector, significant challenges concern the **lack of training** of health professionals in the usage and adoption of AI solutions. There is also a lack of a **clear narrative** on the value of AI for public services. This leads to **misperceptions around the role of AI**, eg as a decision-support system. There is also a challenge that the data used and produced can lead to **biases**, for example in health payment decisions.

During the discussion, points around trust were prominent as there is a fear of AI replacing healthcare professionals. One business association commented that there is enough training for AI development, but a lack of training offered for the adoption of AI. Need to convince professional training organisations to push for the adoption of AI in organisations. Healthcare professionals also need the training to understand the benefits of AI to adopt AI in the workplace.

A national public body pointed out that AI is a buzzword, but there is little evidence of AI improving healthcare for patients and professionals in a real-world setting. The buzz around AI is detrimental to AI itself as it loses its meaning. Better to focus the use of AI on specific aspects, rather than aiming to have it everywhere.

An AI provider commented that healthcare professionals don’t see the iterative aspect of developing an AI product, they see it as a finished product. They need to be involved in the development and refinement of AI rather than having expectations.

A national public body opined that achieving AI in clinical settings is difficult. It just signed a contract with Microsoft to establish a platform already working on two use cases, extended soon to four. It is solving technical questions on how to use the data. The scheme of the platform developed is a joint effort between clinicians and IT professionals that would work best.

Several comments were made about the disconnect between the health sector and the IT sector and expectations from the former.

Organisational capacity challenges

For industry, significant organisational capacity challenge revolves around the **lack of a skilled workforce**. There is a need to increase education in the digital skills of health practitioners and, conversely, data scientists in life science since currently there is a lack of cross-sectoral and cross-organizational competition of qualified experts. It is important to increase understanding in **top management** because currently there is a lack of buy-in and little early engagement with **clinical leaders**, partly stemming from the lack of understanding of digital/AI/data at senior levels and resulting in the lack of integration of AI solutions into medical practice.

Other challenges included difficult access to healthcare markets for companies beyond their country borders and big differences in pay between healthcare and provider sectors.

For the public sector, the most significant challenges also revolve around **skills and expertise**. There is a lack of IT staff and resources inside hospitals, and a lack of hybrid profiles, e.g. clinical and data/AI experts. Thus, linking" HC professionals with IT specialists are demanding, and time-consuming but essential. Also, leadership on the topic is unevenly distributed among top management.

It is difficult to "divert" healthcare professionals from day-to-day clinical work to the implementation of AI solutions. Overall, IT is still perceived as adding unnecessary workload. In addition. "basic" software is often outdated (i.e Windows 98). There is also the lack of a business case for AI solutions and value to patients.

During the discussion, several points were made concerning the barriers at the managerial and technical levels, lack of skills, and limited interoperability. A national public body commented on the need for hybrid profiles. The blending of expertise is needed and it’s still very rare today.

One AI provider thought there is a need to do a better job of making the value case for AI to secure engagement from health professionals.

A national public body suggested using cloud technology for hospitals to share data. A European strategy with a unified cloud would be useful.

3.2.2 Exercise 2: Measures to increase the adoption of AI

In this exercise, participants were asked to write down measures, the most promising ideas or steps in addressing the challenges discussed above, and indicate which ones are the most significant.

Awareness of measures, the most promising ideas or steps

Industry solutions included having a broader adoption of **federated learning** (e.g. through partnerships), creating an **interoperability platform** connected to input layers and cognitive services, increasing the **sharing of datasets from clinical**

trials, generating and sharing **AI principles and policies**, and having **controlled sharing of data**, such as Vivli[446].

Public authority solutions included establishing **European Health Data Space[447]**, measures in the **New European Innovation Agenda[448]**, in particular training 1 million deep tech talents, support for innovation procurements and regulatory sandboxes. At the national level, potential solutions suggested were **national funding programs**, the creation of **national digital agencies**, and **digital healthcare acts**.

Other measures suggested by participants were standardisation, industry/academia/public partnerships, health data donor's initiatives and collaboration on the development of career pathways.

During the discussion, an AI provider suggested that partnership work with academic groups, synergies of expertise, setting up projects with the NHS[449], and embedding data scientists within the NHS. Hybrid roles help to bridge the gap between the IT and healthcare sectors.

A national public body noted that education is very relevant, but there are not enough PhD programmes at the EU level that combine medical and data science. Should identify the leading hospitals in Europe with AI development strategies, they have the highest possibility to involve people and access large data banks. In each country, identifying one or two large hospitals and clustering them would be helpful. Should identify hospitals that start defining the structure.

Another national public body commented that in France, the AI industry has not done a good job of making the business case for clinicians. There is a digital ecosystem that remains apart from healthcare operations, and that is not a viable solution because many IT start-ups will not find clients. Little attention has been paid in policy to the workings of healthcare facilities, therefore nothing will happen in terms of AI adoption. it is important to understand how healthcare establishments work.

Suggestions for other measures

Other suggestions clustered around **education**, such as promoting degrees in Computer Science and related disciplines as the first step to having AI professionals in industry and academia, developing interdisciplinary PhD courses on AI/Healthcare, and having education and awareness programs including a campaign to foster patients' availability to donate data (patient's associations).

Steps related to **regulation** were mentioned, such as improving clarity on the scope of regulation and avoiding duplication, establishing healthcare-specific sandboxes, and addressing different scenarios. Acting on medical device approval for AI solutions in healthcare and definition of accountability. Develop a version of GDPR for AI models.

Another set of suggestions revolves around public initiatives, such as having a public register for CE-marked AI products in healthcare, optimising funding in support of AI in the public sector to promote the spreading and scaling of reusable solutions, reinforcing and advancing existing initiatives on open data and interoperability, and promoting AI in the public sector in support of sustainability while developing

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[446] Vivli is an independent, non-profit organization that has developed a global data-sharing and analytics platform. It's focus is on sharing individual participant-level data from completed clinical trials to serve the international research community, acting as a neutral broker between data contributor, data user and the wider data sharing community. Further information is available at: https://vivli.org/

[447] Further information on the European Health Space available at: https://health.ec.europa.eu/ehealth-digital-health-and-care/european-health-data-space_en

[448] Further information available at: https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/new-european-innovation-agenda_en

[449] National Health Service (NHS). Further information available at: https://www.nhs.uk/

sustainable AI, in compliance with environmental principles, and leveraging civic engagement and participation.

3.2.3 Exercise 3: Examples of cooperation between the public sector and AI providers and success stories

In this exercise, participants were asked to write down cooperation best practices and success stories, and indicate which ones are the most significant.

Cooperation best practices

Best practices include co-creation, federated learning on patient-level data across cancer registries, collaboration with AI in health via conferences, work with universities/schools (especially those with AI and health Masters), and public-private partnerships. In terms of actions to be taken, participants stressed the collection and addressing every stakeholder's viewpoint, involvement of bio-ethics committees, understanding the goals, drivers and motivation of parties, fostering openness, transparency, developing relationships over time and leveraging health and AI communities networks, and linking hospitals with startups.

Success stories

Several success stories were mentioned, including **EIT AI Community**[450], which matches AI start-ups and healthcare organisations to solve specific health challenges, the **ATHENA**[451] partnership, the **Alan Turing Institute – Roche strategic partnership**[452], and the **Salus Coop**[453].

During the discussion, an AI provider pointed to the challenge of data sharing with legal implications. Also, the healthcare sector might find it challenging to articulate its AI needs, there is complexity.

A business association commented that it has already supported a thousand start-ups in Europe - 144 start-ups identified – and it is working closely with healthcare providers to identify AI challenges.

A national public body noted that government, healthcare providers and the AI industry all need to get together to make their priorities clear and articulate a plan. Communities of practice should establish a dialogue between IT, legal and healthcare stakeholders.

An AI provider stressed that the key to partnerships is to address bioethical questions from the start.

[450] More information available at: https://ai.eitcommunity.eu/#page-top

[451] ATHENA (Augmenting THerapeutic Effectiveness through Novel Analytics) is a collaborative network which brings together a unique, multidisciplinary and complementary partnership of academia, hospitals and industry who explore and use the concept of machine learning for the realization of predictive analytics in oncology. Further information available at: https://portal-uat.athenafederation.org/

[452] The goal of this partnership is to establish a world-leading collaboration in advanced analytics between Roche and the Turing, focused on enabling the transformative benefits of personalised healthcare to become a reality for patients around the world. Publication of methods and algorithms will follow the principles of open science to ensure that they are reproducible and interoperable. Further information available at: https://www.turing.ac.uk/research/research-projects/alan-turing-institute-roche-strategic-partnership

[453] Salus is a cooperative that provides a platform for individual users to store their health data and control the use of this data. Through their platform, Salus Coop aims to facilitate secure sharing of health data that enable citizens to control their own health records while incentivizing data sharing to accelerate health research innovation. Further information available at: https://datacollaboratives.org/cases/salus-coop.html

3.3 E-government workshop

The e-government workshop took place on the 27th of September (10:00-12:30 CET) via Microsoft Teams, utilising the Mural board to conduct interactive exercises.

The workshop was attended by 18 participants in total, represented by 1 business association, 2 AI providers, 7 national public bodies, 4 research organisations, and 2 international organisations.

The rest of this section provides an analysis of the results of the exercises undertaken during the workshop and the discussions that followed.

3.3.1 Exercise 1: Challenges affecting the uptake of AI by the public sector

In this exercise, participants were asked to write down challenges affecting the uptake of AI by the public sector concerning procurement process, data, sectoral and AI-specific technology, and organisational capacity challenges for industry and public sector, and indicate which ones are the most significant.

Procurement process challenges

For industry, the most significant procurement process challenges clustered around the unique features of public sector clients. This included the **lack of scaling** of AI services beyond the specific context they are procured, as a research organisation noted, AI companies often favour the private sector where they can sell one-size-fits-all products, then approach public organisations as an afterthought rather than dealing with the complexity of the public sector from the start. Additionally, there are often **unrealistic expectations** from clients in terms of what the technology or service is capable of doing and the **promotion and selling of AI products** that are not yet required by the public sector. Finally, it was noted that many AI suppliers are startups that could potentially disappear during a project lifecycle.

Additionally, industry stakeholders also identified that the market itself is **fragmented** due to a lack of centralised processes and principles, often leading to disconnections across governments, and between tech suppliers and buyers. Furthermore, the **procurement processes** themselves are often lengthy and costly for the industry leading to a lack of

For the public sector, the greatest procurement challenge identified was the **lack of clarity on the purpose behind the adoption** of AI services. This was described by multiple stakeholders as **"AI for the sake of AI"** and was discussed as being driven by an overarching **lack of awareness and understanding of how and why AI services** would be of benefit. It was of particular note that, at times, technology can be experimental or in the early phases of development and there can be an incomplete understanding of how to best integrate such services. One AI provider noted that more work is needed to be done to ensure a common awareness of what AI can deliver, whilst an International organisation detailed how the lack of clear use cases, good practices, clarity and guidance on AI for the government was hindering procurement efforts. Furthermore, a different International organisation discussed how the **lack of a problem-solving** approach to assess technology needs was a key challenge in ensuring the appropriate procurement of AI products.

Like other sectors, **limited internal resources, the outsourcing of IT infrastructure,** and the **lack of internal expertise and skills** within the public sector were noted to hinder the writing of technical procurement documents and the managing of procurement processes. Should AI be successfully procured, it was noted that a **lack of flexibility in the execution of an AI project** and that engagement with the private sector was unnecessarily burdensome and at times difficult to understand. Related to this it was highlighted that at times, several suppliers may be required due to the focusses of their AI services being highly specific, in turn, this increases the administrative and financial burden of engaging with such suppliers. It is also difficult to fully understand the costs and benefits due to the nature of certain AI technologies.

Legal issues were also outlined, primarily around the issue of **data and IP ownership** to ensure that the public sector can avoid vendor lock-in as well as the possible legal issues surrounding the data process where AI development within the private sector lacks transparency.

Data challenges

For industry, the most significant challenge identified was the concern over how to best determine whether source data itself was biased, whether it was sufficiently cleaned, and how to ensure **transparency** and **oversight** when providing data access. This was closely followed by questions about "**data ownership", data management,** and the lack of clarity as to where ownership resides in partnerships between the private and public sectors.

It was also mentioned how the history of outsourcing within public services hinders the data that is available meaning that it can be difficult to properly access the necessary data that AI services would require.

A final group of challenges clustered around **cultural issues.** For industrial stakeholders themselves, it was noted that there is often a lack of incentives to share crucial data, particularly when sharing would require a significant administrative and financial cost. It was acknowledged that there is at times a need to better sensitize the private sector to the data culture and needs of the public sector. Finally, it was noted that there is often a lack of trust between the private sector and citizens who would prefer that private companies not involve themselves with the data of citizens.

For the public sector, two key challenges were identified. The first key challenge focussed on **the strictness of GDPR** and the **lack of training within the public sector to ensure GDPR compliance**. When data is available, there is a **lack of understanding within the system over what public sector data can be used.** The second key challenge focussed on the lack of the quantity and quality of training data needed for AI services. Similar to industry stakeholders, public sector participants noted that there was a **clear lack of clarity around "data ownership",** as well as around questions of **data classification and confidentiality.** In situations where public sector organisations are permitted to share data, it was noted that there remains a **distinct unwillingness to share.** One research organisation noted that vagueness as to what data can be shared between the public and private sectors was partially driving this unwillingness.

A few challenges were noted that clustered around **skills and strategy.** At a strategic level, it was noted that only a **few countries have a public sector data strategy,** making it challenging when working with countries where no such strategy and associated processes exist, particularly when wanting to access private data and share data between the public and private sectors. Consequently, it was viewed that most governments fundamentally lack the required data governance structures and processes needed to fully engage with AI providers and integrate AI services and technologies. As one research organisation highlighted, a clear barrier here can often be the different interpretations of data sharing and data protection found across different administrations. Finally, one international organisation detailed the importance of data leadership was discussed, and how the **lack of clear data leadership** around best practices and good data usage was limiting data sharing, particularly within lower levels of an organisation.

At a **skills level,** it was noted that there is often a lack of internal skills required to assess the quality of data for AI projects, especially as this often needed to be done on a case-by-case basis.

At a technical level, public sector participants noted that **not all services are digitised**, which itself leads to a range of problems when discussing AI services.

When services are appropriately digitised, there is still a **limited amount of interoperable data structures** that would facilitate data sharing and reduce the associated costs of processing and cleaning data. Finally, it was noted that the public sector often lacks the knowledge needed around bias mitigation. One AI provider noted that the technology was out there to be used, but those fundamental issues of interoperability and data standards were inhibiting progress.

Sectoral and AI-specific technology challenges

For industry, key challenges clustered around **trust and transparency**, produced by "AI-washing", for example, portraying AI chatbots as "human", or not providing accessible documentation.

Other challenges are a **willingness to cut corners** to go to market, selling AI systems developed in one context to another one, **adapting models** to future changes in data environments, and fulfilling **requirements for accountability**.

For the public sector, key challenges also orbit around the issue of **trust**, such as the lack of trustworthy certification, and the lack of trust in results. **Accountability** is also a challenge, especially related to algorithms, and due to a lack of ethical frameworks. Due to public fear, an important challenge is an **explainability**. Thus, it is important to underline that the use of AI is to assist, rather than replace, human decision-making. Relatedly, it is important to avoid **bias** and have more benchmarking and impact assessments of AI algorithms.

During the discussion, the AI provider commented that transparency and ethical issues are well-known and covered extensively in the literature. Trust aspects require action to be coordinated across the private and public sector side.

An international organisation suggested more and more governments are embracing data intelligence, also to reinforce accountability. There is a learning curve that comes with it, but intentions are there.

Organisational capacity challenges

For industry, the key challenges are the **lack of co-responsibility** about ethical issues, reselling AI without adaptation and **establishing a portfolio of projects across public sector clients**. Similar issues relate to stakeholder governance and **incentivisation** along use cases, how to build needed **competence/capacity** in government clients, lack of capacity working with public sector organisations and difficulty in replicating private sector development to government.

For the public sector, there is a **lack of knowledge and expertise in AI possibilities** in the organisation, including at the political level. This includes the lack of strategic and tactical management. Often, the attitude of marketing quickly wins rather than paving the way for profound service development. The public sector sometimes forces to apply AI even if it is not necessary to solve their problems. There is a challenge of retaining AI expertise in the public sector as in demand from the private sector and the need for wider recruitment/talent reforms.

There is also a **lack of resources** to deal with data, infrastructure, and ethical responsibilities of AI results, including the lack of resources to sustain implementation beyond a pilot. There is a strong reliance on external expertise due to a lack of internal AI experts. Also, it is difficult to gain a long-term perspective because priorities change with political cycles. Teams are often created for an 'AI project' with time-bound funding rather than teams funded to make the best choices about how to solve a given problem.

During the discussion, a national public body stressed that it's not just about AI skills, but also about dealing with ethical challenges.

A research organisation noted that the use of AI regularly brings up capacity issues, awareness, and competence issues. There is a large spectrum of new competencies public servants would have to acquire.

Another research organisation commented that AI can be used to reduce costs and increase efficiencies. However, this requires public organisations to have the required capacity to do this in the first place. Then there are hiring costs associated with the implementation of AI, for instance, recruiting data scientists.

3.3.2 Exercise 2: Measures to increase the adoption of AI

In this exercise, participants were asked to write down measures, the most promising ideas or steps in addressing the challenges discussed above, and indicate which ones are the most significant.

Awareness of measures, the most promising ideas or steps

Industry solutions include identifying **areas where the same solution can be used by many public administrations** thereby reducing costs for individual administrations. Other solutions would be establishing ethical risk management tools in companies' enterprise architecture management (EAM), creating **prototypes and experiments with synthetic data**, and **feasibility studies**, and sharing success stories. It would be also a good idea to build **networks** for AI research and innovation inviting public administrations and establishing an AI hub with an open-source solution.

Public authority solutions include establishing AI and data **competency centres** within public organizations, **cooperation** between the public sector and the R&D sector, and **innovation partnerships** between public administrations and industry. Another set of solutions included algorithmic assessment and transparency **standards**, codes of practice, and the creation of national and EU frameworks and strategies to build competency within public sector organisations.

Suggestions for other measures

Suggestions for other measures to promote **public-private partnerships**, build a **data/AI sandbox** for member states, and build a **community of practice** among AI leaders/practitioners. Provide a **guide** on problem identification and tech suitability and how to build multi-disciplinary and diverse AI teams in governments, a practical playbook on the challenges that surface and how countries have responded to them. Introduce **certification scheme(s)** for AI.

Support organisation-level creation of data/AI strategies, including **training resources** on AI for civil servants (not only technical). Changing EU **funding resources** to accommodate more on implementation as well, including supporting the creation of national/provincial government AI CoE hubs. Finally, it was suggested to lead by example - show what AI solutions are used in EU agencies/institutions, help to share success stories and provide an **AI Capacity Assessment Tool**/Research for public administrations.

During the discussion, an AI provider commented that what accelerates the adoption of AI is data-driven culture, it is about the intelligent use of data. Privacy-preserving setup also encourages greater use of AI. There are communities of practice developing, for sharing ideas on how to best integrate AI solutions.

An international organisation noted that AI culture needs to develop at the top civil servant level in parallel to the lower and private levels. In the UK, there are digital leaders among civil servants.

According to a national public body, there are a lot of testing and certification aspects that can be quite heavy in the public sector. There is an issue defining AI and maturity isn’t there yet.

One AI provider thought one solution is a general AI technology, like a chatbox provided to municipalities, and the same setup can be reused across many municipalities.

3.3.3 Exercise 3: Examples of cooperation between the public sector and AI providers and success stories

In this exercise, participants were asked to write down cooperation best practices and success stories, and indicate which ones are the most significant.

Cooperation best practices

Some of the best practices for the **industry** include data marketplaces with prespecified ecosystem rules, joint shaping of an in-house AI Center of Excellence, setting-up long-term upskilling workforce paths

Public sector best practices were the use of Universities and research centres for feasibility and prototypes (trust) and industry for operational projects. Building strong, competent teams internally for public sector bodies which initiate collaborations and procurement. Chatbot in the Norwegian tax authority is a good example. 'GovTech' funding streams/catalyst efforts to set public sector challenges and fund private sector solutions. Rather than outsourced contracts, baking knowledge and skills transfer into the procurement process to build public sector capacity from private sector suppliers. Investments into augmenting competencies. Sharing AI knowledge between public sector agencies of different countries in workshops and seminars

Success stories

Several success stories were mentioned, including chatbot / conversational AI in Norway municipalities, a data observatory and Public Procurement Innovation Directive in Chile, the Canadian government's AI Source List for the promotion of innovative procurement[454], an annual update of the land cover map with AI in Walloon public procurement[455], a Programme in Data Science and Artificial Intelligence in Public Administration in Portugal[456], CitizenLab in Belgium[457], AI registers in Amsterdam, Helsinki and Nantes.

In the discussion AI provider commented that projects are a safe space for governments to explore and discuss technologies, and for AI companies to engage with current knowledge and potential public sector clients. Innovation projects involve academia and the private and public sectors.

A national public body said that collaboration between civil servants and AI developers works well from personal experience, with validity ensured at every step. Technical specifications developed in collaboration with private companies being well guided to coach civil servants to use the AI product. Establishing trust across the private and public sectors is paramount.

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[454] Public Services and Procurement Canada (PSPC), together with the Treasury Board of Canada Secretariat (TBS), held a procurement process to establish a list of suppliers who can provide the Government of Canada with responsible and effective AI services, solutions and products. Federal Government departments and agencies across Canada can use these pre-qualified suppliers to launch a streamlined procurement process to obtain AI solutions. More information available at: https://www.canada.ca/en/government/system/digital-government/digital-government-innovations/responsible-use-ai/list-interested-artificial-intelligence-ai-suppliers.html

[455] More information available at: https://www.eurisy.eu/stories/the-public-service-of-wallonia/

[456] More information available at: https://www.fct.pt/media/docs/Brochura_ResearchinDataScienceandAIappliedtoPA.pdf

[457] CitizenLab is an online project and collaboration platform. More information available at: https://www.citizenlab.co/about

3.4 Mobility (transport) workshop

The mobility (transport) workshop took place on the 3rd of October (10:00-12:30 CET) via Microsoft Teams, utilising the Mural board to conduct interactive exercises.

The workshop was attended by 12 participants in total, represented by 6 AI providers, 2 local public bodies, 1 national public body, 2 research organisations and 1 international organisation.

The rest of this section provides an analysis of the results of the exercises undertaken during the workshop and the discussions that followed.

3.4.1 Exercise 1: Challenges affecting the uptake of AI by the public sector

In this exercise, participants were asked to write down challenges affecting the uptake of AI by the public sector concerning procurement process, data, sectoral and AI-specific technology, and organisational capacity challenges for industry and public sector, and indicate which ones were the most significant.

Procurement process challenges

For industry, the continual emergence of start-ups and other new actors within the sector often requires new supplier strategies and processes to be established resulting in delays with procurement processes. Similarly, it was noted that there **were limited levels of international coordination with procurement processes**.

For the public sector, the key procurement process challenge identified was the **lack of experience with Innovation Procurement.** Often the procurement process itself focuses on simply purchasing an AI service rather than being viewed as a longer-term partnership between key stakeholders. The **lack of a standardised legal vocabulary related to AI, limited collaboration between public Data Protection Offices (DPO)** and the **limited involvement of lawyers, DPOs, and procurement experts** at the start of AI-service procurement processes were all identified as significant procurement process challenges. both identified as significant challenges.

Data challenges

Two common challenges facing both industry and the public sector were identified, **a lack of clarity around "data ownership"** and the **lack of data management and sharing infrastructure.** Issues of "data ownership" are particularly prominent due to **the complex nature of an integrated supply chain** where it is challenging to specifically define and identify data owners and holders as data moves across multiple actors and systems. It was noted that there is **a need for the standardising of "data ownership" within contracts** to help mitigate this.

For the public sector, the most significant data challenge concerns **obscurities and obstacles in data transfer.** It was noted that the transfer of both personal and non-personal data had faced challenges due to a **complex legal environment** particularly due to a **lack of coherence between the EU and the US**. It was noted that there was a distinct EU dimension to this, in that even between municipalities and regions there is a **hesitancy to share data** due to the complexity of the environment. It was discussed that the **lack of use cases** within the public sector, more specifically, a **lack of readily available and accessible use cases**, plays a key role in this, often meaning that questions and conversations around the realities and benefits of data-sharing remain abstracted. Finally, a **lack of incentives for private actors to share data,** and the **difficulties in determining the return on investment** were noted as inhibiting public-private initiatives and often resulting in investment decisions being made in silos.

A final challenge was identified as the **lack of investment into data integration infrastructure driven by a lack of legal and financial clarity** that leads to barriers in the availability of data.

Sectoral and AI-specific technology challenges

Industry stakeholders identified two challenges, the first being the 'Right to Rectification and Erasure' under GDPR, the second being a lack of effective transparency of the algorithmic systems often underpinning most AI services and technologies.

For the public sector, no single challenge was perceived as being greater than another, but like industry, there was a clear and sustained focus on the **risk of data bias** and a **lack of transparency** within algorithmic systems. Again, GDPR issues were mentioned with a particular focus on the lack of clarity as to whether the data processor role applies to those undertaking data analytics at a different point of the supply chain. It was discussed that there is a need for more innovation projects that combine datasets, for example, combining mobility and socio-economic data sets to better understand patterns of travel and transportation use and need. Relatedly, it was noted that as more projects of that kind are done, and as more systems and databases are integrated into Mobility as a Service (MaaS) projects, there is a need to better engage with ethical issues and questions of fairness. The **lack of internationally equivalent ethical principles** was identified as proving a challenge when looking across contexts, though it was noted that universal principles are challenging if not impossible to establish given the relative cultural and political context in different countries.

A local public body outlined that there was a need for the mobility sector to move beyond semantic standards when it comes to MaaS and also looks at fostering public trust. They further highlighted the lack of Open Standards for Linked Organisations (OSLO) for MaaS, and that more was needed, for example, around issues of consent, handling metadata, and accessing APIs.

Organisational capacity challenges

For the public sector, a key organisation challenge was identified as being the **lack of competence, experience, and skills,** within the organisational workforce to appropriately identify and make use of AI services and systems. Furthermore, it was noted that often public sector bodies **lack the necessary technical knowledge when it comes to innovation procurement** and that this is often outsourced.

Integrating AI services and technologies into existing city systems (for example by allowing AI to take control of a system) was also discussed as a significant challenge that is compounded by the lack of skills and expertise within the system to appropriately identify where AI services are needed.

During the discussion it was outlined by a research organisation and a local public body that the use of **AI systems should always be a means but never an end in itself,** and that using such services can create short-term challenges if done abruptly and without focus**.** Furthermore, it was noted that if skills and competency gaps aren't properly addressed that public sector bodies will struggle to keep pace with technological developments.

3.4.2 Exercise 2: Measures to increase the adoption of AI

In this exercise, participants were asked to write down measures, the most promising ideas or steps in addressing the challenges discussed above, and indicate which ones are the most significant.

Awareness of measures, the most promising ideas or steps

Public authority solutions change the procurement process to include both pre-commercial procurement and **innovation procurement projects** to better identify and adopt developing technologies. Establishing an EU **AI register** was also noted as one solution to help centralise use cases and foster trusted partnerships.

In terms of infrastructure changes, participants identified the need for data spaces, identifying systems such as the **federated data infrastructure** Gaia-X[458], and the Swedish Logistics Data Lab mobility data space[459], as good working examples. There was also discussion of the need for more open data initiatives with AI Sweden's My AI[460] and VLOCA[461], the Flemish Open City Architecture project identified as two good examples in this space. It was also noted that there is a need to build more trust among citizens with the Flemish Data Utility Company[462] project being a good example. Finally, it was discussed that there is a need to build more communities of practice to help with knowledge sharing.

Suggestions for other measures

Other suggestions focussed on the need for **greater flexibility** with subsidies, particularly for innovation procurement projects, a need for greater accuracy when discussing AI services and data marked by moving away from rhetoric such as "data is the new gold" and instead providing clear and accessible explainers to public sector bodies regarding the prospect and value of AI services. Finally, in terms of wider involvement with AI service projects, it was noted that the conversation needed to include a wider range of voices both in terms of citizen participation, as well as education level. This would move the conversation away from people holding high levels of qualifications and help to stop the conversations from feeling exclusive.

3.4.3 Exercise 3: Examples of cooperation between the public sector and AI providers and success stories

In this exercise, participants were asked to write down cooperation best practices and success stories, and indicate which ones are the most significant.

Cooperation best practices

Best practices in cooperation focussed on ensuring clear arrangements and conditions were in place for any AI procurement activity. Early and clear communication about data access, data needs, and system challenges can help smooth the process. Greater cooperation along the supply chain will also help with this by, for example, pre-commercial procurement processes involving companies at an early stage to ensure the service or technology is developing towards a clear goal.

3.5 Education workshop

The education workshop took place on 4 October (10:00-12:30 CET) via Microsoft Teams, utilising the Mural board to conduct interactive exercises.

The workshop was attended by 12 participants in total, representing 4 public bodies (3 national, 1 regional), 2 NGOs, 2 European Digital Innovation Hubs and 4 AI providers.

The rest of this section provides an analysis of the results of the exercises undertaken during the workshop and the discussions that followed.

[458] Gaia-X is a federated and secure data infrastructure that is working to establish a data space ecosystem. Further information is available at: https://gaia-x.eu/what-is-gaia-x/

[459] Further information available at: https://ibg-sweden.se/2021/11/17/new-logistics-data-lab-creates-better-opportunities-for-attaining-climate-goals/

[460] Further information available at: https://my.ai.se

[461] Further information available at: https://www.ugent.be/mict/en/research/projects/2020/vloca-flemish-open-city-architecture

[462] Further information available at: https://www.vlaanderen.be/digitaal-vlaanderen/het-vlaams-datanutsbedrijf/the-flemish-data-utility-company

3.5.1 Exercise 1: Challenges affecting the uptake of AI by the public sector

In this exercise, participants were asked to write down challenges affecting the uptake of AI by the public sector concerning procurement process, data, sectoral and AI-specific technology, and organisational capacity challenges for industry and public sector, and indicate which ones are the most significant.

Procurement process challenges

For industry, the most important challenges are a general lack of **legislative frameworks, guidelines, and benchmarks** for integrating AI solutions into public service provision. There is a growing demand for the public sector to formulate more clearly what kinds of solutions would be relevant, and what kind of data is going to be made available to train and run these operations. AI is at the top of the pyramid, technology SMEs need **data sources, data collection, data engineering** etc. before AI applications can be implemented. If there is no available data, the chances of starting an AI project are low. A further problem is that SMEs competing for public contracts do not have a clear idea of the challenges facing **work processes in the public sector**. They struggle to demonstrate a clear "return on investment" since some operations seem opaque. There also seem to be concerns about **"procurement theatre"**, long-winded public procedures and press releases, instead of focusing on the best solution and operationalising it fast.

For the public sector, the most significant challenges are a **lack of digital skills and expertise** among public buyers to understand the technology market and its latest products. This leads to technical specifications that are not always at the cutting edge of technological research. AI providers want **performance expectations** to be more clearly expressed. A related issue is the **absence of unified guidance and quality standards** to assess AI solutions. There should be national legislation on the use of high-risk AI, especially when the target audience of AI solutions for education is minors. If, however, a specific AI solution is rolled out at a large scale, the "freedom of education" of each learner should be respected, for example, by always providing at least one alternative.

During the discussion, The most frequent comment was that there is still a lack of knowledge about AI and its potential uses in education. This is partly because school leaders and educators, often trained before the digital revolution in education, lack digital skills and knowledge to use AI solutions, "to make safe use of AI solutions".

The safety of minors is a great concern, but solutions exist and educational stakeholders should receive more information and training about them.

The case for AI in education is yet to be made. As the representative of an EU-wide educational NGO put it, "What is AI good for in the institutions?". Education and training institutions care about raising the quality of education, and "AI might not be the solution." Such challenges regarding the educational content, quality and relevance are not necessarily addressed through technologically supported efficiency gains.

Data challenges

For industry representatives, the most important challenges concern the **quality of data, sensitive data and "data ownership"**. Different data models and a strong belief in "old-fashioned structured data" lead to scalability problems in national education systems. The approach of "data minimalism" is preferred. Since the education sector's main data users and data producers are minors, **access to data** is often very complicated. Industry representatives asked for clearer definitions of "sensitive data" and **ethical frameworks** outlining what can be done with it. The most important challenge for the industry is "data ownership": if the data is produced by minors and used in a state-funded education system, are the data owners the learners, their parents, the educators, the state institution, the education ministry or the private AI provider? What are the "data ownership" options for public-private partnerships?

From the public sector perspective, the biggest challenges are the lack of **data interoperability** and the uneven **implementation of EU regulation** (esp. GDPR) across Member States. The interoperability challenge affects data transfers and data security. One proposal was to create better data spaces accompanied by "national/supranational data governance frameworks". The second challenge concerns **ethical issues in data collection** (esp. for minors) and accountability for AI providers. A more unified interpretation of the GDPR would offer clarity and a safer space for all education stakeholders.

During the discussion**,** AI providers stressed that ownership of and access to data is a big issue. Access to data can be constrained by the GDPR, yet some data is strategically important to have for the sector. Private companies process the data and the data owner (e.g. educational institution) then has to buy it back.

Common challenges include a lack of interoperability and a lack of infrastructure, which might also stem from the limited digital literacy of some users.

Sectoral and AI-specific technology challenges

For **industry** representatives, the main challenges revolve around collecting and processing **data from underage users**. At the moment, it is difficult to feed AI models with sufficient data (big data). Only "big tech" has enough data for certain solutions. Smaller providers would appreciate **"open data sets"** to train their AI. Regardless of company size, the problem of underage consent and transparency is striking. "Do students know what is done with their data?" was the most popular comment overall. A second sector-specific challenge from the perspective of AI providers is the entrenched **infrastructure, hierarchy and bureaucracy of educational institutions**. Providers of AI solutions do not always know who to talk to sell their solutions.

Among the **public sector** notes, the most popular statement was "First, you have to know the goal, second: the data that we have, third: algorithm selection. Too often started with AI selection". This overlaps with the abovementioned comments about the **lack of a guiding framework**, which sets out aims and basic principles for introducing AI in education. It is also an important point about public **procurement procedures** – which should have transparent goals – and public buyers, who need to be able to offer providers reliable data.

Another point discussed in detail was **equity**. Equality is a core principle of the EU and education systems are supposed to promote it, but AI-powered tools are not accessible to all learners and educational institutions. This basic problem of availability and access to high-tech solutions, coupled with algorithms automatically adapting to learner profiles, may enlarge pre-existing social differences. Transparency about what data should be collected (e.g. are data on socio-economic background acceptable?) should

The final discussion concerned the question: "What are the **guiding values of universities**?". Should they be focused on efficient operations and effective preparation for the labour market, or rather allow some space for flexible, serendipitous learning guided by learners' interests? Some participants agreed that the efficiency gains from AI products (esp. for institutional governance) should not override the process of free, inquisitive discovery.

During the discussion**,** the representative of a transnational education NGO said that there were outstanding questions about AI being the most appropriate tool for staff training, improving education and other values that are dear to workers in the education sector.

For educators, the arrival of AI also poses a personal challenge (going beyond the technical challenge), since they feel like their status and authority as sources of knowledge and learning are under threat.

A representative of a higher education institution added that there are cultural differences across Europe when it comes to the adoption of new technologies for operations or teaching, with concerns about learner privacy more marked in some countries than others.

The majority of participants agree that (views on) AI take up vary greatly between educational institutions and the AI industry.

Organisational capacity challenges

For industry representatives, the biggest problem is that most developers have a **limited understanding of pedagogical principles** and the education sector. There is "no real customer orientation – tech comes first". Sometimes this "tech first" principle is reinforced by the perceived need of selling "trendy stuff". The COVID-19 pandemic greatly accelerated the demand for good Edtech.

Nonetheless, **regulation** (comparatively strict for education, due to underage users) could inhibit SME capabilities. Innovative start-ups are struggling to get long-term. The interest in **"open source"** material for educational purposes generates further uncertainty about the sustainability of the developer community.

From a public sector perspective, the most important request is a real discussion on "what kind of future we want". Teachers' beliefs on "what learning/teaching is" are challenged by AI at a fundamental level. Teachers follow pedagogical traditions and will need to improve their **digital skills and literacy**. This includes the interpretation of AI output. "Do we need to change our curricula in addition to teaching style?" was a question posed by several participants. More guidance on the didactical use/integration of AI would be appreciated.

During the discussion, it was commented that a political discussion needs to precede the technological discussion, as to what kind of teaching society wants, whether AI can improve learning outcomes, and on a bigger scale what is the role of education in the data economy. Most questions are political rather than of a technical nature. Discussion on the European approach to learning and teaching and the place of digital tools in that approach is important. Determining the right purposes for using AI solutions is crucial to ensure the right level of adoption of AI technology.

There may be a misunderstanding of the challenges faced by the education sector among AI providers, in that they see them from a business perspective. The overall impression is a disconnect between AI providers and the education sector.

3.5.2 Exercise 2: Measures to increase the adoption of AI

In this exercise, participants were asked to write down measures, the most promising ideas or steps in addressing the challenges discussed above, and indicate which ones are the most significant.

Awareness of measures, the most promising ideas or steps

Solutions provided by the industry include **public-private partnerships**, (e.g. Research partnerships between EdTech & universities), open innovation to increase trust, and **better dialogue** with the education sector – for example by linking the development of new tech products with training courses for educators.

Solutions provided by public authorities include better **risk management** with **clear policies** and **executable procedures** - this will lead to higher consistency and less uncertainty. Better and continuous **professional training for educators** who have to keep up (peer learning is particularly good for the teaching community) is needed. It is important to stimulate discussion about the role of teachers in a changing digital society. These solutions should also be factored into budgeting and the institutional and national level. Detailed **standards** for the development and implementation of EdTech solutions, coupled with **guidelines and benchmarks** would be much appreciated.

Suggestions for other measures

Most additional suggestions revolved around the themes of **transparency and trust**. Participants requested "open data sets", a large-scale "awareness-raising campaign" and "Principles for fair use of AI in education" ensuring a "human-centric approach" in education.

Measures to increase **digital literacy** were also considered very important. Peer learning could be organised across Member States (e.g., for GDPR implementation) to ensure that benchmarks & standards can be reached and upheld. This would allow some degree of standardization of AI in Education.

During the discussion, the representative of an industry association recognised that documentation around AI and its use, how it is developing etc. is important for the education sector. There are good initiatives led by the government on those aspects. Achieving a more centralised understanding and providing a framework for understanding the technology (e.g. cloud infrastructure, esp. during the COVID-19 pandemic) is something that can be replicated for AI. There is a lack of trust in technology within the education sector, which is sensed by the AI industry. It is important to understand in what scenarios the AI industry and education sector can work together. Public-private partnerships could help. At the moment there is a fear among teachers that "robots will take over".

The industry supports a practical approach to making sure regulations do not hamper technological development. The EU's draft AI regulations may be too constraining to ensure AI take-up. AI in education is still in its infancy, having openly available large datasets to build AI tools would be useful.

Partnership work can bring about better outcomes when training education sector workers. Different education sectors often work in silos. Different providers need to work together.

The first step is to establish communities of practice to make sure all stakeholder groups are on the same page, i.e. education workers, policymakers, and AI developers.

3.5.3 Exercise 3: Examples of cooperation between the public sector and AI providers and success stories

In this exercise, participants were asked to write down cooperation best practices and success stories, and indicate which ones are the most significant.

Cooperation best practices

Best practices highlighted by the public sector include the production of national AI strategies (e.g. FR[463]), often with policies to increase the number of AI experts; guidelines for Data Governance in education (NL[464] & CH); Bodies that gather practices and develop policies (CNIL,[465] Hochschulforum Digitalisierung[466], SURF, JISC), and roadmaps for implementing AI in the education system.

[463] More information available at: https://www.economie.gouv.fr/strategie-nationale-intelligence-artificielle

[464] More information available at: https://www.nldigitalgovernment.nl/wp-content/uploads/sites/11/2019/04/data-agenda-government.pdf

[465] More information available at: https://www.cnil.fr/

[466] More information available at: https://hochschulforumdigitalisierung.de/

Success stories

Industry provided 3 examples from FI: The Association of Finnish Municipalities partly funded the development of the "Annie Advisor"[467] chatbot with a condition that there would be an open-source version; my data skills transfer between Finnish DF & higher education; Technology Industries Finland (employer union), relevant labour unions and higher education: personalized learning paths to find a job or a better job via the right training[468].

The public sector provided examples of AMAI!-project (Flanders)[469]: cooperation between public and industry, Smart Education @Schools projects (Flanders)[470]**,** City of Tampere: optimising formal and corporate training to future Labour market demand (including the use of synthetic data), Metropolia UAS (Helsinki): Curriculum to meet SDGs horizontally at a course level[471].

During the discussion, it was suggested that the government and industry have to work together to further develop academic expertise and capacity in AI. Teachers and students also need to be involved in any cooperation process.

The development of a skills portfolio in army training can be transferred to the academic context. If all the players in the ecosystem know their value, cooperation can work.

There is potential for bottom-up cooperation, from teachers' needs to the development of innovations. App developers can have a role to play here. The offer of open-source tools can foster cooperation.

3.6 Policy workshop

The Policy workshop took place on 17 October (10:30-13:00 CET) via Microsoft Teams, utilising the Mural board to conduct interactive exercises.

The workshop was attended by 29 participants in total, represented by 1 business association, 5 AI providers, 9 national public bodies, 7 research organisations, 2 international organisations, 1 regional public body and 1 NGO.

The rest of this section provides an analysis of the results of the exercises undertaken during the workshop and the discussions that followed.

3.6.1 Exercise 1: Identifying solutions to challenges affecting the uptake of AI by the public sector

In this exercise, participants were asked to write down solutions to challenges affecting the uptake of AI by the public sector concerning procurement process, data, sectoral and AI-specific technology, and organisational capacity challenges.

Solutions to procurement process challenges

Participants were asked to provide solutions to four of the most important challenges identified in the sectoral workshops:

Challenge 1: Lack of clarity on regulation (particularly around high-risk AI). Solutions provided by participants:

- Provide clarity as to how EU legislation and regulatory frameworks interact together and address legal misalignment and incoherence between Artificial

[467] More information available at: https://www.annieadvisor.com/
[468] More information available at: https://finland.fi/business-innovation/combining-finnish-educational-expertise-and-artificial-intelligence/
[469] More information available at: https://amai.vlaanderen/
[470] More information available at: https://onderwijs.vlaanderen.be/nl/dien-je-idee-en-project-in-bij-smart-education-schools-najaar-2022
[471] More information available at: https://www.metropolia.fi/en/rdi/rdi-projects/sdg4biz-project

Intelligence Act, GDPR, Data Governance Act, Data Act, and AI Liability Directive. Prepare a basis for guidance on the reconciliation of the regulatory frameworks. Run "war games" to see how use cases may interplay across regulatory frameworks.

- Provide a clear definition of what is AI and clarity on the scope of what AI regulations cover to understand if this will impact any already ongoing activities that we may not think of as AI.
- Introduce certification of AI on different levels and Production Planning.
- Introduce risk classification under AI Act and sectoral regulations.
- Ensure that all sectors engage with policymakers for the AI Act to ensure the regulation meets the needs of all types of AI uses and that all key stakeholders are working together to shape fit-for-purpose EU legislation for AI and data.
- Provide Impact Assessment of AI/ADM implementation in public sector services.
- Monitor developing AI regulations, principles and wider experience where legislation has been enacted, for example, in China.
- Organise inter-organizational discussions on AI/data sharing regulation, for example, between education ministries and the data protection commissioner.
- Promote awareness about possible exemptions from AI Act (e.g. in law enforcement) for public bodies when it comes to implementation.
- Set up regulatory sandboxes on AI to promote public experimentation.
- Use of innovation-friendly procurement modes.

Challenge 2: Lack of centralised procurement strategy and lack of experience with innovation procurement. Solutions provided by participants:

- Identify 'owners' for procurement strategy and their needs, to ensure that AI solution can solve their problems.
- Reinforce ideas through other strategy documents and activities if no strategy is on the horizon.
- Consider the procurement power of larger-scale organisations and assess what the processes and needs are.
- Provide an inventory of best practices from similar entities.
- Encourage open source solutions, not to be locked in proprietary solutions from the US or Chinese companies.
- Cybersecurity standards should be taken into account, given the critical nature of infrastructure in many cases.
- Promote interdisciplinary collaboration between the public sector and other stakeholders.
- Ensure procurement specialists are versed in the technology and flow.

Challenge 3: Lack of expertise among public buyers to articulate needs and understand the purpose behind adoption. Solutions provided by participants:

- Avoid the "AI-first" approach and focus on clear problem framing, on the specific improvements that an AI-based solution would bring.
- Introduce national points of contact for practical advice, Digital Innovation Hubs for consulting, or competence centres for aiding public bodies to adopt/set up fitting solutions.

- Educate and raise awareness of the potential and limitations of AI, and show what AI interventions can achieve with real-world success stories. Education should not only be in"digital literacy" but also on the basic theories underpinning Computer Science and AI.
- Provide EU funds and support for implementing relevant training at the national and local levels.
- Bring together procurement specialists and technical experts throughout the design/delivery process.

Challenge 4: Lack of alignment between industry and public sector expectations. Solutions provided by participants:

- Create regulatory sandboxes.
- Introduce "best practice" dialogues between industry, the public sector and academia, and "roadshow" type events for building networks and shared goals and understanding.
- Conduct internal research within public organisations to understand what expectations and ideas on AI public employees have.
- Include the expectations of citizens and consumers because they are as important as what public bodies want - the user journey should start with end users of services.

Solutions to data challenges

Participants were asked to provide solutions to four of the most important challenges identified in the sectoral workshops:

Challenge 1: Lack of clarity and harmonisation around cross-border data flows. Solutions provided by participants:

- Formulate clear incentives and use cases for data sharing.
- Promote open application programming interfaces (APIs).
- Develop more federated data networks.
- The sector-specific data spaces, such as the European Health Data Space, should bring clarity on data flows per sector.
- Clear rules on the level of de-identification connected to cross-border data sharing, and clarity on applicability/use of GAIA-X/clouds.

Challenge 2: Lack of interoperability. Solutions provided by participants:

- Develop standards for data exchange including principles for metadata creation. Develop "future-proof" standards that will easily adapt to new data types/sources. It is important to use and align all the many existing standards and not create even more new ones.
- Develop national strategies for data complemented by organisation/sector-specific strategies for data that take a wide-angled approach to what's involved (leadership, skills, regulation, architecture, infrastructure).
- Make it a law that data format for anyone doing business in the EU should be open so that anyone could build interoperable software. Or introduce incentives for creating an interoperable system.
- Introduce compulsory documentation for semantic interoperability (data dictionaries, ontologies, etc.).

Challenge 3: Lack of clarity on "data ownership". Solutions provided by participants:

- Define data control, access and other processes in relevant legislation - GDPR, Data Governance Act and the Data Act.
- Increase the use of decentralized data architectures.
- Introduce dedicated system transparency conditions in agreements with AI/ADM system contractors.
- Make it a special issue in certification schemes.
- Engage in public discussion, education and seminars around "ownership" and usage of individuals' data to promote greater understanding by individuals of how their data may be used.
- Encourage donation of data sets.

Challenge 4: Challenges surrounding the sharing of data between and across sectors. Solutions provided by participants:

- Introduce guidelines as to what is and isn't legally possible when it comes to sharing data cross-sectorally, and guidance in structuring data regarding sensitivity.
- Consider GDPR compliance from the ground up.
- Encourage sharing of data between different data spaces, for example, in health or agriculture.
- Promote common sharing, format and metadata standards.
- Promote cross-sectoral teamwork in the early stages of AI adoption for mutual understanding of needs and concerns.
- Ensure that confidential data (business secrets) are end-to-end encrypted and promote privacy-preserving techniques.
- Build the tools that help give users visibility and control over their data and associated consents to see who and for what purpose it's being used in practical terms.

Solutions to technology challenges

Participants were asked to provide solutions to four of the most important challenges identified in the sectoral workshops:

Challenge 1: Managing the potential for bias within data sources and data science teams. Solutions provided by participants:

- Ensure ethics by design - interdisciplinary awareness/competence in developing/procuring teams.
- Recognise that bias will exist in datasets and develop tools/promote education to make understanding bias a standard part of any AI workflow. Actively promote mitigating bias in developing AI as an area for research.
- Ensure representation in data science teams.
- Apply explainable algorithms used in AI/ADM systems in the public sector.
- Have clear requirements for training, testing and validation of data sets.
- Use diverse fictional cases to test AI outcomes. EU AI Act requirements should include bias avoidance, this can be tested/audited before market placement as well as ongoing for learning AI systems.
- Have consistent monitoring and evaluation of bias.

Challenge 2: Limited technological accountability and transparency. Solutions provided by participants:

- Use of explainability tools along EU guidelines. Explainable AI (XAI) requirements would help with accountability and transparency.
- Certification of AI on all assurance levels.
- Deeper user studies before designing interfaces.
- Clear requirements for training, testing and validation of datasets.
- Conformity assessment of transparency requirements, ideally via independent third parties for high-risk areas.

Challenge 3: Misunderstandings of, and a lack of trust in, using AI solutions (fear of the impact of new technology). Solutions provided by participants:

- Use storytelling to communicate the value and the worth, but also manage unintended consequences and fears.
- Testing, inspection, and certification (e.g. by TIC Council companies and notified bodies), especially in high-risk areas, will boost trust. Signal via tested, certified "Made in Europe" label to enable trust needed for uptake.
- Clear regulation and rules.
- Greater education on AI at all levels of society. Promote education on the basics of AI (regression/classification) to demystify it from primary school.
- Position the AI Act and AI Liability Directive as a way to build more trust in the use of AI.
- Promote the adoption of ethical frameworks for AI.
- A position most AI systems will include a human in the loop to ensure safety. There needs to be trusted not just in a single AI product, but also processes and persons underpinning it.
- Making Algorithmic Impact Assessments standard practice and easy to find and read.

Challenge 4: Difficulty in integrating new AI technologies/services into existing systems (education/health/transport). Solutions provided by participants:

- Aim for a longer cycle of integration because this happens with any new IT.
- Address security considerations by undertaking risk-adequate controlled experiments via new solutions.
- Use "data ambassador" campaigns to better involve stakeholders.
- Work alongside existing systems as a support rather than immediately replacing existing systems.

Solutions to organisational capacity challenges

Participants were asked to provide solutions to four of the most important challenges identified in the sectoral workshops:

Challenge 1: Focus often on innovation and developing new solutions rather than long-term implementation. Solutions provided by participants:

- Fund multi-disciplinary teams, not projects.
- Avoid "project silos" and reinvent the wheel each time, a more modular longer-term approach is advisable. The overarching purpose should be not a "shiny

project" but a long-term solution for citizens, real-world solutions with a service mentality.

- Promote, and invest in a facilitate (e.g. via legislation on data sharing) open-source solutions and libraries.
- Make policy with input from representative groups of users.
- Develop reward/payment structures to promote long-term behaviour.

Challenge 2: Lack of central resources to help understand the role of AI and whether AI services are the best solution. Solutions provided by participants:

- Incentivise, emphasise and prioritise service design over tech implementation. Iterative design thinking should be emphasised.
- Better education in AI is needed to understand which techniques to use for a particular case study, and more importantly, when not to use them and rely on a simpler solution.
- Use central governance structures like business cases to challenge the assumptions and be clear on the value of what's being done.
- Establish cascading funding scheme for AI.

Challenge 3: Lack of skills, competencies, and capacity to understand and utilise new AI technologies/services. Solutions provided by participants:

- Focus on social needs and less on technologies.
- Introduce digital Academy-type models for the public sector where AI is part of a balanced curriculum about 21st-century digital era public service design and delivery. Promote AI further education not just to understand AI basics but in change management in terms of how to introduce solutions within and across the organization.
- Ensure AI and tech are a key part of schooling for children.
- Build experimentation labs (controlled environments) for young adults.
- Advertise successful examples and best practices.
- Increase digital literacy through the establishment of communities of practice, or peer learning groups across Member States.

Challenge 4: Lack of established relationships with private AI providers. Solutions provided by participants:

- Public adoption should be safe, not become the testing ground for private AI providers.
- Target SMEs and start-ups less known than big tech companies.
- Open calls targeted at University excellence centres and public interest initiatives.

3.6.2 Exercise 2: Exploring solutions and opportunities for overcoming barriers

In this exercise, participants were divided into three groups. For each group, the most significant solutions from the previous exercise were selected. The participants in groups discussed why each solution is important, who should implement it, what should be the role of EC, who would benefit and how, and what could be the barriers to their adoption.

Solution: Training for public buyers

This solution is important in raising the quality of public services, because of the possible lock-in effects of (also wrong) purchasing decisions, and because smart choices matter and should be taken based on competent assessments.

The solution should be implemented by professional further education bodies, ideally offering certified further training in this domain, public institutions in the Member States and National Institutes.

Europen Commission's role should be in establishing and maintaining a pool of resources (e.g. ISA2 for interoperability), producing guidelines for public AI procurement, awareness-raising, best practice sharing (so mistakes aren't made each time again), quality benchmarks, providing a framework of legal and ethical guidelines.

Beneficiaries of this solution will be everybody really, those taking decisions and those benefitting (or not being harmed by) them at a later stage once solutions are implemented. The buyers – they can do their job better. The users – work with a good system. The sellers – interacting with someone with the right skills.

The potential barriers to this solution are legacy, lock-in effects from previous tools in use (may need to be disrupted), issues of interoperability when each buyer uses a different AI tech, and lack of funding to maintain and support advanced AI applications where constant data collection is needed.

Solution: "data ownership" certification

This solution is important because certification forms a basis for trust in AI solutions, increasing uptake and willingness to share data.

This solution should be implemented by independent third parties and conformity assessment bodies.

European Commission's role should be in ensuring that certified solutions are chosen/recommended and provide guidelines, and frameworks for thinking about these complex issues.

Beneficiaries of this solution will be citizens, who will know who is accountable, governments, who can implement effective data governance, and AI developers, who will have clarity on their freedom to operate.

The potential barriers to this solution are existing data collection systems in the public sector in which the same data are collected by different agencies.

Solution: Ethics by design

This solution is important because it builds protections for individuals in AI solutions, safeguards and prevention of early-on bias and discrimination, and raises awareness of the risks and pitfalls of AI.

This solution should be implemented by development teams together with the owner.

European Commission's role should be in providing training, encouraging research, and providing ethical standards for AI technological development.

The potential barriers to this solution are acknowledging direct and indirect biases.

Solution: Regulatory sandboxes

This solution is important because there are multiple ways to create AI solutions, they must be carefully classified and can be potentially disruptive to society.

This solution should be implemented by the European Commission together with Member States, or by subcontracting to an EU company to avoid conflicts of interest.

European Commission's role should be to facilitate the process and provide templates, and "In-scope/Out-of-scope" guidance, to make sure a European set of solutions emerges.

Beneficiaries of this solution will be start-ups in need of scaling innovation, users and AI technology providers.

Potential barriers to this solution are the time it takes to set them up, the potential of “dual-use” and user suspicion.

Solution: Standards for data exchange / Principles for metadata creation

This solution is important because it is a key to safe AI due to certification which lays on standards, crucial to the end-to-end value of information exchange and creates a consistent layer of data quality.

This solution should be implemented by producers of AI and some standard organisations such as ISO or ECMA.

European Commission’s role should be in the production of AI certification schemes and interacting with international organizations in creating data standards.

Beneficiaries of this solution will be users who would have confidence in AI and producers, so they could focus their efforts.

Potential barriers are lobbying by private companies trying to push their solutions, the complexity of the process, lack of know-how and skills and Change Management in organizations tempted to go the "safest" way.

Solution: Story-telling to communicate the value

This solution is important in providing clear information for a broader society, building trustworthy AI and avoiding repeating mistakes.

This solution should be implemented by local authorities, responsible for AI and GDPR implementation.

European Commission’s role should be to establish the framework and support local authorities.

Beneficiaries of this solution will be citizens and enterprises, public servants and employees that need to apply and use AI technologies, and start-ups that are part of the system.

Potential barriers are a lack of proper strategy, guidance for communication of AI, the threat of a "technological elite" and information sensitivity.

Solution: Avoid “project silos” / Modular longer-term approach

This solution is important to reduce the gap between various stakeholders and increase the longevity of AI solutions.

This solution should be implemented by various decision-makers across the landscape, including Chief Data Officers with the bigger picture.

European Commission’s role should be to provide a policy-driven push for "free flow", and require companies to provide open APIs to their services so that services can be composed by third parties.

Beneficiaries of this solution should be EU SMEs providing advanced services based on publicly available building blocks (APIs), and small projects within departments that are not yet plugged into the overall picture (COVID showcased critical needs in this regard).

Potential barriers are time and the lack of wide knowledge.

3.7 Online survey

The online survey was launched on the 22nd of June 2022 and closed on the 5th of September 2022. More details on the methodology can be found in the Annex.

In total, the survey received 77 complete responses. Most responses came from research organisations (18 responses), academic/independent experts (12 responses), national public bodies (8 responses), European Digital Innovation Hubs (8 responses), enterprises (8 responses), regional public bodies (7 responses) and local public bodies (6 responses).

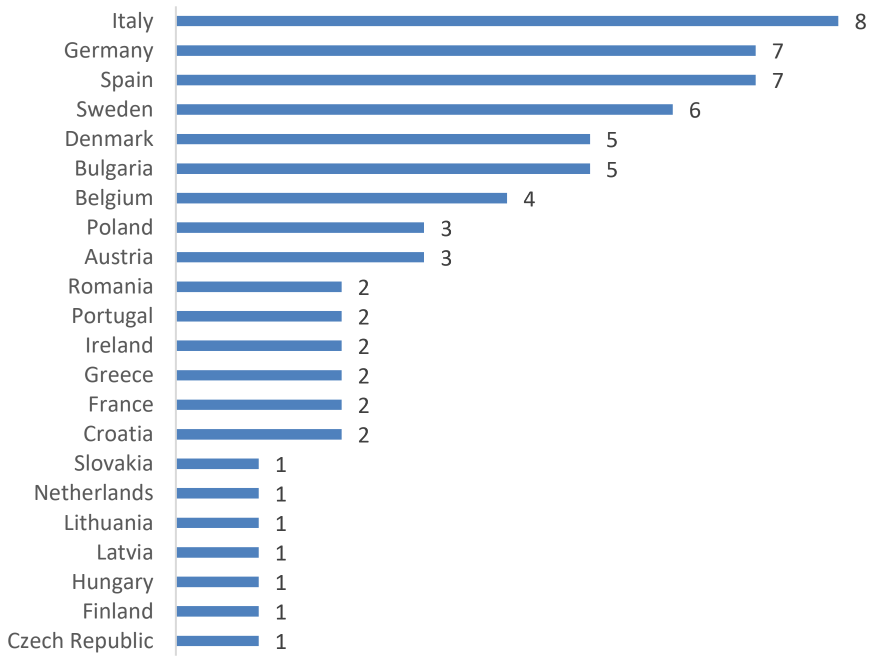
Figure 68 Respondents' affiliation

Source: Online survey, N=77.

Among those identifying as "Other" included an interest organization, several NGOs, a technology consultant and a research organisation.

In terms of country distribution, most respondents came from Italy (8), Germany (7), Spain (7), Sweden (6), Denmark (5) and Bulgaria (5).

Figure 69 Respondents' country of origin



Source: Online survey, N=77.

Respondents outside the EU came from the United Kingdom (3), Canada (1), Mexico (1), Montenegro (1), Scotland (1), Serbia (1), Switzerland (1), and the United States of America (1).

Among the 8 enterprises responding to the online survey, 3 are micro-enterprises[472], 2 are small enterprises[473] and 3 are large enterprises[474].

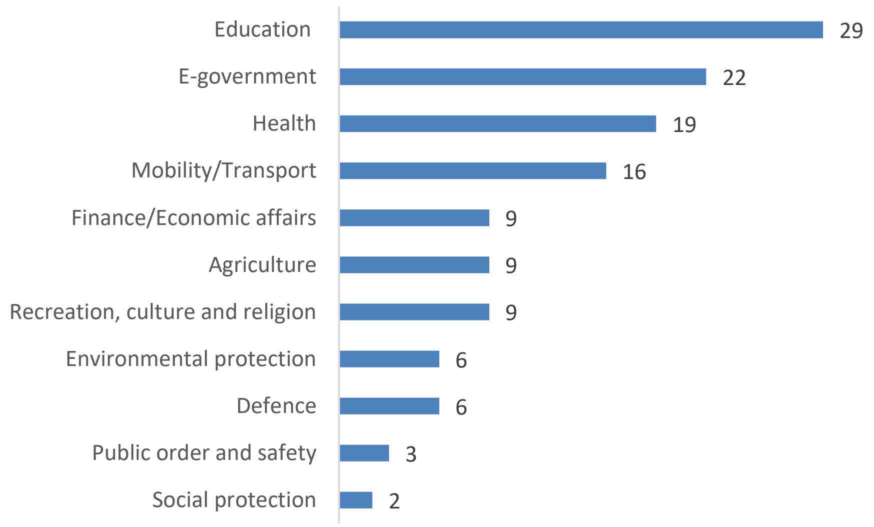
Most of the respondents belong to the education sector (29), followed by e-government (22), health (19) and mobility/transport (16).

[472] Staff headcount is less than 10; Turnover is less/equal EUR 2 million or Balance sheet total is less/equal than EUR 2 million

[473] Staff headcount is less than 50; Turnover is less/equal EUR 10 million or Balance sheet total is less/equal EUR 10 million

[474] Staff headcount is above 250; Turnover is above EUR 50 million or Balance sheet total is above EUR 43 million

Figure 70 Respondents' sectors



Source: Online survey, N=77.

3.7.1 Sectoral comparison of challenges in the online survey

To compare the challenges between sectors in the online survey, the following steps were made. First, the qualitative significance scale in the online survey was converted into a numerical scale, ranging from 1 to 5 (from not significant to strongly significant). Second, the average response was calculated, which allowed us to rank the challenges according to their significance. Third, the same was done for each of the sectors, which allows us to provide a comparison of challenges between the sectors.

Procurement process challenges

The most significant procurement process challenges for all sectors are:

- Burdensome administrative requirements
- Lack of clarity from the public sector regarding their needs/demands
- An emphasis on price/cost-savings over service quality and non-financial benefits
- Unclear regulatory requirements
- The complexity of the writing of technical specifications
- Unclear procurement processes
- Lack of a common language across organisations/sectors
- The need to demonstrate in-year cost savings
- Lack of ethical frameworks/ ethical oversight specific to AI

When comparing the significance of the challenges between the health, e-government, transport/mobility and education sectors, there were **slight sectoral differences in rating**. E-government and mobility/transport sector respondents rated "An emphasis on price/cost-savings over service quality and non-financial benefits" and "The need to demonstrate in-year cost savings" as higher challenges than the total average.

It must be noted that given the relatively small difference in responses and low numbers of respondents, these differences cannot be considered significant.

The table below provides a summary of the results. Red indicates those challenges that are higher than the total average.

Table 8 Comparison of procurement process challenges between sectors.

Procurement process challenges	Total average response (N=77)	Total rating (N=77)	Health sector rating (N=19)	E-gov sector rating (N=22)	Mobility/ transport sector rating (N=16)	Education Sector rating (N=29)
Burdensome administrative requirements	3.92	1	1	1	1	1
Lack of clarity from the public sector regarding their needs/demands	3.83	2	2	3	3	2
An emphasis on price/cost-savings over service quality and non-financial benefits	3.83	3	3	2	2	3
Unclear regulatory requirements	3.78	4	4	4	4	4
The complexity of the writing of technical specifications	3.49	5	5	5	5	5
Unclear procurement processes	3.46	6	6	7	7	6
Lack of a common language across organisations/sectors	3.37	7	7	8	8	7
The need to demonstrate in-year cost savings	3.31	8	8	6	6	8
Lack of ethical frameworks/ ethical oversight specific to AI	3.29	9	9	9	9	9

Source: Online survey, N=77.

Data challenges

The most significant data challenges for all sectors are:

- Unsatisfactory sharing of data across organisational boundaries
- Insufficient access to large volumes of high-quality data
- Lack of data to understand where AI is needed/ best suited
- Underdeveloped data governance
- Lack of clear "data ownership"/ "data sovereignty"
- Inadequate data management
- Lack of trust/ public acceptability with public sector data handling
- Absence of data standards

When comparing the significance of the challenges between the health, e-government, transport/mobility and education sectors, there were **slight sectoral differences in rating**. E-government and mobility/transport sector respondents rated "Insufficient access to large volumes of high-quality data" as a higher challenge than the total average. Also, the "Lack of clear "data ownership"/ "data sovereignty" was rated higher by the e-government sector.

It must be noted that given the relatively small difference in responses and low numbers of respondents, these differences cannot be considered significant.

The table below provides a summary of the results. Red indicates those challenges that are higher than the total average.

Table 9 Comparison of data challenges between sectors.

Data challenges	Total average response (N=77)	Total rating (N=77)	Health sector rating (N=19)	E-gov sector rating (N=22)	Mobility/ transport sector rating (N=16)	Education sector (N=29)
Unsatisfactory sharing of data across organisational boundaries	4.05	1	1	2	2	1
Insufficient access to large volumes of high-quality data	3.95	2	2	1	1	2
Lack of data to understand where AI is needed/ best suited	3.93	3	3	3	3	3
Underdeveloped data governance	3.78	4	4	5	4	4
Lack of clear "data ownership"/ "data sovereignty"	3.77	5	5	4	5	5
Inadequate data management	3.71	6	6	6	6	6
Lack of trust/ public acceptability with public sector data handling	3.68	7	7	7	7	7
Absence of data standards	3.53	8	8	8	8	8

Source: Online survey, N=77.

AI technology challenges

The most significant AI technology challenges for all sectors are:

- Lack of transparency in AI systems decision support/making processes
- Difficulty to inspect and assess an AI solution before their actual deployment
- Potential for biases/discrimination within the systems
- Difficulty in establishing liability and responsibility for the AI system
- Lack of limited regulatory spaces ("sandboxes") for experimenting with AI solutions and monitoring their impacts
- Requirements for the explainability of AI solutions are excessively high

When comparing the significance of the challenges between the health, e-government, transport/mobility and education sectors, there were **slight sectoral differences in rating**. E-government and mobility/transport sector respondents rated "Difficulty to inspect and assess an AI solution before their actual deployment" as higher than the total average.

In addition, the "Lack of limited regulatory spaces ("sandboxes") for experimenting with AI solutions and monitoring their impacts" was rated higher than the total average by respondents in the e-government, transport/mobility and education sectors.

It must be noted that given the relatively small difference in responses and low numbers of respondents, these differences cannot be considered significant.

The table below provides a summary of the results. Red indicates those challenges that are higher than the total average.

Table 10 Comparison of AI technology challenges between sectors.

AI technology challenges	**Total average response (N=77)**	**Total rating (N=77)**	**Health sector rating (N=19)**	**E-gov sector rating (N=22)**	**Mobility/ transport sector rating (N=16)**	**Education sector (N=29)**
Lack of transparency in AI systems decision support/making processes	3.83	1	1	2	2	1
Difficulty to inspect and assess an AI solution before their actual deployment	3.80	2	2	1	1	2
Potential for biases/discrimination within the systems	3.73	3	3	3	3	3
Difficulty in establishing liability and responsibility for the AI system	3.70	4	4	5	5	5
Lack of limited regulatory spaces ("sandboxes") for experimenting with AI solutions and monitoring their impacts	3.68	5	5	4	4	4
Requirements for the explainability of AI solutions are excessively high	3.48	6	6	6	6	6

Source: Online survey, N=77.

Organisational capacity challenges

The most significant organisational capacity challenges for all sectors are:

- Lack of human resources for managing the system
- Lack of political support
- Lack of understanding of the capabilities/benefits of AI solutions
- Lack of human resources for procuring the system
- System complexity and lack of single-entry point
- Lack of system interoperability
- Lack of trust within organisations
- Lack of managerial support
- Lack of digital skills
- Lack of political support

When comparing the significance of the challenges between the health, e-government, transport/mobility and education sectors, there were **slight sectoral differences in rating**. E-government and mobility/transport sector respondents rated "Lack of human resources for procuring the system", "System complexity and lack of single-entry point" and "Lack of digital skills" higher than the total average.

Respondents from the education sector rated "System complexity and lack of single-entry point", "Lack of digital skills" and "Lack of political support" higher than the total average.

It must be noted that given the relatively small difference in responses and low numbers of respondents, these differences cannot be considered significant.

The table below provides a summary of the results. Red indicates those challenges that are higher than the total average.

Table 11 Comparison of organisational capacity challenges.

Organisational capacity challenges	**Total average response (N=77)**	**Total rating (N=77)**	**Health sector rating (N=19)**	**E-gov sector rating (N=22)**	**Mobility/ transport sector rating (N=16)**	**Education sector (N=29)**
Lack of human resources for managing the system	3.84	1	1	1	1	1
Lack of political support	3.64	2	2	2	2	2
Lack of understanding of the capabilities/benefits of AI solutions	3.64	3	3	5	5	3
Lack of human resources for procuring the system	3.63	4	4	3	3	5
System complexity and lack of single-entry point	3.63	5	5	4	4	4
Lack of system interoperability	3.58	6	6	6	6	6
Lack of trust within organisations	3.49	7	7	7	7	7
Lack of managerial support	3.43	8	8	9	9	10
Lack of digital skills	3.42	9	9	8	8	8
Lack of political support	3.42	10	10	10	10	9

Source: Online survey, N=77.

3.7.2 Comparison of policy recommendations in the online survey

To see if there are significant differences in recommendations between the sectors, we took the recommendations identified in the recent JRC Science for Policy Report *AI Watch: Road to the Adoption of Artificial Intelligence by the Public Sector*[475] and asked stakeholders to rate how beneficial they are in the online survey.

First, the qualitative scale in the online survey was converted into a numerical scale, ranging from 1 to 5 (from not beneficial to strongly beneficial). Second, the average response was calculated, which allowed us to rank the recommendations according to how beneficial they are perceived to be. Third, the same was done for each of the sectors, which allows us to provide a comparison of recommendations between the sectors.

The most beneficial recommendations to increase the uptake and public procurement of AI are:

- Optimise **funding** in support of AI in the public sector to promote the spreading and scaling of reusable solutions.
- Support multidisciplinary **research** and knowledge creation amongst European universities and Research and Development (R&D) institutions around AI for the public sector.
- Reinforce and advance existing initiatives on open **data and interoperability**
- Build a **common European Data Space** for public sector bodies and their operators, drawing from the compilation of relevant AI datasets and related Registries throughout Europe.
- Design national and European **capacity-building programmes** for public sector innovators aiming to develop and/or adopt AI in support of the digital transformation of public services.
- Build upon and promote the use of **regulatory sandboxes** for public administrations, allowing experimentation of AI-enabled solutions in controlled environments.
- Promote the adoption of **ethical principles**, the development of **guidelines**, and the identification of mitigating measures to minimize the risks of deployment of AI by the public sector.
- Harmonise and complement **EU regulations** to promote human-centric and trustworthy AI-enabled public services for all citizens.
- Share reusable and **interoperable** AI components at all operational levels of European public administrations.
- Promote AI in the public sector in support of **sustainability** while developing sustainable AI, in compliance with environmental principles, and leveraging civic engagement and participation.

When comparing the recommendations between the health, e-government, transport/mobility and education sectors, there were **slight sectoral differences in rating**. E-government and mobility/transport sectors rated the recommendations on supporting multidisciplinary research and knowledge creation amongst European universities and Research and Development (R&D) institutions around AI for the public sector, building a common European Data Space for public sector bodies and their operators, harmonising and complementing EU regulations to promote human-centric

[475] https://ai-watch.ec.europa.eu/publications/ai-watch-road-adoption-artificial-intelligence-public-sector_en

and trustworthy AI-enabled public services, and sharing reusable and interoperable AI components at all operational levels of European public administrations higher than the total average.

Respondents in the education sector rated recommendations on building a common European Data Space for public sector bodies and their operators, and building and promoting the use of regulatory sandboxes for public administrations higher than the total average.

It must be noted that given the relatively small difference in responses and low numbers of respondents, these differences cannot be considered significant.

The table below provides a summary of the results. Orange indicates those recommendations that are rated higher than the total average.

Table 12 Comparison of recommendations

Recommendations on the procurement/uptake of AI	Total average response (N=77)	Total rating (N=77)	Health sector rating (N=19)	E-gov sector rating (N=22)	Mobility/ transport sector rating (N=16)	Education sector (N=29)
Optimise funding in support of AI in the public sector to promote the spreading and scaling of reusable solutions.	4.12	1	1	2	2	1
Support multidisciplinary research and knowledge creation amongst European universities and Research and Development (R&D) institutions around AI for the public sector.	4.07	2	2	1	1	2
Reinforce and advance existing initiatives on open data and interoperability	3.96	3	3	4	4	4
Build a common European Data Space for public sector bodies and their operators, drawing from the compilation of relevant AI datasets and related Registries throughout Europe.	3.94	4	4	3	3	3
Design national and European capacity-building programmes for public sector innovators aiming to develop and/or adopt AI in support of the digital transformation of public services.	3.86	5	5	5	5	6
Build upon and promote the use of regulatory sandboxes for public administrations, allowing experimentation of AI-enabled solutions in controlled environments.	3.84	6	6	8	8	5
Promote the adoption of ethical principles, the development of guidelines, and the identification of mitigating measures to minimize the risks of deployment of AI by the public sector.	3.83	7	7	9	9	7
Harmonise and complement EU regulations to promote human-centric and trustworthy AI-enabled public services for all citizens.	3.82	8	8	6	6	8
Share reusable and interoperable AI components at all operational levels of European public administrations.	3.82	9	9	7	7	9

Promote AI in the public sector in support of sustainability while developing sustainable AI, in compliance with environmental principles, and leveraging civic engagement and participation.	3.78	10	10	10	10	10
Promote the development of multilingual guidelines, criteria and tools for public procurement of AI solutions in the public sector throughout Europe.	3.74	11	11	11	11	11
Create a European marketplace for GovTech solutions in support of public sector digital transformation.	3.68	12	12	12	12	12
Set up an EU observatory on AI, built on a pan-European network of AI national observatories, to gather, share, and collectively manage best practices and experiences learned from different stakeholders in the public sector throughout Europe.	3.68	13	13	13	13	13
Create an EU-wide network of governance bodies for streamlined management of AI in the public sector.	3.59	14	14	14	14	14
Develop and apply umbrella impact assessment frameworks based on key influencing factors to measure the use and impact of AI in the public sector.	3.54	15	15	15	15	15
Develop and promote dedicated AI-enabled solutions based on co-creation approaches (e.g., through citizen participation in the development and deployment of AI) to increase citizens' and businesses' relevance trust and confidence in the use of AI by the public sector.	3.47	16	16	16	16	16

Source: Online survey, N=77.

3.8 Conclusion

The stakeholder consultations undertaken as part of this study show that the main challenges in the uptake of AI centres on the procurement process, data, AI technology and organisation:

- The most significant procurement **process challenges** are related to burdensome administrative requirements, lack of clarity from the public sector regarding their needs/demands, an emphasis on price/cost-savings over service quality and non-financial benefits, unclear regulatory requirements, and the complexity of writing technical specifications.
- The most significant **data challenges** are related to unsatisfactory sharing of data across organisational boundaries, insufficient access to large volumes of high-quality data, lack of data to understand where AI is needed/ best suited, underdeveloped data governance, and lack of clear “data ownership”/ “data sovereignty”.
- The most significant **AI technology challenges** are lack of transparency in AI systems' decision support/making processes, difficulty to inspect and assess an AI solution before their actual deployment, the potential for biases/discrimination within the systems, difficulty in establishing liability and responsibility for the AI system, lack of limited regulatory spaces ("sandboxes") for experimenting with AI solutions and monitoring their impacts, and high requirements for the explainability of AI solutions.
- The most significant **organisational challenges** are a lack of human resources for managing the system, lack of political support, lack of understanding of the capabilities/benefits of AI solutions, lack of human resources for procuring the system, system complexity and lack of single-entry point, and lack of system interoperability.

The comparative analysis showed that these **challenges are not significantly different across the sectors**. The challenges were raised and discussed by participants in all the workshops, irrespective of the sector. In addition, the differences between the sectors in the online survey were minor.

Similarly, the comparison of the policy recommendations between the health, e-government, transport/mobility and education sectors in the online survey showed **no significant sectoral differences in policy recommendations**. The policy recommendations are transversal and important for all the sectors analysed.

4 Chapter 4: Policy recommendations on the uptake of AI in the public sector

4.1 Introduction

This chapter explores the recommendations to increase the uptake and public procurement of AI. It includes the results from:

- The policy workshop dedicated to identifying and exploring policy solutions and recommendations for the uptake of AI in the public sector.
- An online survey, dedicated to assessing recommendations for the uptake of AI in the public sector. The recommendations are based on the recent JRC Science for Policy Report *AI Watch: Road to the Adoption of Artificial Intelligence by the Public Sector*[476].

The more detailed methodologies for these consultations can be found in the annex.

The chapter proceeds by providing the analysis of the policy workshop, the comparative assessment of recommendations from the policy workshop and the online survey. The chapter concludes by triangulating the results from the two sets of recommendations.

4.2 Comparative assessment of policy recommendations

This section provides a comparative assessment of **the policy recommendations identified in the sectoral and the dedicated policy workshop presented above and in the online survey conducted as part of this study**. The recommendations selected for comparison are the ones that were identified as the most important challenges by the participants in the policy workshop and the potential policy actions are the most significant and direct solutions offered by the participants. The recommendations in the online survey are taken from the recent JRC Science for Policy Report *AI Watch: Road to the Adoption of Artificial Intelligence by the Public Sector*[477].

After presenting the recommendations from the policy workshop and the online survey, section 5 concludes by triangulating the results between the two sets of recommendations and presenting the recommendations in order of significance.

We provide an assessment of the most important recommendations identified in the policy workshop on a scale of low/medium/high based on the following criteria:

- **Effectiveness**. The extent to which recommendations achieve their goals and the level of benefits they provide.
- **Feasibility**. The extent to which recommendations can be implemented and whether they have significant limits.
- **Efficiency**. The extent to which recommendations provide value for money and if they require significant resources.
- **EU added value**. The extent to which recommendations provide benefits at a European level and the Single Market and which level of implementation, European or Member State, is the most appropriate, keeping in mind the principle of subsidiarity.

[476] https://ai-watch.ec.europa.eu/publications/ai-watch-road-adoption-artificial-intelligence-public-sector_en
[477] https://ai-watch.ec.europa.eu/publications/ai-watch-road-adoption-artificial-intelligence-public-sector_en

The following recommendations are analysed in the rest of the section:

- Ensure a clear regulatory framework for AI
- Foster coordinated procurement strategies
- Increase expertise among public buyers
- Improve alignment between industry and public sector expectations
- Increase clarity and harmonisation around cross-border data flows
- Promote interoperability
- Facilitate "data ownership"
- Address the challenges surrounding the sharing of data between and across sectors
- Address bias within AI and data sources
- Improve technological accountability and transparency
- Increase trust in AI solutions
- Facilitate the integration of new AI technologies/services into existing systems (education/health/transport)
- Focus on long-term implementation
- Improve access to funding and resources
- Foster the development of skills and competencies

Ensure a clear regulatory framework for AI

Potential policy actions:

- Adopt a regulatory framework for AI.
- Provide a clear definition of what is AI and clarity on the scope of what AI regulations cover.
- Provide clarity as to how EU legislation and regulatory frameworks interact together.

Criteria	Rating	Description
Effectiveness/ benefits	High	This challenge is identified both by the public administrations (seen in reports from the Danish, Austrian and French governments) and the private sector (the lack of laws or regulations poses an obstacle for 69% of the surveyed private sector enterprises by the European Commission[478]). Consequently, given its significance, addressing the lack of clarity on AI regulation can be highly effective and provide the following benefits: 1. Improved accountability: Defined rules and regulations can help ensure that AI systems are developed and used responsibly and that those who do not follow these rules are held accountable.

[478] European Commission, Directorate-General for Communications Networks, Content and Technology. 2020. European enterprise survey on the use of technologies based on artificial intelligence : final report. URL: https://data.europa.eu/doi/10.2759/759368

		2. Greater transparency: Well-defined regulations can also help increase transparency around the development and use of AI, enabling stakeholders to better understand how these systems work and how they might be affecting society. 3. Enhanced public trust: By establishing clear guidelines for the development and use of AI, regulators can help build public trust in these technologies and address concerns about their potential negative impacts. 4. Increased innovation: Establishing clear regulations can also create a more stable and predictable regulatory environment, which can encourage innovation and investment in AI. 5. Better protection of human rights: Defined regulations can help ensure that AI systems do not infringe on individuals' human rights, such as their right to privacy or their right to be free from discrimination.
Feasibility/ limits	Medium	There are several potential limitations to addressing the lack of clarity on AI regulation: 1. Lack of agreement: There may be disagreement among governments, industries, and experts on how to regulate AI, making it difficult to develop clear and effective regulations. 2. Technological complexity: AI is a rapidly evolving field, and it can be difficult to keep up with the latest developments and their potential impacts. This can make it difficult to craft regulations that are both effective and flexible enough to adapt to changing technology. 3. Legal and ethical considerations: There are many legal and ethical considerations to take into account when regulating AI, including issues related to privacy, bias, and accountability. Balancing these competing interests can be challenging. 4. Limited understanding of the potential consequences: It can be difficult to predict the long-term consequences of AI and how it will be used, which makes it hard to anticipate the potential impacts of regulatory measures.
Efficiency/ resources	High	significant resources required, and at the same time, the work might build on the existing regulation. Thereby, efficiency might be maximised. Some examples of EU regulations related to AI include: 1. The General Data Protection Regulation (GDPR): This legislation, which came into effect in 2018, sets out rules for the protection of personal data, including data processed by AI systems. 2. The Ethical Guidelines for Trustworthy AI: These guidelines, developed by the European Commission's High-Level Expert Group on Artificial Intelligence (AI HLEG), provide a framework for the development and deployment of trustworthy AI. 3. The AI Act: This legislation, which was proposed by the European Commission in 2020, aims to establish a framework for the regulation of AI in the EU. It includes provisions on the development, deployment,

		and use of AI, as well as measures to ensure the transparency and accountability of AI systems. 4. Public procurement of AI: The EU has also established guidelines for the procurement of AI systems by public authorities[479], which aim to ensure that such systems are reliable, robust, and respectful of fundamental rights. The AI Act will be fully consistent with these guidelines as noted in the impact assessment accompanying the proposal[480]. Overall, the EU has taken a proactive approach to regulate AI, with a focus on ensuring that the technology is developed and used in a way that is transparent, accountable, and respectful of fundamental rights.
EU added value/ subsidiarity	High	There are several potential benefits to the European Union (EU) of clarifying the use and procurement of artificial intelligence (AI): 1. Promoting the development of trustworthy AI: By establishing clear guidelines and regulations for the development and deployment of AI, the EU can help to ensure that the technology is developed and used in a way that is transparent, accountable, and respects fundamental rights. This can help to build trust in AI and encourage its adoption by businesses and other organizations. 2. Protecting fundamental rights: Clarifying the use and procurement of AI can help to protect the fundamental rights of EU citizens, including their right to privacy, non-discrimination, and data protection. 3. Levelling the playing field: By establishing clear rules and standards for the procurement of AI systems by public authorities, the EU can help to ensure that all companies have an equal opportunity to compete for these contracts. 4. Supporting innovation: By establishing a clear and predictable regulatory environment for AI, the EU can help to foster innovation and encourage the development of new technologies. Overall, clarifying the use and procurement of AI can help to ensure that the technology is developed and used in a way that is beneficial to society and supports the EU's goals of innovation, competitiveness, and respect for fundamental rights.

Foster coordinated procurement strategies

Potential policy actions:

- Identify 'owners' for procurement strategy and their needs.
- Reinforce ideas through strategy documents and activities.
- Consider the procurement power of larger-scale organisations and assess what their processes and needs are.

[479] https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai
[480] https://digital-strategy.ec.europa.eu/en/library/proposal-regulation-laying-down-harmonised-rules-artificial-intelligence

- Provide an inventory of best practices from similar entities.

Criteria	Rating	Description
Effectiveness/ benefits	High	There are several potential benefits that the European Union (EU) could realize by addressing the lack of a coordinated procurement strategy: 1. Improved efficiency and cost savings: A coordinated procurement strategy could help streamline the procurement process, reducing duplication and bureaucracy, and allowing the EU to leverage its purchasing power to negotiate better deals with suppliers. This could lead to significant cost savings for the EU. 2. Increased transparency and fairness: A coordinated procurement strategy could help increase transparency in the procurement process, ensuring that all suppliers have a fair and equal opportunity to participate in EU tenders. This could help reduce the risk of corruption and ensure that public funds are used effectively and efficiently. 3. Greater alignment with EU priorities: A coordinated procurement strategy could help ensure that the EU's procurement decisions are aligned with its broader policy priorities, such as sustainability, innovation, and regional development. 4. Enhanced competitiveness: By coordinating procurement, the EU could become more competitive by adopting a more agile and flexible approach to procurement, and by making it easier for small and medium-sized enterprises to participate in the EU's procurement market. 5. Stronger bargaining power: A coordinated procurement strategy could give the EU greater bargaining power when negotiating with suppliers, allowing it to secure better terms and conditions, and to drive innovation and value for money.
Feasibility/ limits	High	There are several potential limits to addressing the lack of a coordinated procurement strategy in the European Union (EU). Some of these limits may include: 1. Resistance to change: Implementing a coordinated procurement strategy may require significant changes to existing procurement processes and systems, which may be met with resistance from procurement officials and other stakeholders who are used to working in a decentralized way. 2. Complexity and bureaucracy: A coordinated procurement strategy may introduce additional bureaucracy and complexity into the procurement process, which could lead to delays and increased costs. 3. Loss of local control: A coordinated procurement strategy may involve the transfer of decision-making power from local authorities to a centralised agency, which could lead to concerns about the loss of local control and accountability.

		4. Legal and regulatory challenges: A coordinated procurement strategy may require changes to EU procurement law and regulations, which could be a complex and time-consuming process. It would be important to explain why changes would be needed and what would be the provision in existing procurement laws that currently prevent the adoption of such strategies. 5. Political challenges: A coordinated procurement strategy may be controversial and may face political opposition, particularly if it is perceived as a threat to the sovereignty of member states (MS). Thus, for MS it should be most likely voluntary and presented as a support and good practice tool. Despite these potential limits, it is important to note that a coordinated procurement strategy could also bring significant benefits, including improved efficiency and cost savings, increased transparency and fairness, and greater alignment with EU policy priorities.
Efficiency/ resources	High	Several resources would be required in addressing the lack of a coordinated procurement strategy in the European Union (EU). Some of these resources may include: 1. Funding: Establishing a procurement agency or support unit, and implementing a coordinated procurement strategy, may require additional funding to cover the costs of setting up and operating them, as well as any necessary changes to existing procurement systems and processes[481]. 2. Expertise: A coordinated procurement strategy may require the development of specialized expertise in areas such as procurement law, AI procurement, and data analytics, to support the design and implementation of the strategy. A procurement agency or unit might be responsible for this. 3. Infrastructure: Implementing a coordinated procurement strategy may require the development of new infrastructure, such as a procurement portal or platform, to support the centralised procurement process. An example is the European Commission's procurement portal. 4. Stakeholder engagement: Engaging with a range of stakeholders, including procurement officials, suppliers, and other interested parties, will be important to ensure that the coordinated procurement strategy is well-understood, supported, and implemented effectively. 5. Legal and regulatory frameworks: Establishing a coordinated procurement strategy may require the development of new legal and regulatory frameworks, the modification of existing ones, or the alignment with existing or planned legislation, such as the AI Act, to support the coordinated procurement process. It will be important for the EU to carefully consider these and other resource requirements, and to plan and allocate

[481] A coordinated strategy might necessarily need to be enforced by a single agency or unit, compliance may be decentralised. If the strategy is only for EU institutions, it could be internal and decentralised. MS might have a similar system also.

		resources appropriately, to ensure the success of a coordinated procurement strategy. Efficiency can be maximized and resources minimized by adopting a mix of coordination and de-centralisation. In the United States, AI is both coordinated under the federal government and decentralized among state governments[482]. Coordination is enabled through the National Technical Information Service (NTIS) under the U.S. Commerce Department and the Federal Risk and Authorization Management Program (FedRAMP). The former is responsible for helping federal agencies rapidly analyze, manage, and implement scalable data solutions by leveraging an extensive NTIS network of technical talent from private industry, which is often difficult to locate in today's competitive information technology landscape. FedRAMP's mission is to promote the adoption of secure cloud services across the federal government by providing a standardized approach to security and risk assessment.
EU added value/ subsidiarity	High	Coordination of procurement at the EU level can have significant benefits, as discussed in the effectiveness section above. There may be several benefits to coordinated AI procurement at the member state level in comparison to the EU level: 1. Closer alignment with local needs and priorities: Coordinating AI procurement at the member state level may allow for a better alignment of procurement decisions with the specific needs and priorities of the member state, as well as with the local context and conditions in which the AI solutions will be used. 2. Greater flexibility and agility: Coordinating AI procurement at the member state level may allow for a more agile and flexible approach to procurement, allowing member states to respond more quickly to changing needs and opportunities. 3. Improved accountability and transparency: Coordinating AI procurement at the member state level may help improve accountability and transparency, as procurement decisions will be made by officials who are directly accountable to the member state's citizens and stakeholders. 4. Enhanced competitiveness: Coordinating AI procurement at the member state level may allow member states to better leverage their purchasing power to negotiate better deals with suppliers, and to support the development of local AI capabilities and industries. 5. Greater autonomy: Coordinating AI procurement at the member state level may allow member states to retain a greater degree of autonomy in their procurement decisions, which may be important for some states that are particularly sensitive about the sovereignty of their procurement processes. Overall, the benefits of coordinating AI procurement at the member state level in comparison to the EU level will depend on the specific needs, priorities, and context of the member

[482] The World Bank. 2020. Artificial Intelligence in the Public Sector: Maximizing Opportunities, Managing Risks. Available at: https://openknowledge.worldbank.org/handle/10986/35317

		state, and will need to be carefully balanced against the potential benefits of a coordinated procurement strategy at the EU level.

Increase expertise among public buyers

Potential policy actions:

- Introduce national and European points of contact for practical advice.
- Use Digital Innovation Hubs (DIHs) and GovTech incubators for consulting, or competence centres for aiding public bodies to adopt/set up fitting solutions.
- Educate and raise awareness of the potential of AI with real-world success stories.
- Development of a specific Community of Practice on the development and testing of EU-wide AI procurement Clauses, currently being developed[483].

Criteria	Rating	Description
Effectiveness/ benefits	High	The lack of expertise is a well-documented barrier and challenge in the adoption of AI solutions in public institutions[484]. Addressing the lack of expertise among public buyers in AI procurement in the EU can have several benefits. Some of these benefits include: 1. Improved decision-making: By increasing the expertise of public buyers, they will be better equipped to make informed decisions about which AI products and services to purchase. This can help to ensure that the AI procurement process is more efficient and effective. 2. Increased value for money: With more expertise, public buyers will be better able to evaluate the quality and value of different AI products and services. This can help to ensure that the government is getting the best value for its money when it comes to AI procurement. 3. Greater transparency: By increasing the expertise of public buyers, there will be greater transparency in the AI procurement process. This can help to build trust between the government and the public, and ensure that AI procurement is carried out fairly and transparently. 4. Improved innovation: By increasing the expertise of public buyers, they will be better able to identify and support innovative AI solutions. This can help to drive innovation in the AI industry, and lead to the development of new and improved AI products and services. Overall, addressing the lack of expertise among public buyers in AI procurement can help to improve the efficiency, effectiveness, and transparency of the procurement process, and drive innovation in the AI industry.

[483] https://ec.europa.eu/newsroom/growth/items/746858/en

[484] Assaf Ariel et al, 2021, Barriers and challenges of e-government services: A systematic literature review and meta-analyses, https://iopscience.iop.org/article/10.1088/1757-899X/1125/1/012027/pdf

Feasibility/ limits	High	There are several potential limits to addressing the lack of expertise among public buyers in AI procurement in the EU. Some of these limits include: 1. Time and resources: Building expertise in AI procurement can take time and resources, which may be in short supply for public buyers. 2. Limited budgets: Public buyers may have limited budgets for training and development, which can limit the extent to which they can build expertise in AI procurement. 3. Difficulty finding skilled personnel: There may be a shortage of skilled personnel with expertise in AI procurement, which can make it difficult for public buyers to find the resources they need to build their expertise. 4. Resistance to change: Some public buyers may be resistant to changing their existing procurement processes or adopting new technologies, which can limit the extent to which they can build expertise in AI procurement. 5. Legal and regulatory challenges: There may be legal and regulatory challenges associated with AI procurement, which can make it difficult for public buyers to fully understand and navigate the process. Overall, while addressing the lack of expertise among public buyers in AI procurement in the EU can have many benefits, it may also be subject to several potential limits and challenges. Nevertheless, the feasibility is high given that there are already existing examples to build on. Models on national contact points and Digital Innovation Hubs already exist and can be tailored to promote expertise in AI. There are several other examples of efforts to address the lack of expertise among public buyers in AI procurement in the EU. One example is the European Artificial Intelligence Alliance[485], which was established in 2018 to promote the development and deployment of AI in the EU. The Alliance brings together stakeholders from across the EU to share knowledge and expertise on AI, and to develop recommendations for the development and deployment of AI in the region. Another example is the European AI Procurement Guidelines[486], which were developed by the European Commission in collaboration with the European Artificial Intelligence Alliance. The guidelines guide public buyers on how to effectively procures AI products and services, and how to ensure that these products and services meet the necessary quality and ethical standards. The AI Act will be fully consistent with these guidelines as noted in the impact assessment accompanying the proposal[487].

[485] https://futurium.ec.europa.eu/en/european-ai-alliance
[486] https://digital-strategy.ec.europa.eu/en/policies/european-ai-alliance
[487] https://digital-strategy.ec.europa.eu/en/library/proposal-regulation-laying-down-harmonised-rules-artificial-intelligence

		Another example is DG GROW's Big Buyers platform[488]. It establishes working groups, which focus on a specific unmet public procurement need. The groups meet regularly, both online and in person, and consist of a small number of public purchasing organisations, such as local and regional governments, central purchasing bodies, and other public agencies. One working group – "Digital solutions in the healthcare sector" – focuses on more efficient procurement of innovative medical devices, digital services and IT systems through the collaboration of public hospitals and purchasing bodies that can lower the pressure on health budgets while facilitating better value for money[489]. There are also many individual initiatives and programs being undertaken by governments and other organizations across the EU to help build expertise in AI procurement. These initiatives may include training programs, workshops, and other resources designed to help public buyers understand the AI procurement process and how to effectively evaluate and select AI products and services.
Efficiency/ resources	Medium	Several resources may be required in addressing the lack of expertise among public buyers in AI procurement in the EU. Some of these resources may include: 1. Training programs: Public buyers may need to invest in training programs to help them build their expertise in AI procurement. These programs could include courses, workshops, or other educational materials designed to help public buyers understand the AI procurement process and how to effectively evaluate and select AI products and services. 2. Expert support: Public buyers may need to seek out external expertise and support from organizations or individuals with experience in AI procurement. This could include consulting firms, industry experts, or other organizations that can provide guidance and support to public buyers as they navigate the AI procurement process. 3. Educational materials: Public buyers may need access to a range of educational materials, including guides, tutorials, and other resources that can help them understand the AI procurement process and how to effectively evaluate and select AI products and services. 4. Legal and regulatory guidance: Public buyers may need access to legal and regulatory guidance to help them understand and navigate the complex legal and regulatory requirements associated with AI procurement in the EU. Overall, addressing the lack of expertise among public buyers in AI procurement in the EU may require a range of resources, including training programs, expert support, educational materials, and legal and regulatory guidance.
EU added value/ subsidiarity	Medium	It may be beneficial to address the lack of expertise among public buyers in AI procurement at both the EU and Member State levels.

[488] https://bigbuyers.eu/about/bigbuyers
[489] https://bigbuyers.eu/working-groups/digital-solutions-in-the-healthcare-sector

		At the EU level, efforts to build expertise in AI procurement could include the development of common standards and regulations, the sharing of best practices and expertise among Member States, and the provision of guidance and support to Member States as they seek to build their expertise in AI procurement. At the Member State level, efforts to build expertise in AI procurement could include the development of training programs, the provision of educational materials, and the establishment of dedicated AI procurement units or teams within the government. Overall, a combination of EU-level and Member State-level efforts could be the most effective way to address the lack of expertise among public buyers in AI procurement in the EU. This approach could help to ensure that there is a consistent approach to AI procurement across the EU, while also taking into account the specific needs and circumstances of individual Member States.

Improve alignment between industry and public sector expectations

Potential policy actions:

- Introduce "best practice" dialogues between industry, the public sector and academia, and "roadshow" type events for building networks and shared goals and understanding.
- Conduct internal research within public organisations to understand what expectations and ideas on AI public employees have.

Criteria	Rating	Description
Effectiveness/ benefits	High	Addressing the lack of alignment between industry and public sector expectations in AI procurement in the EU could have several potential benefits. Some of these benefits include: 1. Improved efficiency: By ensuring that there is greater alignment between industry and public sector expectations in AI procurement, the procurement process may be more efficient, as it will be clearer what is expected from the industry and what the public sector is looking for in terms of AI products and services. 2. Increased value for money: By ensuring that there is greater alignment between industry and public sector expectations, the public sector may be able to get better value for its money when it comes to AI procurement. This could be because the industry will be able to offer products and services that more closely meet the needs and expectations of the public sector. 3. Enhanced innovation: By fostering greater alignment between industry and public sector expectations, the public sector may be able to encourage the development of innovative AI solutions that meet the needs of both sides. This could lead to the development of new and improved AI products and services. 4. Improved relationships: By addressing the lack of alignment between industry and public sector

		expectations, the public sector may be able to improve its relationships with industry. This could lead to a more collaborative and productive relationship between the two sides, which could be beneficial for both parties. Overall, addressing the lack of alignment between industry and public sector expectations in AI procurement in the EU could have a range of benefits, including improved efficiency, increased value for money, enhanced innovation, and improved relationships. There are several examples of efforts to address the lack of alignment between industry and public sector expectations in AI procurement in the EU, as discussed in the previous recommendation.
Feasibility/ limits	High	There are several potential limits to efforts to address the lack of alignment between industry and public sector expectations in AI procurement in the EU. Some of these limits include: 1. Misalignment of goals: There may be fundamental differences in the goals and priorities of industry and the public sector, which can make it difficult to achieve alignment in AI procurement. 2. Limited understanding: The industry and the public sector may have a limited understanding of each other's needs and expectations when it comes to AI procurement, which can make it difficult to achieve alignment. 3. Communication barriers: There may be communication barriers between the industry and the public sector, which can make it difficult to effectively share information and build understanding. 4. Misperceptions: There may be misperceptions or misunderstandings on both sides, which can further complicate efforts to achieve alignment in AI procurement. 5. Limited resources: Industry and the public sector may have limited resources to devote to efforts to build alignment in AI procurement, which can make it more difficult to achieve. Overall, while there are many potential benefits to addressing the lack of alignment between industry and public sector expectations in AI procurement in the EU, there are also several potential limits and challenges that may need to be overcome. In light of the several examples of efforts to address the lack of alignment between industry and public sector expectations in AI procurement in the EU, including the European Artificial Intelligence Alliance and the European AI Procurement Guidelines. These initiatives suggest that it is possible to achieve some level of alignment between industry and the public sector in AI procurement in the EU.
Efficiency/ resources	High	Several resources may be required to address the lack of alignment between industry and public sector expectations in AI procurement in the EU. Some of these resources could include: 1. Staff and personnel: Addressing the lack of alignment between industry and public sector expectations in AI

		procurement may require the allocation of staff and personnel to work on this issue. This could include individuals with expertise in AI procurement, as well as individuals with strong communication and relationship-building skills to facilitate collaboration between industry and the public sector. 2. Funding: Addressing the lack of alignment between industry and public sector expectations in AI procurement may require the allocation of funding to support initiatives and programs aimed at building alignment in this area. This could include funding for training programs, workshops, and other resources designed to help build understanding and foster collaboration between industry and the public sector. 3. Time and effort: Achieving alignment between industry and public sector expectations in AI procurement may require a significant investment of time and effort. This could include time spent building relationships and understanding between industry and the public sector, as well as time spent developing and implementing strategies to foster greater alignment in AI procurement. Overall, addressing the lack of alignment between industry and public sector expectations in AI procurement in the EU may require the allocation of a range of resources, including staff and personnel, funding, and time and effort. There are several examples of efforts to address the lack of alignment between industry and public sector expectations in AI procurement in the EU, including the European Artificial Intelligence Alliance and the European AI Procurement Guidelines. These initiatives suggest that it is possible to build on them to aim for higher efficiency.
EU added value/ subsidiarity	Medium	Addressing the lack of alignment between industry and public sector expectations in AI procurement in the EU could be done at both the EU and Member State levels. At the EU level, efforts to build alignment between industry and public sector expectations in AI procurement could include the development of common standards and regulations, the sharing of best practices and expertise among Member States, and the provision of guidance and support to Member States as they seek to build alignment in AI procurement. At the Member State level, efforts to build alignment between industry and public sector expectations in AI procurement could include the development of training programs, the provision of educational materials, and the establishment of dedicated AI procurement units or teams within the government. Overall, a combination of EU-level and Member State-level efforts could be the most effective way to address the lack of alignment between industry and public sector expectations in AI procurement in the EU. This approach could help to ensure that there is a consistent approach to AI procurement across the EU, while also taking into account the specific needs and circumstances of individual Member States.

Increase clarity and harmonisation around cross-border data flows

Potential policy actions:

- Formulate clear incentives and use cases for data sharing.
- Promote open application programming interfaces (APIs).
- Develop more federated data networks and data spaces.

Criteria	Rating	Description
Effectiveness/ benefits	High	Formulating clear incentives and use cases for data sharing specifically focused on supporting the implementation of AI technologies in the public sector would complement the objectives of the European Data Strategy and support their achievement. Promoting AI use cases through publications or repositories such as the ones published by the JRC[490] contribute to the existing body of knowledge on the topic and moves from a more theoretical view to a solutions-based analysis, built around many concrete examples. Federated data networks and data spaces already being implemented such as the Mobility Data Space described in Section 2.2 provide a safe and trusted ecosystem for data sharing, as stakeholders have access to the data they need for new use cases and AI applications. The Commission Staff Working Document on Common European Data Spaces published in 2022[491] highlighted numerous benefits such as security, data control and governance, interoperability, and openness. Promoting open application programming interfaces (APIs) has been explored by the European Commission[492] and is envisaged in the Open Data EU Directive 2019/1024, which requires the use of APIs for 'high-value' and dynamic datasets. The APIs present many benefits for the public sector, including fostering data sharing and innovation in governments and related public services through AI technologies. Addressing the lack of clarity and harmonisation around cross-border data flows in AI procurement in the EU could have several potential benefits. Some of these benefits include: 1. Improved efficiency: By clarifying and harmonising cross-border data flows in AI procurement, it may be possible to make the procurement process more efficient, as it will be clearer what is expected in terms of data management and data protection. 2. Increased confidence: Clarifying and harmonising cross-border data flows in AI procurement may increase confidence among industry and the public sector, as it will be clearer what is expected in terms of data management and data protection. This could encourage more companies to engage in AI procurement with the public sector, and may

[490] See Selected AI cases in the public sector available at https://data.jrc.ec.europa.eu/dataset/7342ea15-fd4f-4184-9603-98bd87d8239a

[491] Available at https://digital-strategy.ec.europa.eu/en/library/staff-working-document-data-spaces

[492] See JRC (2020) Application Programming Interfaces in government - Why, what and how, or JRC (2020) An Application Programming Interfaces (APIs) framework for digital government

		encourage the public sector to be more active in procuring AI products and services. 3. Enhanced trust: Clarifying and harmonising cross-border data flows in AI procurement may enhance trust between industry and the public sector, as both sides will have a better understanding of their respective roles and responsibilities concerning data management and data protection. 4. Greater legal certainty: Clarifying and harmonising cross-border data flows in AI procurement may provide greater legal certainty for both industry and the public sector, as it will be clearer what is expected in terms of data management and data protection. This could help to reduce the risk of legal disputes arising concerning AI procurement. Overall, addressing the lack of clarity and harmonisation around cross-border data flows in AI procurement in the EU could have a range of benefits, including improved efficiency, increased confidence, enhanced trust, and greater legal certainty.
Feasibility/ limits	High	Given that all three actions foreseen under this recommendation are already being implemented at the EU and Member State levels under various forms, their feasibility has been proven to be high. There are several potential limits to efforts to address the lack of clarity and harmonisation around cross-border data flows in AI procurement in the EU. Some of these limits include: 1. Complex legal landscape: The legal landscape surrounding cross-border data flows in the EU is complex, and it may be difficult to achieve clarity and harmonisation in this area. 2. Different national approaches: There may be different approaches to cross-border data flows in different Member States, which can make it challenging to achieve clarity and harmonisation at the EU level. 3. Conflicting priorities: Industry and the public sector may have conflicting priorities when it comes to cross-border data flows, which can make it difficult to achieve clarity and harmonisation. 4. Limited resources: There may be limited resources available to devote to efforts to clarify and harmonise cross-border data flows in AI procurement, which can make it more difficult to achieve. 5. Technological challenges: There may be technological challenges associated with clarifying and harmonising cross-border data flows in AI procurement, which could limit progress in this area. For example, in adopting APIs, governments can encounter certain risks and challenges related to cybersecurity issues, missing API governance structures, or the lack of an API culture.[493] However, the adoption of such actions at the EU level could be supported by the development of standards, guidelines or awareness campaigns.

[493] Ibid.

		Overall, while there are many potential benefits to addressing the lack of clarity and harmonisation around cross-border data flows in AI procurement in the EU, there are also several potential limits and challenges that may need to be overcome. Nevertheless, as regards potential limits, these are quite low when compared to the overall benefits provided by the implementation of the actions.
Efficiency/ resources	High	The implementation of APIs could carry certain technical and organisational costs related to their set-up, but these are expected to be minimal. Similarly, to implement federated data networks and data spaces, further digitalisation is needed at a national level. At the same time, it is necessary to set up interoperable EU-wide infrastructures to enable the cross-border use of data in the EU. However, these will be supported through different EU funds and instruments. Nevertheless, the benefits of all actions are expected to exceed the potential costs and resources. For example, overall, the European Health Data Space is expected to save the EU around €11 billion over ten years.[494]
EU added value/ subsidiarity	Medium	The creation of federated data networks and data spaces at the EU level has clear benefits linked to its cross-border characteristic. For example, the COVID-19 pandemic has highlighted the critical role of data, and in this particular context, a well-functioning common European data space for health, which has been marked as one of the priority initiatives by the European Council, is expected to make a crucial difference in tackling potential health pandemics in the future through EU cooperation.[495] Formulating clear incentives and use cases for data sharing can be implemented both at the EU level and MS level, however, when done at the EU level, such as in the case of the JRC databases, the benefits could be expected to be higher, as such measures would have a higher level of exposure and outreach. Promoting open application programming interfaces (APIs), again is one measure that could be implemented both at the EU level and MS level, although less likely at the EU level. However, certain measures such as interoperability standards and guidelines developed at the EU level which would support the widespread adoption of APIs by national and local governments could have an increased added value.

Promote interoperability

Potential policy actions:

- Develop standards for data exchange.
- Develop national strategies for data complemented by organisation/sector-specific strategies for data.
- Introduce incentives for creating interoperable systems.

[494] Questions and answers - EU Health: European Health Data Space (EHDS) available at https://ec.europa.eu/commission/presscorner/detail/en/QANDA_22_2712

[495] European Commission (2022) Commission Staff Working Document on Common European Data Spaces

- Introduce documentation for semantic interoperability (data dictionaries, ontologies, etc.).

Criteria	Rating	Description
Effectiveness/ benefits	High	Lack of interoperability has been highlighted as an important challenge for the adoption of AI by the public sector (see Section 1.3.1.4 on Organisational capacity challenges and Section 3.7.2 on cross-sectoral challenges reflected by the stakeholder consultations). This was an issue that was especially pointed out concerning the Mobility sector (see section 2.3) and also in the Education sector (see section 2.5). The research showed that the fragmentation of the European data market is a barrier to business competitiveness and the deployment of AI solutions and greater interoperability is a key prerequisite for the development of new AI applications in the public sector. For example, the study found that one uniquely European obstacle to the wider uptake of AI solutions in the mobility sector is the fragmentation of its rail market causing a lack of interoperability (see section 2.3 on challenges in the Mobility sector). Initiatives like the Shift2Rail project were therefore launched to develop a common interoperability framework at the European level.[496] Developing standards, coordinated strategies and interoperability requirements for data exchanges would bring numerous benefits to the development of new AI solutions for the public sector: • Standards can help to ensure that data is shared consistently and reliably between different systems, organisations, and agencies. This can make it easier to develop new AI solutions that can make use of that data. • Coordinated strategies can help to ensure that different organisations and agencies are working together in a coordinated way to achieve common goals related to the development and use of AI in the public sector. This can help to increase the efficiency and effectiveness of AI development efforts. • Interoperability requirements can ensure that new AI solutions can be integrated with existing systems and work seamlessly together. This can help to minimize disruptions and maximize the benefits of new AI solutions to the public sector. Interoperability can foster the democratisation of data and AI across different domains, allowing smaller organisations and agencies to benefit from the same data and AI tools as larger ones.
Feasibility/ limits	High	These types of actions focused on increasing interoperability are already being put in place at the national and EU level, therefore their level of feasibility is expected to be high. The Commission has recently adopted the Interoperable Europe Act[497] to strengthen cross-border interoperability and cooperation in the public sector across the EU. It aims to implement interoperability by design approach and calls for mandatory interoperability assessments to evaluate the

[496] See https://rail-research.europa.eu/about-shift2rail/mission-and-objectives/
[497] COM(2022) 720 final

		impact of changes in IT systems related to cross-border interoperability in the EU. The SEMIC Support Centre[498] is an EU initiative aimed at building an interoperable European administration. In line with the Interoperable Europe Act, the SEMIC community facilitates the co-creation of technical solutions and sharing of best practices. The Support Center is also home to a community that shares tooling, standards and good practices to promote semantic interoperability, including for the common European data spaces.[499] The recent 2022 SEMIC Conference, for example, offered support in overcoming obstacles in implementing data spaces and aimed to clarify how interoperability within and across sectors can be achieved.[500] For example, 'Core Vocabularies' is one EU initiative designed to provide simplified, reusable, and extensible data models that capture the fundamental characteristics of a public organisation, in a context-neutral manner.[501] Open e-TrustEx is an open-source solution which provides a secure file exchange platform for European public administrations[502]. Many other such technical solutions are available on the Joinup platform, which is the European Commission's one-stop shop for interoperable, open and free digital government ICT solutions.[503]
Efficiency/ resources	Medium	Interoperable digital public services are essential for building a digital single market. Apart from the economic benefits and efficiency gains, case studies (see section 2.3 on the Mobility Data Space in Germany) show that interoperability positively affects public values, such as improving trust from citizens in their governments. In the past years, digital government and data experts have developed wide-ranging common interoperability cooperation practices based on the European Interoperability Framework (EIF). However, recent evaluations have exposed the serious limitations of this entirely voluntary cooperation approach.[504] For this purpose, the Commission adopted in November 2022 the Interoperable Europe Act proposal to strengthen cross-border interoperability and cooperation in the public sector across the EU and it is expected to save costs, and cross-border interoperability can lead to cost-savings between €5.5 and €6.3 million for citizens and between €5.7 and €19.2 billion for businesses dealing with public administrations.[505] Any measures designed to increase interoperability would therefore have a high positive impact on the uptake of AI solutions in the public sector as well. However, measures improving interoperability could be expected to incur

[498] See SEMIC Support Centre | Joinup (europa.eu)
[499] See https://joinup.ec.europa.eu/collection/semic-support-centre/data-spaces
[500] See https://semic2022.eu/
[501] See https://ec.europa.eu/isa2/solutions/core-vocabularies_en/
[502] See https://ec.europa.eu/isa2/solutions/open-e-trustex_en/
[503] See https://joinup.ec.europa.eu/collection/joinup/interoperability-solutions
[504] Press Release, November 2022, New Interoperable Europe Act to deliver more efficient public services through improved cooperation between national administrations on data exchanges and IT solutions available at https://ec.europa.eu/commission/presscorner/detail/%20en/ip_22_6907
[505] European Commission Press Release, 2022, New Interoperable Europe Act to deliver more efficient public services through improved cooperation between national administrations on data exchanges and IT solutions available at https://ec.europa.eu/commission/presscorner/detail/en/ip_22_6907

		significant costs in the short term for public administrations even though they are offset over the longer term by the benefits generated. Such measures would be built on already existing frameworks developed at the EU level and could be funded by EU funding instruments such as the Digital Europe Programme.
EU added value/ subsidiarity	Medium	In the past years, digital government and data experts have developed wide-ranging common interoperability cooperation practices based on the current European Interoperability Framework (EIF) and will continue to do so under the Interoperable Europe Act, which may see the revision of the EIF. The actions could be implemented both at the EU level and MS level. However, certain measures such as interoperability standards and guidelines developed at the EU level could have an increased added value over the national solutions as they would ensure higher levels of technical interoperability across the whole EU and would have a wider outreach. The objectives to ensure a coherent EU approach and EU-wide interoperability for data exchanges and a dynamic data ecosystem cannot be achieved by Member States' action alone but need EU action.

Facilitate "data ownership"

Potential policy actions:

- Define data control, access and other processes in relevant legislation (GDPR, Data Governance Act and the Data Act).
- Engage in public discussion, education and seminars around "ownership" and usage of individuals' data to promote greater understanding by individuals of how their data may be used.

Criteria	Rating	Description
Effectiveness/ benefits	Medium	The study found that often in the public sector, there is a reluctance towards data sharing due to challenges related to "data ownership" and "data sovereignty" or because of insufficient tools and appropriate digital infrastructures to permit data sharing more easily (see Section 1.3.1.2. on data challenges). Rules on the B2B and B2G side of data exchanges and interoperability have already been pushed forward through legislation such as the Data Act and the Data Governance Act as part of the European Strategy for Data. They are expected to have a high impact on creating a single market for data that will ensure Europe's global competitiveness and "data sovereignty". Decentralised data architectures, for example, can provide several benefits for the adoption of AI solutions: • Data privacy and security: Decentralised data architectures distribute data across multiple nodes, rather than storing it in a central location. This can make it more difficult for unauthorized parties to access or tamper with the data, which can be especially important in applications that involve sensitive or personal information.

		• Scalability: They can help to ensure that the system can handle large amounts of data, even as the number of users or the amount of data grows. • Interoperability: Decentralised systems typically use open standards and protocols, which makes it easier for different systems to communicate and share data. This can be useful in situations where multiple AI solutions need to work together or share data. • More accessible AI: Decentralised architecture allows data to be shared with a wider population, which could enable more groups or individuals to have access to the data, allowing more inclusive AI development. Nevertheless, most of the actions envisaged under this recommendation are soft law measures intended to increase clarity and awareness and encourage more data sharing, hence their effectiveness can be expected to be lower. Benefits might also be indirect and difficult to capture in practice.
Feasibility/ limits	High	As the actions envisaged under this recommendation are soft law measures intended to increase clarity over "data ownership" and awareness and to encourage more data sharing, their level of feasibility should be high with very few possible limits endangering their implementation. Moreover, the actions could build on already existing initiatives based on the European Data Strategy. For example, Gaia-X is a project whereby representatives from business, politics, and science from Europe and around the globe are working together, hand in hand, to create a federated and secure data infrastructure.[506] The architecture of Gaia-X is based on the principle of decentralization. Similarly, the study also explored the case study of the Mobility Data Space from Germany with its possible implications for the development of AI solutions for the public sector (see Section 2.3.4).
Efficiency/ resources	Medium	The necessary resources required for the actions envisaged would be minimal as these would build on already existing frameworks and solutions. Moreover, the actions are mostly designed to clarify certain concepts, encourage data sharing, and create awareness over existing solutions, therefore they can be expected to not require high implementation costs or technical investments. Nevertheless, for measures such as decentralized data architectures the trade-offs also need to be evaluated carefully, as these could also bring challenges such as higher complexity, increased maintenance costs and lower performance in some cases.
EU added value/ subsidiarity	Medium	All actions could be developed both at the EU and national levels, however, if implemented and coordinated at the EU level, they could support the creation of a data ecosystem based on European values and can provide input to discussions on innovation at the European level.

[506] Further information is available at: https://gaia-x.eu/what-is-gaia-x/

Address the challenges surrounding the sharing of data between and across sectors

Potential policy actions:

- Introduce guidelines as to what is and isn't legally possible and data sensitivity.
- Encourage sharing of data between different data spaces.
- Ensure that confidential data (business secrets) are end-to-end encrypted and promote privacy-preserving techniques.
- Promote common sharing or format and metadata standards.

Criteria	Rating	Description
Effectiveness/ benefits	Medium	On top of challenges related to a lack of interoperability and uniform data quality and unharmonised rules for cross-border data flows, a differentiated GDPR implementation has also been signalled as an important issue influencing data sharing across sectors. In the case of AI/big data applications, the uncertainties are aggravated by the novelty of the technologies, their complexity and the broad scope of their individual and social effects. Further clarifying GDPR and other data privacy rules as well as introducing guidelines which are specifically aimed at specifying the obligations of actors implementing AI solutions would create a better understanding of existing legislation and have indirect positive effects on the level of data sharing occurring in practice, but these are expected to be limited on the uptake of AI by the public sector. Encouraging the sharing of data between different data spaces can provide several benefits for the adoption of AI solutions by the public sector: • Increased efficiency: Sharing data between different data spaces can allow for more efficient use of resources since multiple organisations can access and use the same data instead of each having to collect and maintain their separate datasets. • Improved decision-making: Sharing data can allow for a more accurate and comprehensive analysis of the data, which can lead to better decisions. By pooling data from multiple sources, organisations can gain a more complete understanding of the issues they are addressing. • Better public services: By sharing data, public sector organisations can more easily identify patterns and correlations that can help to improve the delivery of public services. • Cost savings: Sharing data can also help organisations save money since they won't have to spend as much on collecting and maintaining their datasets. Additionally, by sharing data, organisations can reduce duplication of effort and avoid having to perform the same analysis multiple times. • Innovation: Sharing data can also lead to new insights and innovations that would not have been possible with data siloed in one organisation. Exposing data to the wider population can enable new uses and discoveries, which can drive innovations.

Feasibility/ limits	High	Rules on the B2B and B2G side of data exchanges and interoperability have already been pushed forward through legislation such as the Data Act and the Data Governance Act as part of the European Strategy for Data. They are expected to have a high impact on creating a single market for data that will ensure Europe's global competitiveness and "data sovereignty". Given that the actions envisaged under this recommendation are soft law measures intended to increase clarity over data privacy regulation and awareness of existing solutions and to encourage more data sharing, their level of feasibility should be high with very few possible limits endangering their implementation. Moreover, the actions could build on already existing initiatives based on the European Data Strategy.
Efficiency/ resources	Medium	The necessary resources required for the actions envisaged would be minimal as these would build on already existing frameworks and solutions. Moreover, the actions are mostly designed to clarify certain concepts, encourage data sharing, and create awareness over existing solutions, therefore they can be expected to not require high implementation costs or technical investments. It's also important to note that increased data sharing also comes with a set of challenges such as privacy concerns, security, legal and ethical issues, and technical challenges around data integration, all of which need to be addressed through appropriate governance, regulations, and technical solutions. For example, for the implementation of end-to-end encryption and privacy-preserving techniques for data sharing, there are several potential investments necessary including: • Hardware and infrastructure costs are associated with acquiring and maintaining the necessary hardware and infrastructure to support encryption and privacy-preserving techniques. • Development and implementation costs, including costs for software development, testing, and deployment. • Training and support costs: Organizations may need to provide training and support to their employees and users to ensure they understand how to properly use and maintain the systems. • Maintenance and management costs. • Legal and regulatory compliance costs depend on the specific regulations and laws that apply to the data being shared.
EU added value/ subsidiarity	Medium	All actions could be developed both at the EU and national levels, however, if implemented and coordinated at the EU level, they could support the creation of a data ecosystem based on European values and can provide input to discussions on innovation at the European level. Providing guidance requires a multilevel approach, which involves data protection authorities, civil society, representative bodies, and all other stakeholders. The guidance provided by political authorities, such as the European Parliament, the European Commission and the European Data Protection Supervisor could have a higher level of effectiveness and wider outreach. Nevertheless, National Data Protection Authorities should also provide

		guidance, in particular when contacted for advice by controllers, or in response to data subjects' queries.[507]

Address bias within AI and data sources

Potential policy actions:

- Promote ethics by design (interdisciplinary awareness/competence in developing/procuring teams).
- Develop tools and promote education to make understanding bias a standard part of AI workflow.
- Have consistent monitoring and evaluation of bias.

Criteria	Rating	Description
Effectiveness / benefits	High	The study found that in the public sector especially when procuring a technology, the potential for bias and discrimination in AI is an important factor to address during the procurement/development process (see section 1.3 on AI Technology challenges). The question of understanding who bears responsibility and liability for AI technology is also extremely important in ensuring confidence in AI technologies and therefore increases its likelihood to be adopted by public administration. The study also showed that several best practices can already be highlighted for higher uptake and avoiding social rejection of AI solutions: greater involvement of stakeholders, experts, workers and citizens that will be facing/using the AI, and enhancement of digital infrastructure, or the creation of an "AI Data Officer" (see eGovernment section on savings in operational efficiency).[508] The actions envisaged under this recommendation have the potential to tackle some of the issues surrounding bias within data sources and data science teams as the concept of 'ethics by design' is developed at the EU level through various initiatives. For example, guidance has been drafted by a panel of experts[509] and builds on the work of the Independent High-Level Expert Group on AI and their 'Ethics Guidelines for Trustworthy AI'[510] as well as on the results of the EU-funded SHERPA[511] and SIENNA projects.[512] All these initiatives have shown that embedding principles of ethics early on in the implementation of AI can bring numerous benefits, such as more fairness, transparency, accountability and oversight, which in turn enhance trust in AI systems. For high-risk AI systems, this will be addressed by the upcoming AI Act (Articles 9 and 10) and the conformity and monitoring procedures. For non-high risk, there will be the option of Article 69 with codes of conduct[513].

[507] EPRS (2020) The impact of the General Data Protection Regulation (GDPR) on Artificial intelligence
[508] AI Multiple, April 2022, *AI in government: examples, challenges & best practices in 2022*, https://research.aimultiple.com/ai-government/
[509] European Commission (2021) Ethics By Design and Ethics of Use Approaches for Artificial Intelligence
[510] See more at https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai
[511] https://www.project-sherpa.eu/
[512] https://www.sienna-project.eu/
[513] https://digital-strategy.ec.europa.eu/en/library/proposal-regulation-laying-down-harmonised-rules-artificial-intelligence

Feasibility/ limits	High	The actions envisaged within this recommendation would have a high level of feasibility given that they would build on existing initiatives and frameworks. Most importantly, the EU AI Act would provide the necessary legal framework to implement monitoring and enforcement structures as, under the Regulation, public authorities would be required to have appropriate human resources and technical tools when implementing AI systems, especially when these technologies would fall under the high-risk categories established by the act. This will apply to risk management, data quality and bias testing and auditing. There will also be an expectation that the private actors who procure the systems comply with these requirements (they will be providers under the AI Act and will directly be obliged under the AI Act).
Efficiency/ resources	High	The actions envisaged within this recommendation would have a high level of efficiency given that they would build on existing initiatives and frameworks. Nevertheless, the field of data science can be expensive, both in terms of education, training and of technology and software, which can be a barrier for organisations in obtaining representation in their data science teams.
EU added value/ subsidiarity	High	All actions could be developed both at the EU and national levels, however, if implemented and coordinated at the EU level, they could support the creation of a data ecosystem based on European values and can provide input to discussions on innovation at the European level. The guidance provided by EU authorities, such as the European Parliament, or the European Commission could have a higher level of effectiveness and wider outreach. The AI Act requires post-market monitoring plans (Article 61) that providers must establish to document the performance of high-risk AI systems throughout their lifetimes. This can form the basis for an EU-wide ecosystem for conducting AI auditing.

Improve technological accountability and transparency

Potential policy actions:

- Use transparency tools along EU guidelines.
- Promote certification of AI on all assurance levels and conformity assessment of transparency requirements, ideally via independent third parties for high-risk areas.

Criteria	Rating	Description
Effectiveness/ benefits	High	The study found that the transparency of the decisions made by algorithms is essential to make AI in procurement democratic and acceptable to European citizens (see section 1.3 on AI technology challenges).[514] The EU's High-Level Group on AI has also called for further work to define pathways to achieving explainability.[515]

[514] World Economic Forum, June 2020, *AI Procurement in a Box: Procurement guidelines*, https://www3.weforum.org/docs/WEF_AI_Procurement_in_a_Box_AI_Government_Procurement_Guidelines_2020.pdf

[515] EU High Level Group on AI (2019) Ethics guidelines for trustworthy AI. Available at: https://ec.europa.eu/digital-singlemarket/en/news/ethics-guidelines-trustworthy-ai

		Transparency tools and ensuring the transparency of AI systems would be beneficial for several reasons: they would give users confidence in the system, they would safeguard against bias, would help ensure regulatory standards or policy requirements are met and would improve system design.[516]
Feasibility/ limits	High	The actions envisaged within this recommendation would have a high level of feasibility given that they would build on existing initiatives and frameworks. A range of policy instruments already exists that seek to promote or enforce some form of transparency in the use of data and AI. For example, the JRC has stressed the possibility to develop methodologies to evaluate the impacts of AI on society, built on the model of the Data Protection Impact Assessments (DPIA) introduced in the General Data Protection Regulation (GDPR). Another possible solution was also the promotion of transparency systems in sensitive systems, through the implementation of transparency-by-design approaches in AI components that would provide a guarantee of the respect of fundamental rights.[517] The path for transparency mechanisms is also set by the proposed EU AI Act. Specifically, the AI Act sets some new minimum requirements of transparency and interpretability) for AI systems labelled as "high-risk". Transparency tools and metrics would be built at the EU level to check the technical documentation required by the AI Act and, in turn, verify the extent to which the AI system is aligned with the requirements of the regulation.
Efficiency/ resources	Medium	The actions envisaged within this recommendation would have a medium level of efficiency given that they would build on existing initiatives and frameworks. However, designing and implementing transparency tools which go beyond guidelines as well as developing industry standards could require certain significant resources and investment. One example of an ongoing project is NL4XAI, the first European Training Network on Explainable Artificial Intelligence funded by Horizon 2020, which aims to train 11 researchers to leverage the usage of AI models and techniques and integrate their findings into a common open-source software framework for Explainable AI that will be accessible to all the European citizens.[518]

[516] The Royal Society (2019) Explainable AI: the basics – policy briefing available at https://ec.europa.eu/futurium/en/system/files/ged/ai-and-interpretability-policy-briefing_creative_commons.pdf
[517] JRC (2020) Robustness and Explainability of Artificial Intelligence
[518] See https://nl4xai.eu/about/

EU added value/ subsidiarity	Medium	Different users require different forms of explanation in different contexts, therefore transparency tools could be difficult to harmonise across sectors or MS. However, in terms of the development of standards, their value stems from their high level of harmonization at the EU level. For this purpose, according to the proposal for the EU AI Act, the European Committee for Standardisation (CEN) and the European Committee for Electrotechnical Standardisation (CENELEC) will be in charge of developing the technical standards for the AI Act. Technical standards will play a key role in the implementation of the AI Act, as the companies that apply them will be considered by default in conformity with the EU rules. Nevertheless, this will only be finalised once the AI Act has been finalised and by the EU co-legislators, which is unlikely before 2023.

Increase trust in AI solutions

Potential policy actions:

- Adopt and prepare for the implementation of the AI regulatory framework, including the AI Act and the AI Liability Directive.
- Use storytelling to communicate the value and the worth of AI solutions.
- Promote testing, inspection, and certification.
- Promote greater education on AI at all levels of society.
- Promote the adoption of ethical frameworks for AI.

Criteria	Rating	Description
Effectiveness/ benefits	Medium	The study found that some of the main barriers to the adoption of AI technologies are related to social aspects. In this context, it is essential to lessen the possibility of decreasing citizens' trust towards public authorities, by properly addressing and minimising the dehumanisation of public services and attracting experts and finding synergies with the ICT industry (see Section on main drivers and barriers for the E-Government sector). Rules proposed by the AI Liability Directive, which will come after the AI Act, will promote trust in AI (and other digital technologies) by ensuring that victims are effectively compensated if damage occurs despite the preventive requirements of the AI Act and other safety rules. The proposal for the AI Act seeks to establish mechanisms to preserve fundamental rights and values throughout the whole life cycle of AI-based systems, thus ensuring legal certainty that encourages innovation and investments in AI systems. On top of these frameworks, any measures increasing societal trust would benefit all actors involved in the AI-value chain, because strengthening citizens' confidence will contribute to faster uptake of AI.
Feasibility/ limits	High	The actions envisaged within this recommendation would have a high level of feasibility given that they would build on existing initiatives and frameworks.

Efficiency/ resources	High	While relying as much as possible on existing frameworks and solutions to minimize costs, the mandatory nature of the AI Act and Liability Directive would still require some resources to follow all procedures and ensure compliance which public authorities will need to prepare for.
EU added value/ subsidiarity	Medium	The role of both the Liability Directive and the AI Act is to contribute to the rollout of AI. The conditions for the roll-out and development of AI technologies in the internal market can be significantly improved by preventing fragmentation and increasing legal certainty through harmonised measures at the EU level, compared to possible adaptations of liability rules at a national level. The actions could be implemented both at the EU level and national level, however, guidance or awareness campaigns provided by EU Commission and the future EU AI Board could have a higher level of effectiveness and wider outreach.

Facilitate the integration of new AI technologies/services into existing systems (education/health/transport)

Potential policy actions:

- Create regulatory sandboxes
- Aim for a longer cycle of integration because this happens with any new IT.
- Address security considerations by undertaking risk-adequate controlled experiments via new solutions.
- Use "data ambassador" campaigns to better involve stakeholders.
- Work alongside existing systems as a support rather than immediately replacing existing systems.

Criteria	Rating	Description
Effectiveness/ benefits	High	Difficulties in integrating new AI technologies/services into existing systems have been reported in several sectors analysed by the study. For example, in the Health sector, this comes from a lack of complementary solutions to enable the use/uptake of AI MedTechs (e.g., digital medical records require new integration software and platforms) (see Section 2.4.2 on the Health sector's value chain analysis). Improving the integration of new AI technologies/services into existing systems rather than immediately replacing existing systems has several benefits: • Cost-effectiveness: Integrating AI into existing systems rather than replacing them altogether can save a significant amount of money. • Familiarity: Employees and users are already familiar with existing systems, so integrating AI into those systems will cause less disruption and make the transition smoother. • Data compatibility: Integrating AI into existing systems allows the new technology to work with the same data sets and interfaces that are already in use. • Scalability: Integrating AI into existing systems allows for incremental implementation, making it easier to scale up as needed.

		• Flexibility: Integrating AI into existing systems allows organisations to pick and choose which processes and tasks they want to automate, rather than having to replace entire systems. • Reduced risk: Integrating AI into existing systems rather than replacing them altogether can help organisations to reduce the risk of data loss, system failure or other unexpected problems.
Feasibility/ limits	High	The actions envisaged within this recommendation would have a high level of feasibility given that they would build on existing initiatives and frameworks. Moreover, they are soft law measures intended to increase awareness, promote good practices and enhance the testing of AI solutions and their integrations within existing systems, which suggests that there would not be significant limits to their implementation. As regards the measure aimed at promoting the undertaking of risk-adequate controlled experiments via new solutions, it is worth noting that the proposal for the EU AI Act envisages setting up coordinated AI 'regulatory sandboxes' to foster innovation across the EU. A regulatory sandbox is a tool allowing businesses to explore and experiment with new and innovative products, services or businesses under a regulator's supervision. It provides innovators with incentives to test their innovations in a controlled environment, allows regulators to better understand the technology, and fosters consumer choice in the long run.[519]
Efficiency/ resources	Medium	The necessary resources required for the actions envisaged would be minimal as these would build on already existing frameworks and solutions. Moreover, the actions are mostly designed to clarify certain concepts, encourage testing, inspecting and certification, and create awareness over existing solutions, therefore they can be expected to not require high implementation costs or technical investments. Nevertheless, improving the integration of new AI technologies/services into existing systems might require several investments related to auditing and testing the existing systems, preparing them for integration with AI systems as well as the actual integration costs, which relate to measures needed to make sure that existing and new systems work together seamlessly. undertaking risk-adequate controlled experiments via new solutions and working alongside existing systems as a support rather than immediately replacing existing systems are also both measures that can reduce overall resources needed for the implementation of AI technologies. They allow for faster deployment by allowing organisations to test new solutions in a controlled environment before fully implementing them.
EU added value/ subsidiarity	High	The actions could be implemented both at the EU level and national level, however, guidance or awareness campaigns provided by EU authorities could have a higher level of effectiveness and wider outreach. For example, developing testing and regulatory sandboxes at the EU level rather than at the national level can facilitate cross-border deployment of new AI technologies across the

[519] European Parliament (2022) Briefing on Artificial intelligence act and regulatory sandboxes available at https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/733544/EPRS_BRI(2022)733544_EN.pdf

		EU, therefore promoting the Single Market and the EU's digital agenda. They can also provide consistency in the way that new AI technologies are tested and regulated, which can reduce uncertainty for companies operating in multiple member states and can allow EU Member States and can lead to greater efficiencies by avoiding duplication of efforts.

Focus on long-term implementation

Potential policy actions:

- Fund multi-disciplinary projects with a focus on sustainability over time.
- Avoid "project silos" and "reinventing the wheel" each time and promote a more modular longer-term approach. The overarching purpose should be a long-term solution for citizens involving real-world solutions with a service mentality.
- Promote, invest and facilitate (e.g., via legislation on data sharing) open-source solutions and libraries.
- Make policy with input from representative groups of users.

Criteria	Rating	Description
Effectiveness/ benefits	High	Involving multi-disciplinary teams, encouraging collaboration, and focusing on implementation over the longer term has several benefits: • Diverse perspectives: Multi-disciplinary teams bring together individuals with different backgrounds, skills, and expertise, which can lead to more creative and effective solutions. • Increased efficiency: Collaboration allows team members to share their knowledge and work together to achieve a common goal, resulting in faster and more efficient implementation of AI technologies. • Improved decision-making: By involving diverse experts, decision-making can be based on a more comprehensive understanding of the problem at hand, leading to better and more informed decisions. • Better alignment with business goals: By focusing on implementation over the longer term, teams can ensure that AI technologies are being used in a way that aligns with the organisation's overall goals and objectives. • Better generalisation: By involving experts from different fields, the model can be trained on more diverse data, which can improve its generalisation capabilities. • Better ethical consideration: Multi-disciplinary teams can better consider the ethical implications of AI technology, and help to mitigate the negative consequences
Feasibility/ limits	Medium	The actions envisaged within this recommendation would have a high level of feasibility given that they would build on existing initiatives and frameworks. Moreover, they are soft law measures intended to increase awareness, promote good practices and support the implementation of AI solutions by the public sector with a focus on the long term, which suggests that there would not be significant limits to their implementation.

		The *Digital Europe Programme*, as well as the EU *Recovery and Resilience Facility* (RRF) programme, include funding opportunities dedicated to AI for the public sector.
Efficiency/ resources	High	The necessary resources required for the actions envisaged would be reasonable as these would build on already existing frameworks and solutions. However, the actions described under this set of recommendations are related to funding, providing financial incentives and establishing programmes that would ensure long-term involvement in AI implementation projects. As a consequence, the actions can be expected to require significant implementation costs or technical investments. It is possible to improve efficiency by, for example, including scalability as a formal precondition to benefit from EU funding programmes foreseeing AI-related activities[520]. There is also a need to ensure resources are appropriately allocated as a part of this action, here, to ensure funding schemes and initiatives are optimised an initial focus could be placed on those specific innovations with a clear focus on replicability and scalability over the long term.
EU added value/ subsidiarity	High	EU-level funding adds significant value added in complementing national funding through: • Scalability - enhancing the development and implementation of AI technologies on a larger scale, across multiple countries, • Harmonisation: helping to harmonise the development and implementation of AI technologies across different countries, leading to greater consistency and interoperability, • Access to expertise: providing access to a wider pool of expertise and resources, which can support the development and implementation of AI technologies, • International cooperation: encouraging international cooperation and the sharing of best practices among different countries, leading to a more effective and efficient implementation of AI technologies.

Improve access to funding and resources

Potential policy actions:

- Strengthen current initiatives that provide funding and resources, such as EIC Accelerator and Horizon 2020.
- Establish new cascading funding and grants for research and development of AI solutions for the public sector.

Criteria	Rating	Description
Effectiveness/ benefits	High	A lack of funding is a central barrier to AI-enabled public sector innovation[521]. Many national and EU-level projects require significant funding levels to ensure the appropriate resourcing for the designing and developing of AI solutions.

[520] JRC (2022) AI Watch: Road to the Adoption of Artificial Intelligence by the Public Sector. Available at: https://op.europa.eu/en/publication-detail/-/publication/34251428-dc12-11ec-a534-01aa75ed71a1

[521] JRC (2022) AI Watch: Road to the Adoption of Artificial Intelligence by the Public Sector. Available at: https://op.europa.eu/en/publication-detail/-/publication/34251428-dc12-11ec-a534-01aa75ed71a1

		This funding is particularly needed for replicating and scaling up best practices. Whilst a range of measures here focuses on the availability of financial resources, the reputation and position of the Commission are also important in facilitating engagement and partnerships between the public sector and industry. The study found that there are several clear examples and cases (Case Studies 2.2.4, 2.3.4) where multi-disciplinary teams within sectors are effective in breaking down silos of both knowledge and data and bridging the gap between the public and private sectors. Similarly, such ventures demonstrated the value of user-led, rather than technology-led design.
Feasibility/ limits	High	The *Digital Europe Programme*, as well as the EU *Recovery and Resilience Facility* (RRF) programme, include funding opportunities dedicated to AI for the public sector. Build on these programmes and promote the use of international funding together with national, regional and local funding in a complementary manner[522]. In this instance, a range of existing projects already exists that could be chosen for further funding to help scale up good AI practices at the national and EU level. Such action would help spread contextual experiences across settings (local-regional, country-country) as well as help scale the system up from local to central units of administration. Being led by the Commission in this instance would help ensure alignment with European regulations and values.
Efficiency/ resources	High	It is possible to improve efficiency by, for example, including scalability as a formal precondition to benefit from EU funding programmes foreseeing AI-related activities[523]. There is also a need to ensure resources are appropriately allocated as a part of this action, here, to ensure funding schemes and initiatives are optimised an initial focus could be placed on those specific innovations with a clear focus on replicability and scalability.
EU added value/ subsidiarity	High	EU-level funding adds significant value added in complementing national funding through: • Scalability - enhancing the development and implementation of AI technologies on a larger scale, across multiple countries, • Harmonisation: helping to harmonise the development and implementation of AI technologies across different countries, leading to greater consistency and interoperability, • Access to expertise: providing access to a wider pool of expertise and resources, which can support the development and implementation of AI technologies, • International cooperation: encouraging international cooperation and the sharing of best practices among different countries, leading to a more effective and efficient implementation of AI technologies.

[522] JRC (2022) AI Watch: Road to the Adoption of Artificial Intelligence by the Public Sector. Available at: https://op.europa.eu/en/publication-detail/-/publication/34251428-dc12-11ec-a534-01aa75ed71a1
[523] JRC (2022) AI Watch: Road to the Adoption of Artificial Intelligence by the Public Sector. Available at: https://op.europa.eu/en/publication-detail/-/publication/34251428-dc12-11ec-a534-01aa75ed71a1

Foster the development of skills and competencies

Potential policy actions:

- Introduce digital Academy-type models for the public sector where AI is part of a curriculum.
- Develop and maintain digital skills within the workforce through a centralised training portal.
- Improve digital literacy through the establishment of communities of practice, or peer learning groups across Member States.

Criteria	Rating	Description
Effectiveness/ benefits	High	The study found that the lack of skills and expertise is one of the most significant barriers to AI adoption (Section 1.3.1.4 on organisational capacity challenges). The successful adoption and deployment of AI solutions require a mixture of technical and socio-technical skills to ensure an understanding of the technology itself, and its potential[524]. Employees often do not possess the necessary skills, and it is often challenging for public administrations to identify, recruit, and retain the required talent. The use of trusted training packages is one way of building skills and knowledge within the workforce, and are effective as the case study of AI MOOC in Section 2.5.4 demonstrated. Addressing the lack of digital skills and competencies can bring several benefits: • Improved implementation: individuals and organisations will have the necessary skills and knowledge to effectively use and manage these technologies, • Increased efficiency: can lead to more efficient use of AI technologies, as individuals and organisations will be able to better understand and utilize these technologies to achieve their goals, • Greater innovation: individuals and organisations will be better equipped to develop new and creative uses for AI technologies, • Better decision-making: better ability to analyse and interpret the data generated by AI technologies, • More effective use of resources: better utilisation of AI technologies to achieve their goals. • Better security: individuals and organisations will be better equipped to identify and mitigate potential security risks associated with AI technologies. • Greater transparency: individuals and organisations will be better able to understand and explain the decision-making processes and outcomes generated by AI technologies.
Feasibility/ limits	High	Given that the three actions under this recommendation are all currently being implemented at the EU and Member State level in various ways, their feasibility has already proven to be high.

[524] JRC (2022) AI Watch: Road to the Adoption of Artificial Intelligence by the Public Sector. Available at: https://op.europa.eu/en/publication-detail/-/publication/34251428-dc12-11ec-a534-01aa75ed71a1

		For addressing existing workforce skills there is a range of existing and effective databases, initiatives, and platforms across the EU such as Digital Skill Up[525], the Digital Skills & Jobs platform[526], and the ALL-DIGITAL academy[527]. Moreover, Master's programmes are also funded through the Connecting Europe Facility (CEF) Telecom programme. Under this initiative, top-level universities, SMEs and research centres joined forces to design Master programmes on AI, focusing on human-centric AI, AI ethics, AI for the public sector and AI in healthcare. The programmes follow a highly practical approach that will offer hands-on experiences, and opportunities to work closely with business partners and to learn from real case studies.[528] The potential limit here is down to the training provision itself. Certain industries may require more tailored, or highly curated packages. These more technical training offers may fall outside the scope of this recommendation, but more work can be done on the provision and dissemination of general skills development pathways to help increase the basic digital skills of the population. AI professionals are relatively scarce in the global market, as the demand outweighs the supply[529]. In addition, such professionals tend to prefer engagement in the private sector, given its higher benefits. The higher salaries expected by AI experts are also one of the main variables behind the high cost of adopting AI solutions in the public sector.
Efficiency/ resources	High	As mentioned, several solutions already exist that could be leveraged at low cost and to increase efficiency. Platforms such as the 'elements of AI' MOOC can continue to be used to assist in educating citizens on the basics of AI. If the commission wished to produce or procure further, sectoral-specific training packages through these platforms then this would increase the cost. Similarly, any expansion of existing systems would incur additional costs, but this would be less than the full production of such systems Currently the resource costs are needed. to secure the appropriate AI professionals is high, and the expansion of trusted training platforms here would help over the medium term.
EU added value/ subsidiarity	Low	Efforts to address the lack of skills and competencies should be undertaken at both the EU and national levels. However, given that Education is a national competence, it is expected that the EU added value is rather low and that Member States would wish to tailor measures and initiatives to the specifics of their national educational systems, especially in what concerns school and higher education. The EU added value in this instance would focus on the use of a centralized and trusted training platform that could ensure shared training across the Member States which is important for establishing a common understanding of the topics, as well as ensuring alignment with the European Digital Decade policy programme.

525 See https://www.digitalskillup.eu/catalog/
526 See https://digital-skills-jobs.europa.eu/en/opportunities/training
527 See ALL DIGITAL Academy – Erasmus+ Project
528 See https://digital-skills-jobs.europa.eu/en/artificial-intelligence-masters-supported-cef
529 JRC (2022) AI Watch: Road to the Adoption of Artificial Intelligence by the Public Sector. Available at: https://op.europa.eu/en/publication-detail/-/publication/34251428-dc12-11ec-a534-01aa75ed71a1

Ranking of policy recommendations

The table below provides a ranking of the most important recommendations based on the analysis above. It must be noted that the ranking is based on mostly qualitative evidence. To have a more systematic quantitative assessment and ranking, a full impact assessment would be needed, with a dedicated cost-benefit analysis. This was beyond the scope of the current study.

Table 13 Ranking of policy recommendations

Recommendations	Effectiveness/ Benefits	Feasibility/ limits	Efficiency/ resources	EU added value/ subsidiarity	Ranking
Improve access to funding and resources	High	High	High	High	1
Address bias within AI and data sources	High	High	High	High	2
Foster coordinated procurement strategies	High	High	High	High	3
Increase clarity and harmonisation around cross-border data flows	High	High	High	Medium	4
Improve alignment between industry and public sector expectations	High	High	High	Medium	5
Ensure a clear regulatory framework for AI	High	Medium	High	High	6
Facilitate the integration of new AI technologies/services into existing systems (education/health/transport)	High	High	Medium	High	7
Focus on long-term implementation	High	Medium	High	High	8
Foster the development of skills and competencies	High	High	High	Low	9
Promote interoperability	High	High	Medium	Medium	10
Increase expertise among public buyers	High	High	Medium	Medium	11
Improve technological accountability and transparency	High	High	Medium	Medium	12
Increase trust in AI solutions	Medium	High	High	Medium	13
Facilitate "data ownership"	Medium	High	Medium	Medium	14
Address the challenges surrounding the sharing of data between and across sectors	Medium	High	Medium	Medium	15

Source: Authors' elaboration.

5 Conclusion

The comparison and triangulation of recommendations from the policy workshop and the online survey provide the following set of recommendations in order of importance. For each recommendation, we note the recent policy actions that have been taken and the potential policy actions that could be taken by the European Commission to increase the uptake of AI by the public sector in Europe.

It's worth mentioning that these policy recommendations and potential actions are not exhaustive and might vary depending on the context and the specific needs of each country or sector. Also, it's important to note that some of these policy actions were proposed in recent publications of the European Commission and might not have been adopted yet.

1. **Increase funding and resources for AI in the public sector:**

Potential policy actions the Commission could take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Establishing a dedicated AI fund to support AI projects in the public sector and provide grants for public sector organizations to develop and implement AI solutions.
- Co-funding AI projects in the public sector together with private sector companies, to encourage collaboration and knowledge sharing.

On-going activities:

The European Commission has recently provided funding for research and development of AI in the public sector through programs such as Horizon Europe, and the EU Framework Program for Research and Innovation (2021-2027)[530]. They also established a dedicated funding stream for AI in the public sector under the European AI Alliance, to support the scaling and spread of reusable solutions (2018)[531]. The Commission set up a European AI Alliance, a network of national AI alliances to exchange best practices and support the development and uptake of AI in the public sector (2018)[532].

2. **Reduce bias within AI and data sources:**

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Establishing a dedicated AI bias detection and mitigation centre to support the public sector in identifying and addressing bias in data and AI models.
- Providing training on bias detection and mitigation techniques for data scientists and other professionals in the public sector.
- Developing a set of common ethical guidelines for data collection, management, and sharing in the public sector to ensure data quality and reduce bias[533].
- Encouraging the use of interpretable AI methods in the public sector to make AI models more transparent and accountable for their decisions[534].

On-going activities:

[530] https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en
[531] https://ec.europa.eu/digital-single-market/en/european-ai-alliance
[532] Ibid
[533] This will be covered in the upcoming AI Act Articles 9 and 10.
[534] This will be covered in the upcoming AI Act Article 13.

The European Commission has recently established guidelines and best practices for data collection, management, and sharing in the public sector to ensure data quality and reduce bias (2021)[535]. They funded research on bias detection and mitigation techniques and invest in training programs to educate data science teams on the importance and methods of mitigating bias in data and AI models (2021)[536]. The upcoming AI Act[537] proposal complements existing Union law on non-discrimination with specific requirements that aim to minimise the risk of algorithmic discrimination, in particular concerning the design and the quality of data sets and mandating bias examination, testing and risk mitigation measures.

3. **Encourage coordination of AI procurement strategies:**

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Establishing a procurement office for AI solutions in the public sector, to streamline the procurement process and ensure compliance with guidelines and best practices.
- Developing a set of common criteria and guidelines for procurement of AI solutions by public sector organizations, to ensure transparency and accountability in the procurement process.
- Encouraging the use of AI solutions developed by European companies and SMEs, to support the development of the European AI ecosystem.
- Offering dedicated training and certification programs for public procurement officers, to ensure they are equipped with the knowledge and skills needed to evaluate and select AI solutions.

On-going activities:

The European Commission has recently developed guidelines and best practices for the procurement of AI solutions by public sector organizations (2021). They also aim to establish a European marketplace for GovTech solutions, to facilitate the procurement of AI solutions by public sector organizations (2021). The upcoming AI Act[538] proposes a governance system at the Member State level, plus a cooperation mechanism in European Artificial Intelligence Board. It also envisages mandatory requirements and procedures to be followed by providers and users of high-risk AI systems, including public authorities.

4. **Increase clarity and harmonization around cross-border data flows:**

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Developing a common European data space for public sector bodies and their operators, to facilitate the sharing and reuse of relevant AI datasets and related registries across Europe.
- Establishing a European data governance framework to ensure that data can be used and shared across borders in a secure and trusted way.
- Encouraging the development of cross-border data-sharing agreements between public sector organizations, to support the development and deployment of AI-enabled services.

[535] https://digital-strategy.ec.europa.eu/en/policies/data-governance-act-explained
[536] https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence
[537] https://digital-strategy.ec.europa.eu/en/library/proposal-regulation-laying-down-harmonised-rules-artificial-intelligence
[538] https://digital-strategy.ec.europa.eu/en/library/proposal-regulation-laying-down-harmonised-rules-artificial-intelligence

- Encouraging the use of open data standards and common data models in the public sector, to support the interoperability of AI-enabled services.

On-going activities:

The European Commission has recently proposed several policy actions to ensure the free flow of data in the EU, including the establishment of a European Data Governance Act (2021)[539] and the adoption of the Data Act (2022)[540]. These initiatives aim to facilitate data sharing across sectors and Member States. The Commission also proposed regulations to protect personal data and ensure "data sovereignty", including the General Data Protection Regulation (GDPR) (2018)[541]. The upcoming AI Act[542] proposes harmonised rules for the development, placement on the market and use of AI systems. It also proposes a single definition of AI.

5. **Promote alignment between industry and public sector expectations:**

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Encouraging the development of public-private partnerships to support the development and deployment of AI-enabled services in the public sector.
- Establishing a dedicated AI observatory to gather, share, and collectively manage best practices and experiences learned from different stakeholders in the public sector throughout Europe.
- Developing a set of common guidelines and standards for the development and deployment of AI-enabled services in the public sector, to ensure alignment between industry and public sector expectations.
- Encouraging the participation of public sector organizations in international AI initiatives and standards development.

On-going activities:

The European Commission has recently established the European AI Alliance, a network of national AI alliances to exchange best practices and support the development and uptake of AI in the public sector (2018)[543]. They also established dedicated funding streams for AI in the public sector under the European AI Alliance, to support the scaling and spread of reusable solutions (2018)[544]. The Commission also plays an active role in the OECD AI Observatory, which was launched in 2019, which acts as a global hub for information and knowledge-sharing on AI policies and practices[545]. Finally, the upcoming AI Act will provide a harmonised approach for the development, placement on the market and use of AI systems in the EU.

6. **Establish a clear AI regulatory framework:**

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Adopting AI regulatory framework, including the AI Act and the AI Liability Directive.

[539] https://digital-strategy.ec.europa.eu/en/policies/data-governance-act
[540] https://digital-strategy.ec.europa.eu/en/policies/data-act
[541] https://ec.europa.eu/info/law/law-topic/data-protection_en
[542] https://digital-strategy.ec.europa.eu/en/library/proposal-regulation-laying-down-harmonised-rules-artificial-intelligence
[543] https://ec.europa.eu/digital-single-market/en/european-ai-alliance
[544] Ibid
[545] https://oecd.ai/en/about

- Establishing a regulatory sandbox for public sector organizations to experiment with AI-enabled solutions in controlled environments.
- Developing a set of common guidelines and standards for the development and deployment of AI-enabled services in the public sector.
- Encouraging the participation of public sector organizations in international AI initiatives and standards development.
- Encouraging the development of multilingual guidelines, criteria and tools for public procurement of AI solutions in the public sector throughout Europe.

On-going activities:

The European Commission has recently proposed several policy actions to ensure the responsible development and deployment of AI in the EU, including the adoption of a European AI Act (2021)[546]. The High-level expert group on AI also established a set of ethical guidelines for the development and deployment of AI in the EU - the Ethics Guidelines for Trustworthy AI (2019)[547]. The upcoming AI Act[548] proposes harmonised rules for the development, placement on the market and use of AI systems. It also proposes a single definition of AI.

7. **Promote the integration of new AI technologies and services into existing systems in education, health and transport:**

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Developing a set of guidelines and best practices for the integration of AI in existing systems, to support the development and deployment of AI-enabled services in the public sector.
- Encouraging the development of multidisciplinary research and knowledge creation amongst European universities and R&D institutions around AI for the public sector.
- Offering dedicated capacity-building programs for public sector innovators aiming to develop and/or adopt AI in support of the digital transformation of public services.
- Supporting the development of reusable and interoperable AI components at all operational levels of European public administration.

On-going activities:

The European Commission has recently proposed several policy actions to support the integration of AI in existing systems, including the establishment of a European AI Fund supporting the integration of AI in existing systems (2021)[549]. They also established several dedicated funding streams for AI in the public sector, including funding for the development and deployment of AI in the fields of health, education, and transportation[550]

8. **Promote interoperability:**

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

[546] https://eufordigital.eu/discover-eu/eu-digital-single-market/
[547] https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence
[548] https://digital-strategy.ec.europa.eu/en/library/proposal-regulation-laying-down-harmonised-rules-artificial-intelligence
[549] https://eufordigital.eu/discover-eu/eu-digital-single-market/
[550] https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence

- Developing a set of guidelines and best practices for interoperability and data sharing in the public sector.
- Encouraging the development of open data and data sharing initiatives between public sector organizations.
- Supporting the development of reusable and interoperable AI components at all operational levels of European public administration.
- Promoting the use of a common European Data Space for public sector bodies and their operators, drawing from the compilation of relevant AI datasets and related Registries throughout Europe.

On-going activities:

The European Commission has recently proposed several policy actions to support interoperability, open data and data sharing, including the European Data Strategy (2020)[551] as well as to strengthen public sector interoperability in general, through the Interoperable Europe Act[552]. They also established several dedicated funding streams for AI in the public sector to support the interoperability and data-sharing initiatives[553]

9. Build trust in AI solutions through transparency and accountability:

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Developing a set of guidelines and best practices for transparency and accountability in the public sector.
- Encouraging the development of transparency and accountability initiatives between public sector organizations.
- Promoting the adoption of ethical principles, the development of guidelines, and the identification of mitigating measures to minimize the risks of deployment of AI by the public sector.
- Harmonizing and complementing EU regulations to promote human-centric and trustworthy AI-enabled public services for all citizens.

On-going activities:

The European Commission has recently proposed several policy actions to support building trust in AI solutions through transparency and accountability, including the Coordinated Plan on Artificial Intelligence (2021)[554]. They also established several dedicated funding streams for AI in the public sector to support transparency and accountability initiatives[555]. The upcoming AI Act will place predictable, proportionate and clear obligations on providers and users of "high-risk" AI systems to ensure the safety and respect of existing legislation protecting fundamental rights throughout the whole AI systems' lifecycle. For some specific AI systems, only minimum transparency obligations are proposed, in particular when chatbots or 'deep fakes' are used.

10. Harmonize EU regulations to promote human-centric and trustworthy AI-enabled public services:

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

[551] https://eufordigital.eu/discover-eu/eu-digital-single-market/
[552] COM(2022) 720 final
[553] https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence
[554] https://digital-strategy.ec.europa.eu/en/library/coordinated-plan-artificial-intelligence-2021-review
[555] https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence

- Developing a set of guidelines and best practices for harmonization of EU regulations in the public sector[556].
- Encouraging the development of harmonization of EU regulations initiatives between public sector organizations.
- Promoting the adoption of ethical principles, the development of guidelines, and the identification of mitigating measures to minimize the risks of deployment of AI by the public sector[557].
- Harmonizing and complementing EU regulations to promote human-centric and trustworthy AI-enabled public services for all citizens[558].
- Creating a European marketplace for GovTech solutions in support of public sector digital transformation.

On-going activities:

The European Commission has recently proposed several policy actions to support harmonizing EU regulations to promote human-centric and trustworthy AI-enabled public services, including the AI Act and the Coordinated Plan on Artificial Intelligence (2021)[559]. They also established several dedicated funding streams for AI in the public sector to support the harmonization of EU regulations initiatives[560]. The upcoming AI Act[561] will address most of the policy actions proposed. It aims for consistency with existing Union legislation applicable to sectors where high-risk AI systems are already used or likely to be used. The Commission is supporting the creation of a GovTech incubator as well as a knowledge platform through the Digital Europe Programme.

11. Focus on long-term implementation in the use of AI in the public sector:

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Developing a set of guidelines and best practices for long-term implementation in the public sector.
- Encouraging the development of long-term implementation initiatives between public sector organizations.
- Creating an EU-wide network of governance bodies for streamlined management of AI in the public sector.

On-going activities:

The European Commission has recently proposed several policy actions to support focusing on long-term implementation in the use of AI in the public sector, including the Coordinated Plan on Artificial Intelligence (2021)[562]. The Commission also established several dedicated funding streams for AI in the public sector to support long-term implementation initiatives[563].

[556] This aspect will be covered by the upcoming AI Act.
[557] This aspect will be covered by the upcoming AI Act.
[558] This aspect will be covered by the upcoming AI Act.
[559] https://digital-strategy.ec.europa.eu/en/library/coordinated-plan-artificial-intelligence-2021-review
[560] https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence
[561] https://digital-strategy.ec.europa.eu/en/library/proposal-regulation-laying-down-harmonised-rules-artificial-intelligence
[562] https://digital-strategy.ec.europa.eu/en/library/coordinated-plan-artificial-intelligence-2021-review
[563] https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence

12. **Develop dedicated AI-enabled solutions based on co-creation approaches:**

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Developing a set of guidelines and best practices for co-creation approaches in the public sector.
- Encouraging the development of co-creation initiatives between public sector organizations and citizens.
- Leveraging civic engagement and participation in the development and deployment of AI.
- Creating an EU-wide network of governance bodies for streamlined management of AI in the public sector.
- Developing and applying umbrella impact assessment frameworks based on key influencing factors to measure the use and impact of AI in the public sector.

On-going activities:

The European Commission has recently proposed several policy actions to support the development of dedicated AI-enabled solutions based on co-creation approaches, including the Coordinated Plan on Artificial Intelligence (2021)[564]. The Commission also established several dedicated funding streams for AI in the public sector to support co-creation initiatives[565].

13. **Create a European marketplace for GovTech solutions in support of public sector digital transformation:**

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Developing a set of guidelines and best practices for GovTech solutions in the public sector.
- Encouraging the development of GovTech initiatives between public sector organizations.
- Promoting the development of multilingual guidelines, criteria, and tools for public procurement of AI solutions in the public sector throughout Europe.
- Creating an EU-wide network of governance bodies for streamlined management of AI in the public sector.
- Developing and applying umbrella impact assessment frameworks based on key influencing factors to measure the use and impact of AI in the public sector.

On-going activities:

The European Commission has recently proposed several policy actions to support creating a European marketplace for GovTech solutions in support of public sector digital transformation, including the Communication on the European Data Strategy (2020)[566]. They also established several dedicated funding streams for AI in the public sector to support the GovTech initiatives[567]. The JRC has also recently published two

[564] https://digital-strategy.ec.europa.eu/en/library/coordinated-plan-artificial-intelligence-2021-review
[565] https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence
[566] https://ec.europa.eu/info/strategy/data-strategy_en
[567] https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence

reports related to GovTech; on scoping GovTech dynamics in the EU and on GovTech practices in the EU.[568]

14. Strengthen the role of the EU Artificial Intelligence Observatory:

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Fostering a pan-European network of AI national observatories.
- Encouraging the sharing of best practices and experiences between different AI observatories.
- Developing a set of guidelines and best practices for the governance of AI.
- Developing an EU-wide network of governance bodies for streamlined management of AI in the public sector.
- Developing and applying umbrella impact assessment frameworks based on key influencing factors to measure the use and impact of AI in the public sector.

On-going activities:

The European Commission has created AI Watch[569], an initiative of the European Commission (EC) jointly developed by the EC Joint Research Centre (JRC) and the Directorate General for Communications Networks, Content and Technology (DG CONNECT). AI Watch monitors industrial, technological and research capacity, policy initiatives in the Member States, uptake and technical developments of Artificial Intelligence and its impact on the economy, society and public services. It provides analyses necessary to monitor and facilitate the implementation of the European Strategy for AI.

15. Promote the development of sustainable AI

Potential policy actions the Commission can take to increase the uptake of AI in the public sector in Europe that are specific to this recommendation include:

- Establishing environmental standards and guidelines for AI development and use.
- Encouraging the use of renewable energy sources.
- Promoting the development of energy-efficient AI technologies.
- Establishing a certification program for sustainable AI.
- Providing education and training on sustainable AI.
- Collaboration with international organizations.

On-going activities in this regard:

European Green Deal[570], launched in December 2019, is a comprehensive plan to make the European Union climate-neutral by 2050. The Green Deal includes measures to promote the use of sustainable AI, such as funding for research and development of energy-efficient AI technologies and support for the use of renewable energy sources. AI4EU[571] is a European Union-funded project aimed at promoting the development and use of AI in Europe. The project includes a focus on sustainable AI and has established

[568] See: https://www.researchgate.net/publication/359001983_Scoping_GovTech_dynamics_in_the_EU and https://op.europa.eu/en/publication-detail/-/publication/b0ce2f17-a021-11ec-83e1-01aa75ed71a1/language-en

[569] https://ai-watch.ec.europa.eu/about_en

[570] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

[571] https://www.ai4europe.eu/

a working group on "AI for Sustainable Development." The European AI Alliance[572] is a forum for stakeholders to discuss and provide input on AI policies and initiatives in Europe. The Alliance has established a working group on "AI and Climate Change," which is focused on promoting the use of AI to address climate change and other environmental challenges.

[572] https://digital-strategy.ec.europa.eu/en/policies/european-ai-alliance

6 Annexes

6.1 Chapter 1 Annex

6.1.1 Methodology

The main subject for the analysis of the scoping report is public procurement, and more specifically the following research questions:

- What are the main gaps and obstacles that hinder public procurement and the uptake of AI?
- What are the benefits and added value that can be generated by a wider uptake and procurement of AI systems in the EU?
- What are the main sectors/areas and AI technologies with high economic potential (e.g. technological readiness, high growth performance) where accelerated public procurement could bring the highest EU-added value?

Based on these research questions, the selection of the sectors will be made.

The following approach was taken to tackle the research questions above and get to the selection of the public sector priority policy areas ready for large-scale deployment of AI technologies:

- <u>State of play focused on public procurement</u>
  Qualitative and quantitative mapping and analysis of national initiatives on AI (e.g. strategies, action plans) and AI projects.

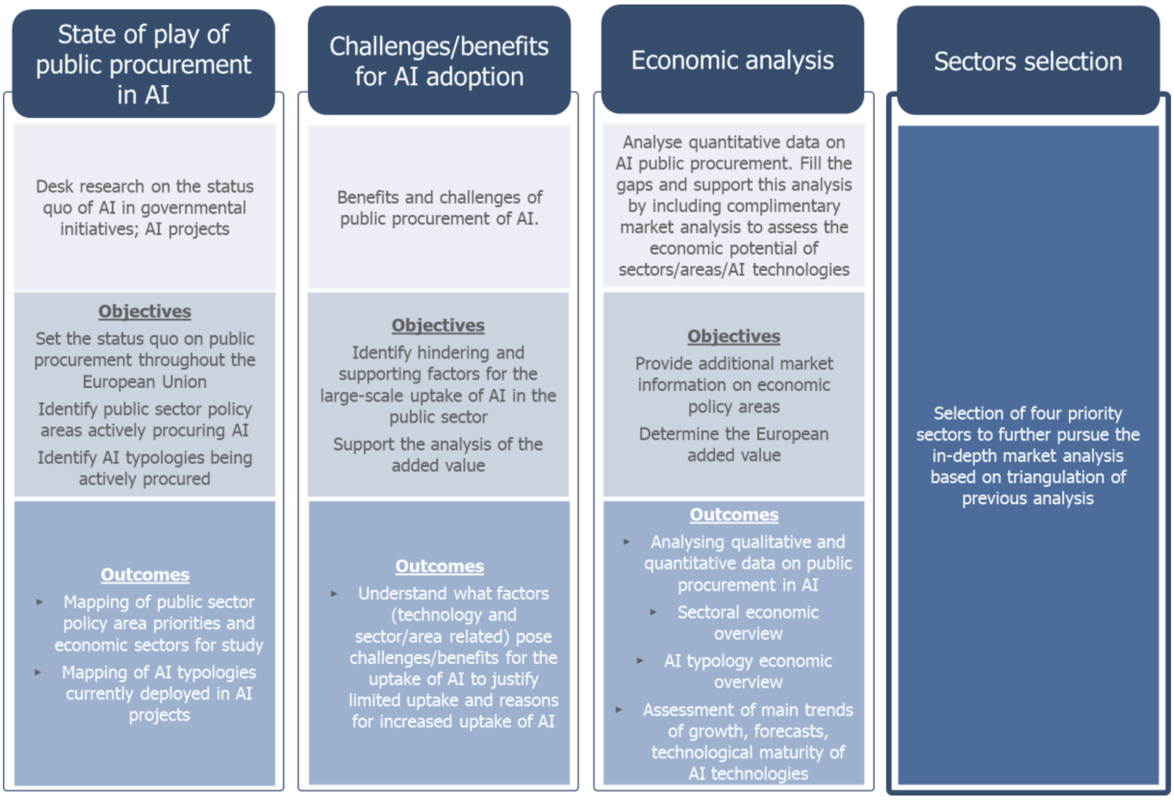
- <u>Challenges and benefits analysis in public procurement</u>
  Analysis and mapping of identified challenges and benefits for the public procurement of AI, complemented by findings of the private sector.

- <u>Economic analysis</u>
  Quantitative mapping of current investments in AI projects and future national projections. Moving beyond public procurement, an analysis of the indicators of innovation in selected economic sectors (based on NACE classification) is complemented by an analysis of market indicators of AI typologies.

- <u>The selection of the public sector policy areas</u>
  Selection of the four priority areas, based on the above steps and triangulation of findings based on the specific criteria of identified trends in governmental initiatives, projects, and the market; maturity of AI technologies; and the economic potential of the sectors that will create European added value for the public procurement of AI.

The figure below visually describes how the analysis performed funnels into the final selection of the (four) public sector policy areas to be the focus of the work for this study.

Figure 71 Task 1 Methodology



Source: Author's elaboration

6.1.2 Public sector areas

As generally recognised, the public sector is defined as consisting "of governments and all publicly controlled or publicly funded agencies, enterprises, and other entities that deliver public programs, goods, or services"[573]. Within this, there are multiple functions that it undertakes by further breaking down into policy areas. These policy areas may be covered by any of the three levels of the public sector within one country: national, regional, and local.

According to the COFOG (Classification Of the Functions Of Government)[574], which is also used by the AI Watch, there are ten categories of governmental expenditure, which are depicted in the figure below. For the goals of this research, this report will rely on the COFOG classification and report on further public sector policy areas that were identified throughout the research that falls under the depicted main categories of COFOG below.

[573] Dube, S. and Danescu, D., Supplemental Guidance, 2011. Public Sector Definition. URL: www.globaliia.org/standards-guidance

[574] The COFOG (Classification Of the Functions Of Government) is an international classification which breaks down data on general government expenditure from the System of National Accounts according to the different purposes or functions in which the funds are used. More information: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Classification_of_the_functions_of_government_(COFOG)

Figure 72 Public sector policy areas

Defense	Economic affairs	Education	Environmental protection	General public services
Health	Housing and community amenities	Public order and safety	Recreation, culture, and worship	Social protection

Source: Authors' elaboration based on COFOG.

To further break down the COFOG categorisation, according to the official definitions and research in the national political initiatives on AI and the AI projects, further sub-categories to the COFOG classification were identified, as shown in Figure 73 below.

Figure 73 Full overview of public sector policy areas

Defence
- Military defence
- Civil defence
- *Cybersecurity

Health
- Public health services
- Medial products, appliances, and equipment
- *Social work activities

Economic affairs
- General economic, commercial, and labour affairs
- Agriculture, forestry, fishing
- Fuel and energy
- Mining, manufacturing, and construction
- Transport
- Other industries (e.g. *ICT)

Housing and community amenities
- Housing development
- Community development
- Water supply

Education
- Education definable and non-definable by level
- *Research

Public order and safety
- Police services
- Law courts

Environmental protection
- Waste management
- Pollution abatement
- Protection of biodiversity and landscape
- *Sustainability

Recreation, culture, and worship
- Recreational and sporting services
- Cultural services
- Broadcasting and publishing services
- *Tourism

General public services
- Executive and legislative organs
- Financial and fiscal affairs
- General (public) services
- Justice and judicial activities

Social protection
- Sickness and disability
- Old age
- Unemployment

*Source: Authors' elaboration. Note: *Sub-category added by authors based on research findings.*

6.1.3 Mapping of public sector areas versus economic sectors

The overview of national government initiatives and AI projects relies on the COFOG (and its expanded) classification of public sector policy areas. As the economic analysis will turn towards market-related developments and statistics, that section of the research will base itself on economic sectors, as prescribed by the European statistical classification of economic activities, NACE codes[575].

Looking at the public sector policy areas as classified by COFOG, mapping was carried out against the NACE classification to determine the most relevant correspondences. Based on the mapping, the following selection of economic areas will be studied, as illustrated in the figure below.

Figure 74 Mapping of public sector areas vis-à-vis NACE codes

Defence
- Military defence
- Civil defence
- *Cybersecurity

Health
- **Public health services (NACE Q)**
- Medial products, appliances, and equipment
- ***Social work activities (NACE Q)**

Economic affairs
- **General economic, commercial, and labour affairs (NACE M, N)**
- **Agriculture, forestry, fishing (NACE A)**
- Fuel and energy
- **Mining (NACE B)**, **manufacturing (NACE C)**, and **construction (NACE F)**
- **Transport (NACE H)**
- Other industries (e.g. ***ICT (NACE J)**)

Housing and community amenities
- Housing development
- Community development
- **Water supply (NACE E)**

Education
- **Education definable and non-definable by level (NACE P)**
- *Research

Public order and safety
- **Police services (NACE O)**
- Law courts

Environmental protection
- **Waste management (NACE E)**
- Pollution abatement
- **Protection of biodiversity and landscape (NACE N)**
- *Sustainability

Recreation, culture, and worship
- **Recreational and sporting services (NACE R)**
- **Cultural services (NACE R)**
- **Broadcasting and publishing services (NACE M)**
- *Tourism

General public services
- Executive and legislative organs
- **Financial and fiscal affairs (NACE K)**
- **General (public) services (NACE O)**
- **Justice and judicial activities (NACE O)**

Social protection
- **Sickness and disability (NACE Q)**
- **Old age (NACE Q)**
- Unemployment

Source: Authors' elaboration.

*Note: * Sub-category added by authors based on research findings.*

The NACE economic activities that are not represented and thus will not be studied for this research are Electricity, gas, steam and air conditioning supply (NACE D);

575 https://nacev2.com/en

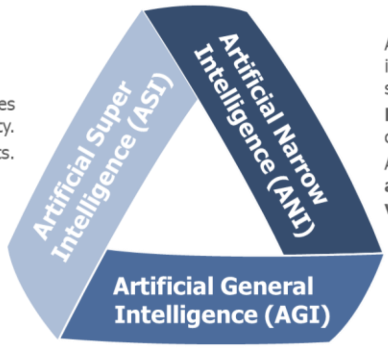
Wholesale and retail trade, repair of motor vehicles and motorcycles (NACE G); Accommodation and food services activities (NACE I); and Real estate activities (NACE L). Furthermore, the defence does not form part of the Coordinated Plan on Artificial Intelligence, for which reason it will not be considered for this study.

6.1.4 AI technologies

Throughout the literature, there are multiple ways of categorising AI as a technology into different types or typologies.

The system of classification that is more generally used in tech parlance is the classification of the technology into Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), and Artificial Superintelligence (ASI).[576] Another alternative is to classify AI according to its ability to 'think' by itself: reactive machines, limited memory machines, theory of mind, and self-aware AI.[577] Furthermore, AI can also be classified according to the main purpose behind the technology: analytic, functional, interactive, text, and visual.[578] These classifications are combined and summarised in Figure 75.

Figure 75 AI general classification



Source: Author's elaboration based on Medium, Forbes, and Science Soft.

Finally, the researchers at AI Watch[579] have created a detailed overview of AI typologies and their purpose in public services, depicted and defined in the figure below. The AI technologies (typologies) that will be used for this scoping report are based on the AI Watch classification.

[576] https://medium.com/mapping-out-2050/distinguishing-between-narrow-ai-general-ai-and-super-ai-a4bc44172e22

[577] https://www.forbes.com/sites/cognitiveworld/2019/06/19/7-types-of-artificial-intelligence/?sh=2305ba1233ee

[578] https://www.scnsoft.com/blog/artificial-intelligence-types

[579] European Commission. 2020. AI Watch Artificial Intelligence in public services – Overview of the use and impact of AI in public services in the EU. URL: https://publications.jrc.ec.europa.eu/repository/handle/JRC120399

Figure 76 AI Watch AI typologies

- **Audio Processing:** These AI applications are capable of detecting and recognizing sound, music and other audio inputs, including speech, thus enabling the recognition of voices and transcription of spoken words.
- **Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems:** This AI typology includes virtualised assistants or online 'bots' currently used in CRM environments, both in the private and the public sectors, not only to provide generic advice but also behaviour related recommendations to users.
- **Cognitive Robotics, Process Automation and Connected and Automated Vehicles:** The common trait of these AI technologies is process automation, which can be achieved through robotized hardware (such as prostatic limbs or precision surgery equipment) or software (either following rule-based, machine-learning or mixed approaches). We have also included here the use of unmanned vehicles to deliver services (e.g. for independent mobility of disabled people).
- **Computer Vision and Identity Recognition:** AI applications from this category use some form of image, video or facial recognition to gain information on the external environment and/or the identity of specific persons or objects.
- **Expert and Rule based Systems, Algorithmic Decision Making:** The reason why these apparently distant AI developments are joined into a single application is their prevalent orientation to facilitate or fully automate decision making processes of potential relevance not only to the private but also to the public sector.
- **AI-empowered Knowledge Management:** The common element here is the underlying capacity of embedded AI to create a searchable collection of case descriptions, texts and other insights to be shared with experts for further analysis.
- **Machine Learning, Deep Learning:** While almost all the other categories of AI use some form of Machine Learning, this residual category refers to AI solutions which are not suitable for the other classifications.
- **Natural Language Processing, Text Mining and Speech Analytics:** These AI applications are capable of recognising and analysing speech, written text and communicate back.
- **Predictive Analytics, Simulation and Data Visualisation:** These AI solutions learn from large datasets to identify patterns in the data that are consequently used to visualise, simulate or predict new configurations.
- **Security Analytics and Threat Intelligence:** These refer to AI systems which are tasked with analysing and monitoring security information and to prevent or detect malicious activities.

Source: European Commission. 2020. AI Watch Artificial Intelligence in public services – Overview of the use and impact of AI in public services in the EU.

The studied AI projects are mapped according to these typologies, and further detailed or added on when relevant, to be explored in the section on the Overview of AI projects in the public sector. These AI typologies will serve as a basis to carry out the market analysis of these existing AI solutions' maturity levels. Throughout the economic analysis, indicators analysed will not always adopt the AI watch classification, hence, the analysis will make conclusions based on the closest fit with the AI watch classification.

6.1.5 List of initiatives

Country	Title (Hyperlinked)	Year
Austria	32nd Amendment to the Austria Motor Vehicles Act	2016
Austria	Automated Driving Regulation	2019
Austria	Code of Practice: Automated	2018

Country	Title (Hyperlinked)	Year
Austria	Digital Roadmap Austria	2017
Austria	Artificial Intelligence Mission Austria 2030	2019
Belgium	Autonomous vehicles - code of practice for testing in Belgium	2016
Belgium	AI 4 Belgium	2019
Belgium	Plan next tech Brussels	2017-2020
Belgium	Regional Innovation Plan	2016-2020
Belgium	Action Plan AI (Flanders)	2019-2024
Belgium	DIGITALWALLONIA4AI	2019
Bulgaria	Concept for the development of AI in Bulgaria until 2030	2020
Croatia	National Plan for the Development of Artificial Intelligence (not yet published)	N/A
Cyprus	National Artificial Intelligence (AI) Strategy: Key action for promoting the integration and development of AI in Cyprus	2019
Czechia	Digital Czech Republic	2018
Czechia	Digital Education Strategy to 2020	2014-2020
Czechia	Innovation Strategy	2019-2030
Czechia	Artificial Intelligence Strategy	2019-2035
Czechia	National Strategy of Open Access to Scientific Information and Data	2017-2020
Denmark	Law on the disclosure of Data Ethics Policy	2020
Denmark	National Strategy for Artificial Intelligence	2019-2022
Denmark, Estonia, Finland, the Faroe Islands, Iceland, Latvia, Lithuania, Norway, Sweden, and the Ãland Islands	Declaration on AI in the Nordic-Baltic Region	2018
Estonia	Bürokratt	2020
Estonia	National Artificial Intelligence Strategy	2019-2021

Country	Title (Hyperlinked)	Year
Finland	Leading the way into the age of Artificial Intelligence	2019-2025
Finland	National Regulation on automated decision-making	2020
Finland	Artificial Intelligence 4.0	2020
France	National Strategy on Artificial Intelligence	2018-2022
France	Addressing human rights concerns arising from facial recognition technology	2019
France	Digital Republic Bill	2016
France	Law on mobility orientation	2019
Germany	Artificial Intelligence Strategy	2018
Germany	Action Plan for Digitalisation and AI in Mobility	2018
Germany	Automated Vehicles Bill in the Road Traffic Act	2017
Germany	Ethical Guidelines for Self-driving Cars	2016
Greece	National Strategy on AI	2020
Hungary	Artificial Intelligence Strategy	2020-2030
Ireland	Data Sharing and Governance Act	2019
Ireland	National Artificial Intelligence Strategy	2021
Italy	National Artificial Intelligence Strategy	2019
Italy	Proposals and Report for an Italian Strategy on AI	2018
Latvia	National AI Strategy	2020
Lithuania	Law on Road Traffic Safety (self-driving cars)	2017
Lithuania	Artificial Intelligence Strategy: A vision of the future	2019
Lithuania	LT.AI - Fostering AI and the creation of Lithuanian language technological resources for AI	2020-2021
Luxembourg	Artificial Intelligence: A strategic vision for Luxembourg	2019
Luxembourg	Digital Luxembourg	2014
Malta	National AI Strategy	2019
Malta	Towards Trustworthy AI: Malta's ethical AI framework	2019
Netherlands	Strategic action plan on Artificial Intelligence	2019
Netherlands	Dutch Digitalisation Strategy (DDS)	2021

Country	Title (Hyperlinked)	Year
Netherlands	Experimental law on self-driving vehicles	2019
Netherlands	Non-discrimination by design	2021
Poland	Artificial Intelligence Development Policy in Poland	2020-2030
Poland	National AI Strategy	2020
Portugal	Advanced Computing Portugal 2030	2019-2030
Portugal	National Strategy for Artificial Intelligence - AI Portugal 2030	2019-2030
Romania	National AI Strategy (not yet published)	N/A
Slovakia	Action Plan for Digital Transformation	2019-2022
Slovenia	National Programme on AI	2019-2025
Spain	National AI Strategy	2020
Spain	Spanish RDI Strategy in Artificial Intelligence	2019
Spain	Digital Rights Charter	2021
Spain	National Plan for the Advancement of Language Technologies	2016-2020
Spain	Notice 15/V - 113 (Authorisation to test automated driving systems)	2015
Spain	Notice 16 TV/89 (Automatic parking systems)	2016
Spain	Plan for the Digitalisation of Public Administration	2021-2025
Spain	Recovery, Transformation and Resilience Plan	2021
Spain	Spanish Strategy for Science, Technology, and Innovation	2021-2027
Spain	Strategy for Connected Industry 4.0	2015
Sweden	National Approach to Artificial Intelligence	2018
Sweden	AI Agenda for Sweden	2019

6.1.6 List of projects

Country	Title (hyperlinked)	Year
Austria	Mona - Public chatbot on relevant questions for companies on the subject of the corona crisis and the economy	2020

Country	Title (hyperlinked)	Year
Austria	ELAK - Electronic file	In development (AI aspect)
Austria; Germany; France; Spain; Turkey	IMAGINE	2017-2021
Austria; Switzerland	Automated damage detection for different road surfaces using deep learning techniques (DACH cooperation) - ASFALT	2018-2021
Belgium	Camera System - Mobile phone usage on vehicles	2021
Belgium	ILVO - AI4Agriculture	2020
Belgium	Jobnet - Reskilling, upskilling and retraining people	2018
Belgium	Verontrustingen - Enabling accurate predictions to detect day-care services which require further inspection	2014
Belgium	Walloon - Agricultural subsidy monitoring with the use of GeoAI	2020
Belgium	AcPaas - Technical procurement documents comparison	2017
Belgium	CitizenLab - Citizen participation platform	2019
Belgium	Flemish Infoline - Automatic classification of incoming phone calls	2021
Belgium	VDAB - Chatbot for job seekers	2018
Bulgaria	Plovdiv - City Concierge Chatbot	2018
Croatia	Andrija - Virtual assistant supporting and advising suspected COVID-19 infections	2020-2021 (over)
Croatia	Hope - Chatbot informing work of the Civil Protection Staff	2020
Cyprus	WaterAnalytics - Water quality monitoring	2018-2020
Denmark	Corti's AI - Emergency medical services real-time speech analysis for cardiac predictions	2018
Denmark	CHAIN - Smart Water optimising energy consumption	2020

Country	Title (hyperlinked)	Year
Denmark	Erhvervsstyrelsen - Detection of errors in business statements	2019
Denmark	Kiri - a chatbot for citizens' enquiries	2019
Denmark	Sprogteknologi (Language technology)	2020
Estonia	Datel - Speed cameras for detecting speeding violations	2010
Estonia	Traffic load - Machine vision for collecting information on traffic load	2018
Estonia	OTT - Predicting employment pathways	2019
Estonia	SATIKAS - Detecting the agricultural grasslands changes	2019
Estonia	X-Road AI - Detect anomalies and incidents in Data Exchange Layer	2020
Estonia	Monitoring and species identification using images and artificial intelligence	2021
Estonia	Remote monitoring of forest resources	2020
Estonia	Ice map based on satellite data	2021
Estonia	e-Residency - Chatbot for customer assistance	2018
Estonia	Hans - A system for preparing verbatim reports	2020
Estonia	Iti - Chatbot for Statistics Estonia	2020
Estonia	Riigikogu - Language speech synthesiser for the Estonian Parliament	2020
Estonia	SUVE - Chatbot for questions about emergency situations	Unknown
Estonia	Texta Toolkit - Identifying documents published without authorisation	2019-2022
European Union (JRC)	Digitranscope	2018-2020

Country	Title (hyperlinked)	Year
Finland	Case Fiva (RPA) - Support the Financial Supervisory Authority	2018
Finland	Helsinki HUH - Intensive care for a premature baby	2017
Finland	AuroraAI - Programme with many AI examples	2019-2023
Finland	Kamu - Chatbot about immigration processes	2017
Finland	OuloBot - Virtual assistant for business	2020
Finland	PatRek - Chatbot for business	2019
Finland	VeroBot - Chatbot for citizens about tax management	2019
Finland	Parking chatbot	Unknown
Finland	Oodi's book recommendation service	Unknown
Finland	Intelligent material management system	2019
Finland	Health centre chatbot	Unknown
Finland	Maternity clinic chatbot NeRo	Unknown
Finland; Estonia; Greece; Portugal; Netherlands; Norway	FABULOS	2018-2021
Finland; France; Denmark; Estonia; Norway; Germany	AI4Cities	2020-2022
France	Datakalab - Covid-19 Mask wearing detection In some French cities	2020-2021 (over)
France	French Fraud - Fraud detection value declarations	2017
France	Datajust - AI in judicial decisions	2020
France	SignauxFaibles - Predictive analysis of business difficulties	2020
France	Aria - Chatbot answering retired people	2018

Country	Title (hyperlinked)	Year
France	ClaudIA - Chatbot for the invoicing portal for purchases by public authorities	2017
France	IAlim - Targeting restaurant health inspections	2019
France	RenoiRH - Chatbot in HR management rules to facilitate access	2020
France	LaBonneBoite - Identification of companies with a high probability of hiring	2016
Germany	MARS	2016
Germany	Germany's Federal Office for Migrants and Refugees - Refugee Language Detection	2017
Germany	Against pornography - Analysis of suspicious material	2019
Germany	ARC-D - Automatic Road Condition Detection	2019-2020
Germany	C-19 - Interdepartmental chatbot on the topic of Corona	2020
Germany	Child benefit - Voice assistant for parents' support	2020-2021
Germany	Notification procedure - Automatic control of accidents occurring at the workplace	2019
Germany	Study certificates - Automatic recognition for applying for child benefit	2018
Germany	Govbot - Administrative search engine for citizens' enquiries	2012
Germany	AI - supported data analysis and simulation of the rescue service - AI-Rescue	2021
Germany	Weather-independent and highly automated ridesharing service in Kelheim - KelRide	2021-2023
Germany	Adaptive maps and AI-based infrastructure monitoring - AK-KII	2021
Germany	AI-based cross-type mobility optimization in non-urban regions - KIMoNo	2020-2022
Germany	Artificial intelligence in Ingolstadt's traffic system - KIVI	2020-2023
Germany	Improved quality of rail traffic through intelligent, data-based damage pattern detection on rail vehicles - QUISS	2018-2021

Country	Title (hyperlinked)	Year
Germany	Mobility digital High Franconia - MobiDig	2017-2020
Germany	Fleet Weather Map - FloWKar	2017-2021
Germany	Holistic network approach to identify systemic obstacles and coordination potential in mobility planning - GaNEsHA	2017-2020
Germany	Applications of V2X technology in rail traffic - Rail2X Smart Services	2017-2020
Germany	Dynamic transport optimization through anticipation and real-time data analysis - TransData	2017-2020
Germany	ally Mobility Analytics Platform - allyMAP	2017-2019
Germany	Data analytics and artificial intelligence for safe and reliable mobility - DAYSTREAM	2017-2020
Germany	Intelligent pump station and lock control in the port - Tide2Use	2018-2021
Germany	Proactive video-based use of telecommunications technologies in innovative highway scenarios - Providentia	2016-2019
Germany	Prediction of image sequences from FAS video sequences - FAS-VidGen	2017-2020
Germany	Satellite-based system for displaying, forecasting and simulating air pollutants for sustainable urban and regional development - SAUBER	2018-2021
Germany	Intelligent information technologies for process optimization and automation in inland ports - Binntelligent	2018-2021
Germany	Port operation optimization through predictive embedded condition monitoring of the track infrastructure - HavenZuG	2018-2021
Germany	Interactive robotic system for emptying sea containers - Iris	2017-2020
Germany	Innovative fields of application for Augmented Reality (AR) in inland and seaports - InnoPortAR	2018-2021
Germany	Hybrid 3D as-built data acquisition and model-based inspection of waterway structures for sustainable infrastructure lifecycle management - 3D HydroMapper	2018-2021
Germany	Autonomous machines in road construction 4.0 - ROBOT road construction 4.0	2017-2020

Country	Title (hyperlinked)	Year
Germany	Optimization of utilization in long-distance truck traffic through the use of artificial neural networks - Cargonexx	2018
Germany	Techniques for Interactive Nautical AIS Data Analysis - TINA	2018-2019
Germany	The digital construction assistant of the future - DeepSpaceBIM	2018-2021
Germany	Acquisition system for high-precision and up-to-date maps in buildings, data processing for accessibility and BIM integration - indoorRobot	2018-2020
Germany	Open Data Crowd Sensing Service for the easy fusion of annotated and swarm-based mass data - OCROSS	2018-2021
Germany; Netherlands; United Kingdom; France; Spain; Czechia; United States; Belgium; Italy; Portugal	Solve-RD	2018-2022
Greece, Belgium, Germany, Portugal, Sweden and United Kingdom	i-Prognosis	2016-2020
Greece; Belgium; Italy; United Kingdom; Romania; Netherlands; Malta; Switzerland; France; Germany; Austria; Ireland; Portugal; Denmark; Bulgaria	AI4Media	2020-2024
Greece; Germany; Spain; United Kingdom; United States	iASIS	2017-2020
Greece; Sweden;	BigO	2016-2021

Country	Title (hyperlinked)	Year
Netherlands; Ireland; Spain		
Hungary	TÉBA - Decision on the Maternity Benefit following the family support scheme of the Hungarian State Treasury	2010-2013
Hungary	Home Quarantine App - Supporting the use of electronic control for home quarantine	2020
Hungary	Véda - System Operated by the Police for Traffic Safety Automated Processing	2018
Ireland	VDA - Voicebot on calls from Irish taxpayers on tax clearance	2018
Ireland	Area Monitoring System (AMS)	2021
Ireland	The Dublin Beat - Citizen opinion analysis	2020
Ireland	SynchroniCity initiative (Dublin)	2019
Ireland; Spain; France; Italy; Germany; Poland; Greece; Finland; Cyprus; Luxembourg; Netherlands; Serbia; Austria; United Kingdom; Belgium; Denmark	Cybele	2019-2022
Italy	R1 - humanoid robot	2016
Italy	Toscana Open Research - Allows users to access information through "queries" without having to know the technical terms	2017
Italy	Noovle - Management of health documentation	2018
Italy	Borbot - Virtual assistant for museums	2017
Italy	Pierino - PIatform for the extraction and retrieval of online information	2016

Country	Title (hyperlinked)	Year
Italy	TALIA SF - Extract and organize knowledge coming from the analysis of a huge quantity of textual documents	2017
Italy, Belgium, Greece, Ireland, Spain	FANDANGO	2018-2021
Italy; Belgium; Germany; Luxembourg	Pantheon - Precision Farming of Hazelnut Orchards	2017-2021
Italy; Belgium; Poland; Germany; Spain; Switzerland; Sweden	Exscalate4Cov	2020-2021
Italy; Belgium; Slovenia; Italy; Iceland	Cyberlegs++	2017-2021
Italy; Denmark; Norway; Greece; Belgium; Sweden; France; Austria	CERTH-MUKA - Public Organizations Multi-factor Misinformation Handling (ETAPAS)	2020-2023
Italy; Spain; United Kingdom	SIMPATICO	2016-2019
Italy; Spain; United Kingdom; Portugal; Sweden; Germany	Nevermind	2016-2020
Latvia	FITS ITEMS - Road safety	2018
Latvia	Automatic decision-making of the Electronic Declaration System of the State Revenue Service	2019
Latvia	Hugo.lv - Virtual Assistant for governments	2018
Latvia	Tom - Chatbot facilitating customer communication with the State Revenue Service	2020
Latvia	UNA - Chatbot regarding the process of enterprise registration	2018
Latvia	VARIS - Reviews all the applicants to Rural Support Service	2018

Country	Title (hyperlinked)	Year
Lithuania	viLTe' - Chatbot answering relevant questions regarding the COVID-19	2020
Netherlands	Amsterdam - Holiday rental home fraud	2021-2022
Netherlands	ANPR - Car plate recognition	2021
Netherlands	Cameras - Detection holding a phone in a car	2020
Netherlands	Rotterdam – Improving the usage of rooftops	2017
Netherlands	CAS - Crime anticipation system	2013 (over)
Netherlands	RWS - Machine learning for road accident predictions	2017
Netherlands	SyRi - Detect welfare fraud	2014-2019 (over)
Netherlands	Xomnia - The Burglary Predictor	Unknown
Netherlands	Xomnia - Law enforcement optimization system	Unknown
Netherlands	Amberscript - Automated speech translation for public organisations	2019
Netherlands	SIA - Notifications of public space	2019
Netherlands	Automated parking control	Unknown
Netherlands; Italy; Iceland; Australia	MyLeg	2018-2022
Netherlands; United Kingdom; Sweden; Germany; Italy; Estonia	TECHNEQUALITY	2019-2021
Norway; United Kingdom; France; Denmark; Netherlands	SelfBACK	2016-2021
Poland	Construction of a central system of automatic road traffic supervision	2011-2015
Poland	Home Quarantine - app on COVID-19 risk	2020

Country	**Title (hyperlinked)**	**Year**
Poland	Poland - Fraud Detection COVID-19 support	2020
Portugal	IPOscore - Predicting complications of surgery and prognosis of cancer patients	2018
Portugal	CCM-SNS - Verification of medical prescriptions	2016
Portugal	Derm.AI - Tele Dermatological Screening	2019-2021
Portugal	Failstopper - Study the compressed air system of the vehicle	2018-2021
Portugal	EPISA - Entity and property inference for semantic archives	2019
Portugal	Sigma - Chatbot on changing citizens' address	2019
Portugal	Data2Help - Optimizing the allocation of resources for a better and faster response to medical emergencies	2019
Romania	Bucharest airport - Face recognition	2019
Romania	Antonia - Automatic processing of requests for public services	2018
Slovakia	PCA - AI algorithms in audit methodology detecting potential fraud when prescribing medicines	2019
Slovakia	OverSi - Chatbot to faster bureaucracy	2018
Slovakia	Taxana - Chatbot for financial administration	2019
Slovenia	Semantic analyser - Document analyser for the public administration	2019
Slovenia, Germany, Italy	RECONCYCLE	2020-2024
Spain	Fuengirola Town Hall - measuring beach attendance	2020
Spain	Mercé - citizen science for better urban life	2020
Spain	VeriPol - Detect false police reports	2018
Spain	VioGen - Forecast gender violence	2007
Spain	Chatbot - Boost relations with citizens	2018
Spain	Misty II - Robot for elderly people	2020

Country	Title (hyperlinked)	Year
Spain, France, Ireland, Germany, Netherlands, United Kingdom	VI-DAS	2016-2019
Spain, Greece, Poland, France, Romania, Germany, Lithuania	FCIS - Machine learning to identify suspicious patterns (trade, financial flows)	2019-2021
Spain; France; Germany; Italy; United Kingdom; Austria; Belgium; Poland	PRIMAGE	2018-2022
Spain; Italy; Germany; United Kingdom; Switzerland; Portugal	BETTER	2017-2021
Spain; Netherlands; Romania; Greece; France; Germany; Italy; Sweden; Switzerland	Deep Health	2019-2022
Spain; Switzerland; France; Czechia; Netherlands; Greece; Norway	PILOTING	2020-2023
Sweden	Tengai - Robot in recruitment processes	2019
Sweden	Scapis - Prevention of heart- and lung diseases	2021
Sweden	SKOSA - Interpreting medical information	2019
Sweden	Stockholm3 - Diagnosing prostate cancer	2019
Sweden	AIDA - Interpreting detailed plan provisions	2021
Sweden	Skatti - Answering system about population registration and income tax return	2022
Sweden	Swedish Land Registry (SLR) - Fostering efficiency when dealing with land registry requests	2019

Country	Title (hyperlinked)	Year
Sweden; Germany; Austria; United Kingdom	SmokeBOT	2015-2018

6.2 Chapter 2 Annex

6.2.1 Definitions

A clear definition of the core concepts is paramount for this chapter to ensure coherence and clear demarcation between the sectors. For example, the first analysis of the "e-government" sector needs to be well-defined to avoid overlap with the other three sectors of mobility, health and education.

Figure 77 The 4 sectors studied in the chapter

General public services	Mobility	Health	Education
• Executive and legislative organs, financial and fiscal affairs, external affairs; foreign economic aid; general services; basic research; R&D related to general public services; general public services n.e.c.; public debt transactions, transfers of a general character between different levels of government.	• (Level 2 - part of economic affairs)	• Medical products, appliances and equipment; outpatient services; hospital services; public health services; R&D related to health; health n.e.c.	• Pre-primary, primary, secondary and tertiary education, post-secondary non-tertiary education, education non definable by level, subsidiary services to education, R&D; n.e.c.

Source: COFOG

Public sector

The chapter uses Dube and Danescu´s definition of the public sector as "governments and all publicly controlled or publicly funded agencies, enterprises and other entities that deliver public programmes, good or services"[580]. This definition caters for the significant diversity of public bodies involved with the introduction and development of AI in a particular sector. In terms of the sectors themselves, the COFOG (both levels I and II) serve as a useful starting point for deciding the limits of the sectors. For example, the first section on "e-government" uses the narrower COFOG classification of "general public services" to define its scope more. The sectors on "health" and "education" also have their COFOG level I classification while "transport" has a level II classification falling within the scope of the "economic activity" level I classification.

Nevertheless, there are inevitably areas of sectoral overlap which need to be addressed. For example, the category of "research", is an activity carried out in each of the 4 sectors yet this is categorized in the "education" COFOG level I. A similar problem arises with data infrastructure and data spaces, an essential base for AI development which could fall into multiple categories. As a general rule, the chapter´s approach places initiatives into the sector that is explicitly stated (eg. a healthcare-specific chatbot or a mobility data space). If the policy is more general, it falls within the remit of "e-government" and general public services in the first section.

Procurement

Increasing public procurement of AI and accelerating uptake is important for the EU to reach its AI policy goals. This process, whereby public authorities purchase work, goods or services from companies[581], has long been seen as a key lever for enacting systemic change in specific sectors and the wider economy. Accounting for €2 trillion

[580]Dube, S. and Danescu, D., Supplemental Guidance, 2011. Public Sector Definition. URL: www.globaliia.org/standards-guidance

581 https://ec.europa.eu/growth/single-market/public-procurement_en

of the EU´s annual spending (14% of total GDP)[582], public procurement is rightly considered one of the public sector´s principal tools in achieving its policy ends. Moreover, procurement from central, regional and local governments can have myriad social, political and environmental benefits beyond the initial payment for goods or services.

More specifically to this chapter, AI is both something that is procured by a government, usually a technological solution and a tool for improving the procurement process itself through deploying it in areas such as strategic sourcing, contract management and predictive analytics[583]. This chapter focuses on both of these faces of AI and procurement. However, the paucity of publicly available information and the complexity of the technology means that cases of simple traditional procurement as defined above are uncommon. Subsequently, the emphasis of the report will be on the **use** of the technology, its value chain and the policy architecture behind it.

A typology of Public Sector AI Policy

A useful starting point when thinking about the public sector and AI is to ascertain the principal forms of policy instruments used throughout the EU. Past research and databases on the subject have categorized public policy in distinct yet complementary ways (as seen in figure 4). These typologies, when combined into a single list, provide a helpful lens through which to measure the progress of different member states with AI and identify the main policy trends. These categories are also used in the economic analyses in each section.

As of late 2022, almost every EU member state has published a National AI Strategy and, in the process, signalled significant intent when it comes to AI adoption. Indeed, amongst the literature, there is a relative consensus that, with EU-level backing, Europe as a whole is moving into a new stage of macro-AI policy[584] where the public sector is an increasingly central actor.

Sources such as the **OECD´s AI Observatory** and European Commission **AI Watch´s** National Strategy Reports highlight different policy types in use such as regulation, governance financial support, infrastructure etc. Alternatively, others such as AI Watch´s report on the public sector by **Misuraca** and **Van Noordt[585]** and its **3rd Peer learning workshop[586]** describe the public sector´s relationship with AI as more of a progression or trajectory. The latter starts with regulating and facilitating AI Innovation followed by using the technology and finally developing it themselves. Of course, good regulation is a constant process that needs to be updated to remain relevant, especially with such a fast-moving technology. Leading countries in AI will have a repertoire containing each type of policy however using and developing the technology should be seen as the normative policy goal for the public sector.

[582] https://ec.europa.eu/growth/single-market/public-procurement_en

[583]https://sievo.com/resources/ai-in-procurement#:~:text=the%20full%20experience.-,Use%20of%20AI%20in%20procurement,contract%20management%20and%20strategic%20sourcing.

[584] Misuraca, G. and Van Noordt, C., AI Watch - Artificial Intelligence in public services, EUR 30255 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-19540-5 (online), doi:10.2760/039619 (online), JRC120399

[585] Misuraca, G. and Van Noordt, C., AI Watch - Artificial Intelligence in public services, EUR 30255 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-19540-5 (online), doi:10.2760/039619 (online), JRC120399

586 van Noordt, C., Alishani, A., Tangi, L., Gattwinkel, D. and Pignatelli, F., AI Watch. Artificial Intelligence for the public sector. Report of the “3rd Peer Learning Workshop on the use and impact of AI in public services”, 24 June 2021, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-41530-5, doi:10.2760/162795, JRC126501.

In addition to a member state in its entirety, this typology can be also used to assess the role of the public sector as it relates to individual policies. This report A) identifies the role of the public entity within each AI policy during the initial policy mapping and B) Gives countries a category based on the sum of these policies which is used in the economic analysis. The report relies on the following categories which are a blend of the typologies in figure 4. Below is the list of five modes of government action as they relate to AI policy.

Planning

The likely first stage in a government´s AI journey will be as a ***planner*** for subsequent other actions. In terms of policies, these could be national strategies, agendas, plans[587] or white papers. Finally, in the economic models, this category is used for countries which have not yet passed any concrete AI policy in that sector.

Regulating

If the policy is a form of guidance and regulation then the government´s role is deemed to be a ***regulator.*** These actions could include regulatory oversight and ethical advice bodies or standards and certification[588].

Facilitating

The ***facilitator*** category denotes a policy in the area of infrastructure or networking. Also, as a form of AI Enabler (OECD), actions such as building and maintaining dataspaces and conducting public awareness campaigns on AI fall into this category.

Funding

A distinct and more direct form of public investment is the category of **a *funder*.** Any policy in the OECD´s "financial support" or AI Watch´s "from the lab to market" sections fall into this section. In terms of specific instruments, this includes "grants for public research", "business R&D and innovation" and "procurement programmes for R&D and innovation" mentioned above.

Using

The final category, ***User***, is used in cases where public bodies are using AI technology themselves. These may have been developed themselves or procured from the private sector.

[587] https://oecd.ai/en/dashboards
[588] https://oecd.ai/en/dashboards

Table 14 Typologies of AI public sector activity from the literature

Source	**AI Watch: AI in public services (Misuraca and Van Noordt)**	**AI Watch´s 3rd Peer learning workshop**	**OECD´s AI Policy Observatory**	**AI-Watch National Strategies Report**
Categories of Public Sector Policy	Regulator Facilitator User Developer	Data-focused approach Private sector leadership AI4GOV front-runner	Guidance and Regulation Governance Financial support AI Enablers and other support	Regulation Infrastructure Networking Human Capital From the lab to the market

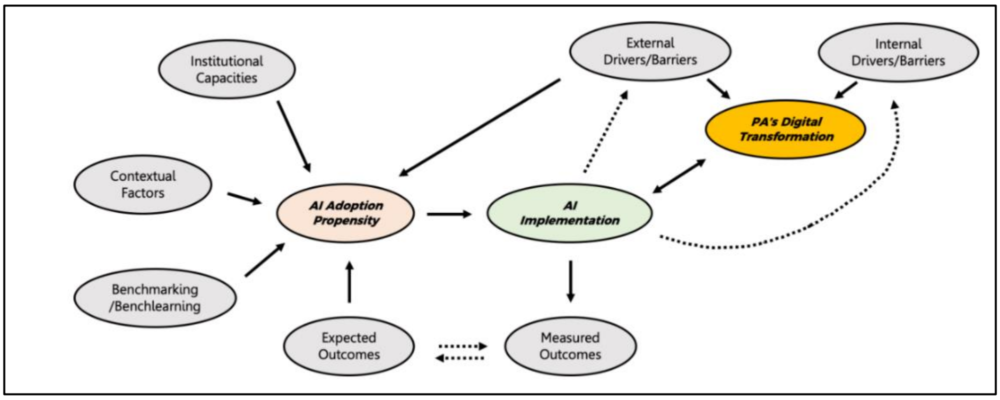
Source: Authors' elaboration.

6.2.2 Methodology

This chapter deploys a mixed-methods research design to fully investigate the four sectors in question. With the synergistic value of using multiple methods, each subsection will address a different aspect of the research question(s) to produce a holistic and triangulated analysis of AI adoption and uptake.

The approach draws an AI Watch report by Misuraca and Van Noordt and their proposal (see below) for studying public sector innovation. With the qualitative components of the chapter, the study identifies the context, internal and external drivers and barriers related to the implementation of AI into public administrations in each sector. Through the *policy mapping* and *challenges and solutions* sections, inferences regarding the **propensity** of the public sector to adopt AI technology are possible. Furthermore, the value chain analysis in conjunction with the SWOT and PESTEL analyses approaches the **implementation** of AI itself. Likewise, the quantitative aspect, where possible, performs the role of **measuring outcomes** against the expected theory. The conclusion will summarize the main lessons from the research and forward a series of suggestions for other administrations looking to enact policy in AI. In its totality, the chapter aims to illustrate the dynamics underpinning the introduction of AI into public administrations.

Figure 78 Summary of the structural factors affecting the adoption of AI in public services taken from an AI Watch study



Source: Misuraca and Van Noordt

Policy Mapping

To establish the state of play for each sector and provide a solid base for further investigation, each section will start with a mapping of the policy landscape and build on the existing inventory carried out in previous research. Using desk research, the policy landscape indicates the broader trends in each sector such as areas of geographic strength or the popularity of a certain type of policy or AI being used (e.g. a chatbot in "eGovernment"). Furthermore, this catalogue of policies will dictate the category (e.g. regulator, facilitator, user) into which member states are placed for the economic analysis (explained in more detail below).

High-performance computing has not been included in this chapter which would expand an already wide scope even further. The full list of policies can be found as an annex and is broken down into each sector. These tables also include other categories of interest including the implementing body, the type of AI technology used (where relevant), the level of government (national/subnational etc), the source and crucially government´s role in the policy. As displayed in figure 3, this draws on earlier typologies but, rather than the country writ large, the governmental role is assessed for each policy. This includes the categories of the *planner, regulator, facilitator, funder and user* as outlined above.

Value Chain Analysis

The value chain analysis was carried out by leveraging publicly available information. The methodology started by looking for existing representations in the literature. When sufficient, these models were recovered and are used in the present study (see e-government sector). However, for both the mobility and the health sector, different models were brought together and merged to allow a joint analysis of the R&D value chain, the physical value chain and the digital value chain. For the education sector, existing models were considered unsatisfactory for this study and a new model was developed from scratch.

These models were developed to identify the key areas where public procurement and interventions from public authorities could support the deployment and uptake of Artificial Intelligence. Each link in the value chain was analysed separately. To make the study concise and focused on the key elements, these links are not always analysed separately, but jointly. This is especially interesting to identify synergies. Furthermore, when relevant, the impact of the COVID-19 outbreak on the redefinition of the value chain was also considered and analysed.

SWOT and PESTEL analyses

For the identification of the main drivers and barriers in the identified four sectors, two main tools are used. The PESTEL analysis enabled the classification of the divers and drawbacks identified at six different levels: Political, Economic, Social, Technological, Environmental and Legal. The SWOT (Strengths, Weaknesses, Opportunities and Threats) gave an accurate diagnosis of the current situation and the surrounding environment

To construct these two analyses, the main challenges and solutions identified and presented in the previous section were gathered and reorganized. Based on this information, the different barriers and drivers were identified and categorised in the corresponding level of the PESTEL. This categorisation enabled, at a later stage, the synthesis action of similar ideas that have connections among them. This integration work led to the definition of the strengths, weaknesses, opportunities and threats of the uptake of AI technologies in public procurement in the identified sectors. Furthermore, the weaknesses and threats identified in the SWOT analysis allow a deeper understanding of the barriers detected during the study.

Case studies

In terms of the selection strategy, the case studies were selected on several criteria. The first, central to the idea of best practices and key lessons to be followed by other government actors, was innovation and the verifiable success of the case. Secondly, to promote the adoption of AI by public authorities in mind, the idea of replicability was also key. Cases which required levels of resources likely unavailable to most member states such as a very large budget or a pre-existing level of development in a certain sector were not considered. The areas examined in the case study were the basic timeline of the policy/project/initiative, the type and nature of the procurement/development such as the funding dynamics and a series of **key** lessons that can serve as a guide for other public entities wanting to involve themselves in AI.

Economic analysis

The final part of each section is a brief economic analysis that complements the preceding qualitative components. The two main aims of this subsection are to test and quantify some of the theories and findings of the prior analysis and wider literature as well as compare the relationships between different types of government intervention with factors of interest. While the models do not make any sweeping causal claims, the aim is generally to support the claim with quantitative evidence that investment and development of AI by governments is beneficial.

The quantitative component of each sector (except mobility) will use **linear regression** to compare the performance of different modes of government policy on a selection of sector-specific indicators drawn from the literature and the prior research in each section.

Each of the models uses the same categorical **independent variable** based on the types of government action highlighted in *the typology of the public policy above.* Each member state will be given a category according to the relationship of its public sector to AI based on the policy mapping. This draws on previous literature (see figure 24 above), including research conducted by AI Watch, in clustering countries according to their approach to AI. This section uses the five modes of policy action explained above: *user, regulator, facilitator, funder* and *user.* if a member state is already using AI technology at the national level, it is categorized as a "user" in the model much like a country with no AI policies is categorized as a "planner". Each member state´s designation in each section is illustrated in a multi-coloured map at the start of each subsection. As highlighted above, the journey of a country is not a linear path from the planner to the regulator to the user. Nevertheless, the evidence from the mapping in these sectors indicates that countries which have reached a certain threshold (ie. AI use) will only continue on that path.

The **dependent variables** differ in each sector. These variables are taken from the literature and other findings in the report and are drawn from "relevant social and economic indicators being representative of the context in which AI is embedded and integrating into the analysis of other direct and indirect factors that are also influencing impact"[589]. Generally, these indicators quantify some of the theoretical benefits of AI in the public sector such as improving internal efficiency, policy delivery, public services and citizen-government interaction[590]. While the lack of indicators on the public sector and AI are frustrating, to the extent that the mobility section does

[589] Misuraca, G. and Van Noordt, C., AI Watch - Artificial Intelligence in public services, EUR 30255 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-19540-5 (online), doi:10.2760/039619 (online), JRC120399.
[590] Manzoni, M., Medaglia, R., Tangi, L., Van Noordt, C., Vaccari, L. and Gattwinkel, D., AI WatchRoad to the adoption of Artificial Intelligence by the Public Sector: A Handbook for Policymakers, Public Administrations and Relevant Stakeholders, EUR 31054 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-52131-0, doi:10.2760/693531, JRC129100.

not contain any linear regression models, the economic analyses still test and quantify some of the expected outcomes of the theory behind AI public sector implementation. Some examples of this hypothesis testing in the report include: whether countries with adult education on AI have a higher concentration of AI talent or whether is there any evidence that member states using AI will have a more accessible government in terms of the number of digital users. Although the lack of indicators and recency of AI investment mean that **proving causality** between public sector activity and these trends is challenging, the correlations are still insightful for the reasons laid out above.

6.2.3 Data sources and collection

In terms of data collection of policies, several sources were used to carry out the mapping including the OECD AI observatory´s policy inventory, the national AI strategy reports from AI watch, and the AI-X initiative inventory. Another source that was used heavily was the JRC´s database on use cases of AI in the public sector[591]. This used the COFOG headings according to the sector in question and only included policies that had been "implemented". Nevertheless, given the reliability of these data sources and the relative paucity of AI policies, this mapping should encompass most of the policies on AI that have publicly available information. All of the policies used in the mapping, and tangentially in the economic analysis, can be found in the annex.

The drivers and barriers to the uptake of AI technologies in public procurement in the identified four sectors build on the findings from the value chain analysis.

Interviews were also carried out mostly concerning the case studies. Interviewees were selected from representatives of organizations that had been part of the chosen initiatives. This included both public and private sector actors such as representatives from the Mobility Data Space and Reaktor, a Finnish technology consultancy which was involved in the Elements of AI MOOC, the case study in the education section. While the principal focus was on the intricacies of the cases, interviewers were also asked about the wider sector with their responses contributing to other subsections in the chapter.

[591] https://ipsoeu.github.io/ips-explorer/case/

6.2.4 Policy overview

Member State	Policy Name	Implementing body	Government Role	Policy Type	Source	Level of Government
Austria	MONA	UnternehmensseService Portal	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	Austrian Council for Robotics and AI	Federal Ministry for Transport, Innovation and Technology	Regulator	Regulation	OECD	National
Belgium	Innovative public procurement programme	Flemish Department of Economy, Science and Innovation	Funder	From the lab to market	National strategy report	Regional
	Datastore.Brussels	Brussels Regional Informatics Centre	Facilitator	Infrastructure	National strategy report	Regional
	Opendata.Brussels	City of Brussels	Facilitator	Infrastructure	National strategy report	Regional
	ACPaas	City of Antwerp	User	Platform	AI-X	Regional
	CitizenLab	Traffic Institute Vias	User	Platform	AI-X	National
	Flemish Infoline	Information Flanders	User	Audio processing	AI-X	Regional
	VDAB – Chatbot for job seekers	Vlaamse Dienst voor Arbeidsbemiddeling en Beroepsopleiding	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	Regional
	Veronstrustingen	Kind en Gezin	User	Predictive analytics	AI-X	Regional
	Reducing night noise through nudging	Leuven	User	Audio Processing, Machine Learning	AI Watch Landscaping Report	Regional
	eTranslation: Machine translation for public administrations	European Parliament **	User	Natural language processing	JRC	National
Bulgaria	Plovdiv – City Concierge Chatbot	UMNI	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	Regional
Cyprus	National Open Data Portal	Data.gov.cy	Facilitator	Infrastructure	National strategy report	National

Denmark	National Centre for Public Sector Innovation	Danish Government	Funder	From the lab to Market	National strategy report	National
	Investment Fund	Danish Government	Funder	From the lab to Market	National strategy report	National
	Performance contracts with 7 GTS Institutes	Danish Government	Funder	From the lab to Market	National strategy report	National
	Kiri	Frederiksberg Municipality	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	Regional
	Intelligent Control Platform	Danish Business Authority	User	Machine Learning, Automated Reasoning	AI Watch Landscaping Report	National
	Taxation and the automatization of property evaluation	Danish Tax Authority	User	Automated reasoning	JRC	National
Estonia	Open data portal	Ministry of Economic Affairs and Communications	Facilitator	Infrastructure	National strategy report	National
	Estonian catalogue of public sector information systems	Information System Authority	Facilitator	Infrastructure	National strategy report	National
	e-Residency – Chatbot for customer assistance	e-Residency organization	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	EE Parliament – a system for preparing verbatim reports	Estonian Parliament	User	Audio processing	AI-X	National
	Iti - Chatbot for Statistics	Estonian Statistical Office	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	Riigikogu – language speech synthesizer for the Estonian Parliament	Estonian Parliament	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and	AI-X	National

				Recommendation Systems		
	Texta Toolkit	Ministry of Education and Research	User	Natural language processing	AI-X	National
	X-Road AI	State Information Systems Board RIA	User	Predictive Analytics, Simulation and Data Visualisation	AI-X	National
	Automatic translation in the information system of the Commercial Register	Commercial Register	User	Natural language processing	JRC	National
	KRATID - detecting traffic anomalies and incidents of the Estonian data exchange layer (X-Road)	Information system authority	User	Computer vision	JRC	National
Finland	Aurora AI	Ministry of Finance	Regulator	Regulation	OECD	National
	AI Registers	City of Helsinki	Regulator	Regulation	National Strategy Report	Regional/International
	Case Fiva – Support the financial supervisory authority	The Financial Supervisory Authority	User	Natural language processing	AI-X	National
	Kamu Chatbot about immigration processes	Finnish Immigration Authority	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	Oulobot – virtual assistant for business	City of Oulo	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	Regional
	Automation of subtitling videos and audio - Improving accessibility of public websites	Finnish Tax Administration	User	Audio Processing	JRC	National
	Explore state spending	Hansel Oy	User	Automated reasoning	JRC	National
France	AI sandbox programme of the National Data Protection Authority	National Data Protection Authority	Facilitator	AI Enablers and other support	OECD	National
	Labor AI – Centre of expertise of the global partnership on AI	Foreign Office, Ministry of Economy and Finance, INRIA, Ministry of Labour	Facilitator	Governance	OECD	International

	CASD secure Data Hub	National Institute of Statistics	Facilitator	Infrastructure	National strategy report	National
	Aria – Chatbot answering retired people	National Old Age Insurance Fund (Cnav)	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	ClaudIA – a chatbot for the invoicing portal for purchases by public authorities	State Financial IT Agency, France	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	RenoiRH – Chabot in HR Management rules to facilitate access	Interministerial Centre for IT services relating to Human Resources	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	Noa chatbot	Prefecture de l'Ile de France	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	JRC	Regional
Germany	Reality lab for AI in Civil Protection	German Federal Agency for Technical Relief	Funder	From the lab to Market	National strategy report	National
	Universal AI platform for the BFV	Federal Ministry of Finance (BMF)	Facilitator	Governance	OECD	National
	Plattform Lernende System	Federal Ministry of Education and Research	Facilitator	Networking	National strategy report	National
	Observatory for AI in Work and Society	Federal Ministry of Labour and Social Affairs	Regulator	Regulation	OECD	National
	Govbot – administrative search engine for citizens' enquiries	Ministry of Home Affairs and Local NRW	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	Regional
	Project ML-SAST	Federal Office for Information Security (BSI)	User	Machine Learning	JRC	National

	Enhancing metadata for textual information - improving the quality of search and automatic reasoning	Federal Office for Security in Information Technology (Bundesamt für Sicherheit in der Informationstechnik - BSI)	User	Natural language processing	JRC	National
	ChatBot Botty Bonn	City of Bonn	User	Natural language processing	JRC	Regional
	Bobbi - Berlin administration	City of Berlin	User	Natural language processing	JRC	Regional
	Frag-den-Michel! Innovativer Online-Bürgerservice in Betrieb	Free and Hanseatic City of Hamburg	User	Natural language processing	JRC	Regional
	Crisis Prevention: PREVIEW	German Federal Foreign Office	User	Planning and scheduling	JRC	National
Greece	CERTH-MUKA	Municipality of Katerini	User	Natural language processing	AI-X	Regional
Hungary	TEBA – Decision on maternity benefit	Hungarian State Treasury	User	Expert and Rule-based Systems, Algorithmic Decision Making	AI-X	National
	Automated administrative procedures in Hungarian	Ministry for Innovation and Technology	Facilitator	AI enablers and infrastructure	OECD	National
Ireland	The Dublin Beat – Citizen opinion analysis	Municipality of Dublin	User	Natural language processing	AI-X	Regional
	VDA – voicebot on calls from Irish taxpayers on tax clearance	Irish Revenue Commissioners	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	Virtual Digital Assistant with the Revenue Commissioners of Ireland	Office of the Revenue Commissioners	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	JRC	National
Italy	Toscana Open Research	Regional Conference for Research and Innovation	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	Regional

	Evasometro Anonimizzato - Big data analysis of taxpayer behaviour	Italian Tax Authority	User	Planning and scheduling	JRC	National
	SegnalaCI - Transparent management of citizen reports about City status	Genova Municipality	User	Planning and scheduling	JRC	Regional
	AI Autonomation - Automatic classification tools and integration with Robot Process Automation (RPA)	CSI Piemonte	User	Robotics and automation	JRC	Regional
	Citizen Conversational AI Platform	CSI Piemonte	User	Natural language processing	JRC	Regional
	ConsolONE: proactive monitoring and management system for real-time control of all company resources,	Smartnet Srl*	User	Automated reasoning	JRC	National
	IBM Watson Content Hub	AGID (Agenzia per Italia Digitale)	User	Automated reasoning	JRC	National
	Amazon Lex: service for creating communication interfaces via voice and text for any type of application	AGID (Agenzia per Italia Digitale)	User	Natural language processing	JRC	National
	Amazon Polly: Text-to-Speech service	AGID (Agenzia per Italia Digitale)	User	Automated reasoning	JRC	National
	LombardiaInforma: proactive Citizen Communication	Regione Lombardia	User	Automated reasoning	JRC	Regional
	YUCCA-Smart Data Platform	Regione Piemonte	User	Machine learning	JRC	Regional
	ANAC, Machine learning tool	ANAC	User	Machine learning	JRC	National
	Caterina, the first (virtual) municipal employee for identity cards and changes of residence	Siena Municipality	User	Natural language processing	JRC	Regional
	Chatbot Comune di Collegno (TO)	Collegno Municipality	User	Natural language processing	JRC	Regional
	Chatbot Covibot Provincia Trento (TN)	Autonomous Province of Trento - Health Agency	User	Natural language processing	JRC	Regional
Latvia	Automatic decision-making of the electronic	State Revenue Service	User	Chatbots, Intelligent Digital	AI-X	National

	declaration system of the state revenue service			Assistants, Virtual Agents and Recommendation Systems		
	Hugo - Virtual Assistant for governments	Culture Information Systems Centre	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	Toms – chatbot facilitating customer communication with the State Revenue Service	State Revenue Service	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
Luxembourg	AI: a strategic vision for Luxembourg	Ministry of State	Facilitator	Networking	OECD	National
	Unlocking digitized documents - using OCR, extracting entities and organising image content	Bibliothèque nationale de Luxembourg	User	Computer vision	JRC	National
Netherlands	AI Register	City of Amsterdam	Regulator	Regulation	National strategy report	(Inter)National
	AI Coalition of the Netherlands	Ministry of Economic Affairs and Climate Policy	Funder	From the lab to market	National strategy report	National
	Non-discrimination by design	Ministry of the Interior and Kingdom Relations	Regulator	Regulation	OECD	National
	Amberscript	Multiple local governments	User	Audio processing	AI-X	Multiple Regional
	SIA – Notifications of public space	Municipality of Dordrecht	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	Calculemus FLINT - Ensuring understandability of normative law texts		User	Natural language processing	JRC	National
	Digital assistant for answering Parliamentary questions	Ministry of Social Affairs and Employment	User	Natural language processing	JRC	National

	Amsterdam City Archive - Handwritten Text Recognition for enabling searches on old handwritten texts	Ancient B.V., Picturae, Sioux Technologies, Islands of Meaning, Amsterdam City Archive.	User*	Natural language processing	JRC	Regional
	Reporting issues in public space	Research, Information & Statistics (OIS)	User	Planning and scheduling	JRC	National
Poland	GovTech	Government of Poland	Facilitator	Networking	National strategy report	National
	Fraud Detection COVID-19 support	National Tax Administration	User	Natural language processing	AI-X	National
	State Clearance Chambre – Financial Risk Indicator	State Clearance Chambre	User	Predictive Analytics, Simulation and Data Visualisation	AI-X	National
	Virtual Clerk - Assistance with the search for information	Chorzow	User	Natural language processing	JRC	Regional
	Intelligent Management Systems	Plonsk	User	Machine Learning	JRC	Regional
	Resident's Virtual Advisor	Wroclaw	User	Natural language processing	JRC	Regional
	Kąty Wrocławskie Virtual clerk	Kąty Wrocławskie	User	Natural language processing	JRC	Regional
	iVoting - a cyberdemocracy tool	Jawor	User	Natural language processing	JRC	Regional
Portugal	Forum AI	AI Portugal 2030	Facilitator	Networking	National strategy report	National
	iSIMPLEX	Administrative Modernization Agency	Planner	National Strategies, agendas and plans	OECD	National
	LabX	Centre for Innovation	Funder	From the lab to market	National strategy report	National
	InnoLabs	Centre for Innovation	Funder	From the lab to market	National strategy report	International
	Sigma – Chatbot on changing citizens' address	Administrative Modernization Agency	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	ASAE Intelligent Management and Operational Control Center - CIGESCOP	AMA (Agência para a Modernização Administrativa)	User	Planning and scheduling	JRC	National

Romania	Antonia – Automatic processing of requests for public services	Municipality of Cluj-Napoca	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	Regional
Slovakia	OverSi – Chatbot to faster bureaucracy	Office of the Deputy Prime Minister of the Slovak Republic	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	Taxana – Chatbot for financial administration	Financial Administration	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
Slovenia	Semantic analyser – document analyser for the public administration	Ministry of Public Administration	User	Natural language processing	AI-X	National
Spain	GovTechLab	Comunidad de Madrid	Funder	From the lab to market	National strategy report	National
	060 Service – Answer FAQ from citizens and bureaucratic terms in informal language	General Secretariat of Digital Administration	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	Chatbot – Boost relations with citizens	Municipality of Sant Just Desvern	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	Regional
	Mercé – citizen science for a better life	City of Barcelona	User	AI-empowered Knowledge Management	AI-X	Regional
	Support system for classification of citizen inquiries or complaints	City of Barcelona	User	Natural language processing	JRC	Regional
	IBM Watson: Automated assistance in the tax filing	Spanish Tax Authority	User	Natural language processing	JRC	National

	Brain4it: monitoring the SmartCity	City Council of Sant Feliu de Llobregat	User	Planning and scheduling	JRC	Regional
	Sentilo BCN - Plataforma de Sensors i Actuadors de Barcelona	City of Barcelona	User	Natural language processing	JRC	Regional
Sweden	AIDA – Interpreting detailed plan provisions	Orebro Municipality	User	Predictive Analytics, Simulation and Data Visualisation	AI-X	Regional
	Skatti – Answering system about population registration and income tax return	Swedish Tax Agency	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
	Swedish Land Registry (SLR) - Fostering efficiency when dealing with land registry requests	Swedish Land Registry	User	Natural Language processing	JRC	National
	Automated processes Uddevalla - AI to internal processes	Uddevalla Municipality	User	Robotics and Automation	JRC	National

Member State	Policy Name	Implementing body	Government Role	Policy Type	Source	Level of Government
MOBILITY						
Austria	32^{nd} Amendment to the Austrian motor vehicle act	National Government of Austria	Regulator	Regulation	OECD	National
	Automated driving regulation	Federal Ministry for Traffic, Innovation and Technology	Regulator	Regulation	OECD	National
	Code of Practice: Automated	Federal Ministry for Transport, Innovation and Technology	Regulator	Regulation	OECD	National
Belgium	Autonomous vehicles – code of practice for testing	Federal Public Service Mobility and Transport	Regulator	Regulation	OECD	National
	Innoviris	Innoviris	Funder	Funding Support	OECD	Regional
	Digital Wallonia 4AI	Agency of Development	Funder	Funding Support	OECD	Regional
	FARI Institute	Brussels Capital Region	Funder	Funding Support	National Strategy Report	Regional
Czechia	Catalogue of autonomous vehicle	Ministry of Transport	Regulator	Regulation	OECD	National

	testing areas on public roads					
Denmark	Danish Road Directorate	Ministry of Transportation	Regulator	Regulation	OECD	National
Estonia	Traffic load – Machine vision for collecting information on traffic load	Public Transport and Traffic Management Transport Board	User	Computer Vision	AI-X	Regional
	A unique artificial intelligence system now directs Ülemiste City drivers to available parking spots	Ulemiste City	User	Computer Vision	JRC	Regional
Finland	Road Traffic Act	Ministry of Transport and Communications	Regulator	Regulation	OECD	National
	AI Business Programme	Business Finland	Funder	From the lab to the market	National Strategy Report	National
	Parking chatbot	Urban Environment Division	User	Chatbot	JRC	Regional
France	AI Challenges	Directorate General for Enterprises	Funder	Funding Support	OECD	National
	Law on mobility orientation	Ministry of Ecological Transition	Regulator	Regulation	OECD	National
	Rouen Moveo	l'Assemblée Générale du Pôle de compétitivité	Facilitator	Networking	National Strategy Report	Regional
Germany	AI Automatic Road Condition Detection	Federal Ministry of Transport and Digital Infrastructure	User	Computer vision	AI-X	National
	An act amending the road traffic act and the compulsory insurance act	Federal Ministry of Transport and Digital Infrastructure	Regulator	Regulation	OECD	National
	mFund	Federal Ministry of Transport and Digital Infrastructure	Funder	Financial Support	OECD	National
	Mobility Data Marketplace/data space mobility Germany	Federal Ministry of Transport and Digital Infrastructure	Facilitator	Infrastructure	National Strategy Report	National
	Automated and connected driving	Federal Ministry of Transport and Digital Infrastructure	Planner	National Strategies, agendas and plans	OECD	National
	Real-world Test Field for Digital Mobility	Federal Ministry of Transport and Digital Infrastructure	Funder	Funding Support	OECD	National
	Ethical guidelines for self-driving vehicles	Federal Ministry of Transport and Digital Infrastructure	Regulator	Regulation	OECD	National
Greece	ANPR Greece	Hellenic Police	User	Computer visión	JRC	National

Hungary	Robocop – System operated by the Police for Traffic Safety Automated Processing	National Tax and Customs Administration	User	Computer vision	AI-X	National
Ireland	SFI CRT in AI	Science Foundation Ireland	Funder	From the lab to market	National Strategy Report	National
Italy	Smart Planner – Navigation planning assistant	FBK Research Centre	User	Computer vision	AI-X	National
	Mobilità Integrata Trentino Trasporti (MITT)	Bologna, Trento, Rovereto Municipalities	User	Machine Learning	JRC	Regional
Latvia	FITS ITEMS – Road Safety	State Public Traffic Safety Directorate	User	Computer vision	AI-X	National
	VARIS – Reviews all the applicants to Rural Support Service	Rural Support Service	User	Searching	AI-X	National
Netherlands	Experimental law on self-driving vehicles	Ministry of Infrastructure and Water Management	Regulator	Regulation	OECD	National
	Bridge sensors	Province of South Holland	User	Computer vision	JRC	Regional
	The Smart bridge	Province of South Holland	User	Planning and scheduling	JRC	Regional
	Automated parking control	Amsterdam Parking Services	User	Planning and scheduling	JRC	Regional
Poland	Gliwice & Poznan Integrated Public Transport Management System - ITS	Gliwice & Poznan	User	Automated reasoning	JRC	Regional
	AI-based timetables	Poznan	User	Planning and Scheduling	JRC	Regional
	Wroclaw Intelligent parking system	Wroclaw	User	Planning and Scheduling	JRC	Regional
	Integrated Public Transport Management System - ITS	Lublin	User	Automated reasoning	JRC	Regional
Portugal	Failstopper – Study the compressed air systems of the vehicle	Metro de Porto	User	User	AI-X	National
Slovakia	Smart Mobility Lab	Ministry of Transport	Funder	From the lab to market	OECD	National
Spain	Notice on automatic parking systems	National Department of Traffic	Regulator	Regulation	OECD	National

	Notice of the authorization to test automated systems	National Department of Traffic	Regulator	Regulation	OECD	National

Member State	Policy Name	Implementing body	Government Role	Policy Type	Source	Level of Government
HEALTH						
Belgium	Innoviris	Brussels City Region	Funder	Funding Support	OECD	Regional
	Flanders Care	Department of Welfare, Public Health and Family	Funder	From the lab to market	National Strategy Report	Regional
	AI Research Programme	Flemish Department of Economy, Science and Innovation	Funder	From the lab to market	National Strategy Report	Regional
	FARI Institute	Brussels Region Government	Funder	From the lab to market	National Strategy Report	Regional
Denmark	Innovation Fund Denmark	Danish Government	Funder	Funding Support	OECD	National
Finland	Hyteairo Programme	Finnish Institute for Health and Welfare	Funder	From the lab to market	National Strategy Report	National
	AuroraAI	Ministry of Finance	User	Chatbot	AI-X	National
France	Datakalab – COVID-19 mask-wearing detection in some French cities	Public Transport	User	Computer Vision	AI-X	Regional
	Breakthrough Innovation Challenge on AI in Health:	The National Portal for eHealth Innovation	Funder	Funding Support	OECD	National
	3IA Institutes	Directorate General for Enterprises	Funder	From the lab to the market	National Strategy Report	National
	Health Data Hub	Ministry of Solidarities and Health	Facilitator	AI Enablers	OECD	National
	Inria	Ministry of National Education, Advanced Instruction and Research	Facilitator	Networking	OECD	International
Germany	Funding priority: digital innovation for the improvement of patient-centred care in healthcare	Federal Ministry of Health	Funder	Funding Support	OECD	National

	Research on AI technologies in Agriculture, Health nutrition, food chain and rural areas	Federal Ministry of Food and Agriculture	Funder	Funding Support	OECD	National
	Research data centre	Federal Institute for Drugs and Medical Devices	Funder	Funding Support	OECD	National
	C-19 – Interdepartmental chatbot on the topic Corona	ITZBund	User	Chatbots, Intelligent Digital Assistants, Virtual Agents and Recommendation Systems	AI-X	National
Hungary	Home Quarantine App – Supporting the use of electronic control for home quarantine	Hungarian Government	User	User	AI-X	National
Ireland	Rapid Response R+I Programme	Irish Research Council	Funder	From the lab to market*	National Strategy Report	National
	SFI Discover	Science Foundation Ireland	Funder	From the lab to market*	National Strategy Report	National
Italy	Italian Institute for AI	Ministry for Economic Development	Funder	Funding Support	OECD	National
Lithuania	National Research Programme for Healthy Aging	Research Council of Lithuania	Funder	Funding Support	OECD	National
Netherlands	Knowledge and Innovation Covenant – Health and Care	Ministry of Economic Affairs and Climate Policy	User	User	OECD	National
	National Growth Fund – regenerative medicine, health data infrastructure	Economic Affairs and Climate Policy	Funder	Funding Support	National Strategy Report	National
Portugal	CCM-SNS – Verification of medical prescriptions	Public National Health Service	User	Predictive Analytics, Simulation and Data Visualisation	AI-X	National
	Data2Help – Optimizing the allocation of resources for a better and faster response to medical emergencies	National Institute of Medical Emergency	User	Predictive Analytics, Simulation and Data Visualisation	AI-X	National

	Derm.AI – Tele Dermatological Screening	National Health Service	User	Predictive Analytics, Simulation and Data Visualisation	AI-X	National
Sweden	Analytic Imaging Diagnostic Arena	Swedish Energy Agency	User	User	Other	National

Member State	Policy Name	Implementing body	Policy type	Level/area of education	Government Role	Source	Level of government
EDUCATION							
Austria	Society for measurement, automation and robotics	Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology	Platform	Research/Industry	User	OECD	National
Belgium	Smart Education@schools	Flemish Government	Project Grants	Schools	Facilitator	National Strategy Report	Regional
	i-Learn	Flemish Agency for Innovation and Entrepreneurship	Portal	Schools	User	National Strategy Report	Regional
	Klascement	Flemish Government	Portal	Schools	User	National Strategy Report	Regional
	Databuzz	Flemish Government	Workshop	Schools	Facilitator	National Strategy Report	Regional
	VubAI Experience	Flemish Government	Workshop	Industry/Policymakers/NGOs	Facilitator	National Strategy Report	Regional
	EluciDATA Lab	Flemish Government	Course	Industry (tech)	Facilitator	National Strategy Report	Regional
	MolenGeek	Brussels Capital Region	Course	Industry	Facilitator	National Strategy Report	Regional
	BeCode	Brussels Capital Region	Course	Industry	Facilitator	National Strategy Report	Regional
	Numeria	Brussels Capital Region	Course	Industry	Facilitator	National Strategy Report	Regional
	Jobnet	Flemish Employment and Vocational Training Service	Initiative	Industry	User	National Strategy Report	Regional
Bulgaria	AI Research Centre of Excellence	Ministry of Economy	Centre	Industry	Facilitator	OECD	National

Denmark	Exam control in schools: fighting fraud or profiling students?	Danish Ministry of Education	Initiative	Schools	User		
Estonia	ProgeTiger	Information Technology Foundation for Education	Course	Schools	Facilitator	National Strategy Report	National
	University of Tartu´s MOOC	University of Tartu	MOOC	All	Facilitator	National Strategy Report	National
Finland	Elements of AI Course	Ministry of Economic Affairs and Employment	MOOC	All	User	OECD	National
France	4 Interdisciplinary Institutes of AI	Directorate General for Enterprises	Centre	Industry/Higher Education	Facilitator	OECD	National
Germany	AI Campus	Federal Ministry of Education and Research	Centre	Industry/Higher Education	Facilitator	National Strategy Report	National
	Helmholtz Information and data science academy	Federal Ministry of Education and Research	Centre	Higher Education	Facilitator	National Strategy Report	National
Ireland	ADAPT Research Centre	Science Foundation Ireland	Centre	Industry/Higher Education	Facilitator	National Strategy Report	National
Italy	Pierino – Platform for the extraction and retrieval of online information	Ministry of Education	Initiative	Schools/Higher Education	User	AI-X	National
	REDOC – Digital tutor to make easier learning the STEM subject	Redoc (private)	Initiative	Schools	User	JRC	National
	Respondus: Assessment software for remote management of students	Università Cattolica di Milano	Initiative	Schools	User	JRC	National
Luxembourg	AI Academy learning course	Digital Academy	Course	Industry	Facilitator	National Strategy Report	National
Malta	AI Family Challenge	Ministry of Education and Employment	Workshop	Schools	Facilitator	National Strategy Report	National

	AI Olympiad	Ministry of Education and Employment	Workshop	Schools	Facilitator	National Strategy Report	National
Netherlands	National Data Science Trainee Programme	Statistics Netherlands	Course	Higher Education	Facilitator	National Strategy Report	National
	National online course in AI	Innovation Center for AI	MOOC	All	Facilitator	National Strategy Report	National
	STAP-scheme	Ministry of Social Affairs and Employment	Course	Industry	Facilitator	National Strategy Report	National
Portugal	Ciencia Viva clubs	Directorate General for Education	Workshop	Schools	Facilitator	National Strategy Report	National
	MOOC on AI in education	Directorate General for Education	MOOC	All	Facilitator	National Strategy Report	National
	NAU	National Foundation for Scientific Computation	Portal	All	User	National Strategy Report	National
Slovakia	AI courses for the employees of the public sector	Ministry of Education	Course	Industry	Facilitator	National Strategy Report	National
Slovenia	MIRRI´s Kinit.SK and Slovak.AI platform	KInIT Institute	Platform	Industry	User	OECD	National

6.3 Chapter 3 & 4 Annexes

This Annex outlines the organisation of the stakeholder consultation, including workshop running, collection and analysis of data of the sectoral dialogues.

The online sectoral dialogues aimed to collect **original empirical data** to better understand, verify and complement findings and analyses carried within Tasks 1 and 2 of the study, with innovative ideas sourced directly from a wide spectrum of stakeholders on how to accelerate the uptake and procurement of AI technologies in the public sector.

The sectoral dialogues also **helped understand the problems faced by stakeholders** in key sectors identified, public services need for AI as well as requirements for adoption in public procurement processes, best practice implementation, and user needs. The Policy Workshop was used to gather further insights and practical policy solutions.

6.3.1 Methodology

The organisation of online sectoral dialogues

Organising the online sectoral dialogues involved inviting the participants, finalising the agendas and shaping the facilitation of the workshops.

In line with the Coordinated Plan on Artificial Intelligence, the Sectoral Dialogue and Policy Workshops were open, transparent and EU-wide.[592] Openness and transparency have been ensured by:

- launching an open survey which was open to everyone interested in contributing and expressing their opinion on the topic - the survey was open from June to September 2022 and gathered a total of 77 complete responses.
- sharing the results of the Sectoral Dialogue and Policy Workshops with all participants in the workshops.

The **dissemination of the online survey** took place using multiple dissemination channels. This dissemination was also used to inform stakeholders about the upcoming workshops and ask for their expression of interest in participating in them. Invitations were later sent to those stakeholders that expressed interest in participating, and the study team created a simple registration portal to facilitate the registration process and the follow-up with the participants. Following their registration, participants were informed about the key questions that were to be addressed during the events and what was expected of them as participants.

The agenda and workshop materials were also finalised in close cooperation with DG CNCT and were shared with stakeholders ahead of the workshops (see section 6.3.2 for final workshop agendas and materials).

The **mapping of stakeholders** was done keeping in mind their level of influence and engagement. The study team sent out invitations well in advance and closely monitored the registration of participants. Moreover, the study team constantly sent out invitations to a large number of possible participants, to ensure the required level of attendance.

After the mapping was finalised, additional **invitations were sent** throughout August and September. The workshops were carried out on the following dates:

- **Health workshop on 26 September (10:00-12:30 CET)**
- **E-government workshop on 27 September (10:00-12:30 CET)**
- **Mobility (transport) workshop on 3 October (10:00-12:30 CET)**

[592] https://digital-strategy.ec.europa.eu/en/library/coordinated-plan-artificial-intelligence-2021-review

- **Education workshop on 4 October (10:00-12:30 CET)**
- **Policy workshop on 17 October (10:30-13:00 CET)**

The study team used the following software solutions to facilitate the online workshops:

- **Videoconferencing solution**: Microsoft Teams
- **Mural**: digital whiteboarding where participants could share ideas using sticky notes, shapes, images and videos and even drag and drop files directly onto the Mural Board to bring ideas to life.

The virtual meetings were conducted in English and open discussions were encouraged throughout all the designed sessions. Using digital whiteboard software (Mural), the level of interactivity was increased and attracted a higher level of engagement from the participants.

During the Policy workshop, the study team also explored the option of splitting the participants into three different breakout rooms. This setup enabled both in-depth specific discussions as well as cross-cutting discussions between stakeholder groups.

Structure of the workshops

The **4 Sectoral Workshops** were focused on understanding the problems and needs of stakeholders from the selected sectors. In these 2.5 hours workshops, facilitators engaged with workshop participants (including businesses, sectoral organisations, and public sector buyers), to clarify challenges, identify important organisational considerations and surface opportunities for overcoming barriers to adopting AI in public tendering and public services.

Based on the findings of the desk research, the study identified the main challenges (issues/obstacles) that the Member States' governments face when considering the public procurement of AI technologies. Four main axes of challenges that may pose a barrier to the public procurement and adoption of AI technologies in the public sector (and private sector when relevant) guided the discussion throughout sectoral dialogues:

- Procurement process challenges
- Data challenges
- AI technology challenges
- Organisational capacity challenges
- Sectoral and AI technologies-related challenges

The discussion on challenges was closely followed by stakeholders' consultation on possible recommendations, best practices and sharing of success stories.

The **Policy Workshop** was focused on discussing policy recommendations and the audience was formed of stakeholders about all 4 sectors involved in the Sectoral Workshops. The 2.5 hours workshop built on the problems and issues identified in the sectoral workshops and facilitated a solutions-oriented discussion aimed at understanding the needs and priorities of the selected sector stakeholders and their recommendations for future EU policy actions. Through open discussions facilitated within breakout groups, the stakeholders also explored, compared and assessed the feasibility of the potential solutions from the policy-making perspective.

6.3.2 Workshop materials

Information packs have been distributed to participants in advance of the virtual workshops for them to reflect on the discussion topics and prepare. These contained the agenda of the workshop with the discussion questions and emerging study findings for each of the selected sectors and can be accessed under the documents linked below.

Workshop material and Agenda - Health :

Workshop material and Agenda - E-Gove

Workshop material and Agenda - Mobilit

Workshop material and Agenda - Educati

After the finalisation of the online workshops, the **resulting Mural boards** have been shared with registered stakeholders. These capture the main points of the discussions which took place in each of the workshops organised and can be found under the documents linked below.

Mural board Health workshop.pdf

Mural board E-government worksh

Mural board Mobility workshop.pdf

Mural board Education workshop.p

Mural board Policy workshop.pdf

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