European Commission

Artificial intelligence – critical industrial applications

Report on current policy measures and policy opportunities

April 2020

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EUROPEAN COMMISSION

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ISBN 978-92-9202-922-7

doi: 10.2826/47005

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Context and objectives

The adoption of AI[1] technologies may significantly boost the European economy, but a considerable part of this impact is at risk if SMEs[2] fail to adopt the technology

As described in the *Report on foresight scenarios,* AI could already have a modest positive incremental GDP impact of about 1.8% by 2025 compared to 2017 GDP. This impact could further accelerate to a cumulative incremental impact of about 13.5% by 2030 compared to 2017 GDP, as AI adoption spreads through the economy and early adopters begin to reap benefits. In fact, the positive impact of AI technologies could go far beyond GDP growth: by enabling cleaner, more efficient mobility or more effective healthcare solutions, AI could contribute to sustainable development and overall societal welfare.

Given that SMEs are the backbone of the European economy, representing 67% of employment and 57% of value added (EC 2019a), they play a crucial role in capturing this impact potential. However, SMEs also face specific challenges in adopting AI, which are described in detail in the *Report on market analysis of prioritised value chains, the most critical AI applications and the conditions for AI rollout.* If these challenges are not addressed and a large share of SMEs is thus unable to adopt AI technologies, the economic impact of AI by 2030 could be up to 30% lower.

The EC has put AI at the top of its agenda and is working on a comprehensive European framework

The EC has defined AI as one of the most strategically important technologies of the 21st century, and 'a Europe fit for the digital age' is one of six headline ambitions for the current EC cycle. On 19 February 2020, the EC presented its 'Digital Package', i.e. a white paper on AI (EC2020a), currently open for public consultation, and the European Data Strategy (EC 2020b). The EC has also published a new industrial policy (EC 2020c) and SME strategy (EC 2020d) on 10 March 2020, and is expected to unveil an updated skills agenda, as well as a Digital Services Act and a European Democracy Action Plan, among others, later this year.

Building on these efforts and the base of existing policy measures on the European level, the EC aims to address the specific needs of SMEs and enable them to make the most out of the opportunities AI has to offer. In line with these ambitions, the EC has thus identified promising opportunities for action to accelerate the development and deployment of AI applications among European SMEs in key strategic value chains (Industrial Internet of Things (IIoT), Future Mobility, Smart Health).[3]

Approach and methodology

The process of identifying opportunities for policy action to support SMEs' AI adoption was guided by the following six research questions:

1. What is the impact potential of AI in the EU-28?[4]
2. In which strategic value chains (SVCs) does AI have the largest impact in the EU-28?
3. Where in each SVC does AI have the largest impact?
4. Which are the most critical AI applications in each SVC?
5. What are key barriers to the development and deployment of the most critical AI applications per SVC?
6. Where are there gaps in the policy landscape that impact the development and deployment of critical AI applications per SVC?

Research followed a mixed-mode approach, including expert interviews and five multi-stakeholder workshops with in total more than 60 external experts, as well as quantitative analysis and extensive desk research on current AI policies and policy recommendations from EU/other governmental bodies, think tanks and industry associations. Findings for research question #1 are described in the *Report on foresight scenarios*, research questions #2 to 5 are covered in the *Report on market analysis of prioritised value chains, the most critical AI applications and the conditions for AI rollout*.

During the research process, a long list of policy opportunities was compiled and structured along the following policy dimensions:

- Setting the **rules of the game** (regulation and legal frameworks)
- Securing **input factors** (research support, coordinated investments, infrastructure creation, skill development)

- Putting in place **success factors** (ecosystem strengthening, proactive communication, incentives).

This long list was then prioritised in line with findings for the research questions outlined above. The resulting short list of high-priority policy opportunities was then validated through a series of expert interviews and discussions at the AI4SMEs conference, which was held in Brussels on 18 and 19 February 2020 and welcomed more than 190 participants. The following chapter presents key ideas for each of these opportunities, along with specific examples of what action could look like.

Policy opportunities to accelerate AI deployment

Applying the six guiding research questions presented above, five high-priority policy domains can be identified that could address the most pressing needs for action to accelerate the development and deployment of AI applications among European SMEs.

For each of the five high-priority policy domains, the following sections present key challenges that could be addressed through policy action, and highlight existing efforts and examples from relevant contexts. In some cases, the policy opportunities are specific to one or two of the prioritised SVCs (IIoT, Future Mobility, Smart Health), while others are relevant for all prioritised SVCs. Wherever feasible, concrete examples of what policy action could look like are outlined in separate text boxes.

Adaptation of existing regulatory frameworks to the specific requirements of AI applications

Existing rules and regulations often do not fully reflect the particularities of AI, causing friction and uncertainty, especially for SMEs that can only allocate limited financial and personnel resources to these topics. For example, traffic rules usually presuppose a human driver in a vehicle: the Geneva and Vienna Conventions (United Nations 1949, 1968) on Road Traffic stipulate that vehicles shall have a ‘driver’, i.e. ‘a person who drives a vehicle’, which is usually interpreted as a human person. In the digital health space, medical device regulation mandates manufacturers to inform notified bodies of ‘substantial changes’ to dynamic devices, but without defining the meaning of ‘substantial’ (Ordish et al. 2019, p. 31). Generally, existing EU regulation is focused on the safety of products when they are first placed on the market and does not yet adequately address safety-relevant changes that might occur later on (EC 2020a, p. 14). Moreover, AI-enabled products and services are often treated differently across Member States, creating barriers for SMEs looking to expand to new markets. For instance, telemedicine can be considered both a healthcare service and an information and telecommunication service: the Member States’ approach to regulation currently ranges from an IT to a healthcare or social security perspective (JASEHN 2017).

These challenges affect SMEs in all three prioritised SVCs. In the IIoT value chain, a lack of clarity about which regulation applies and how it may affect business models (e.g. which data is potentially protected by IP rights) contributes to reluctance to adopt AI applications. In the Future Mobility value chain, regulatory barriers for testing (e.g. autonomous driving) may negatively affect product development and, ultimately, competitiveness. Moreover, uncertainty regarding safety and liability regulation – such as the attribution of liability if an

autonomous vehicle is involved in an accident or the level of algorithm accuracy required for autonomous vehicles to be considered safe for traffic – could negatively affect a product's economic viability. In the Smart Health value chain, challenges in navigating the regulatory treatment of AI-enabled products and services and patient data negatively affect market access. For instance, depending on the interpretation of the Medical Device Regulation, many wellness-focused smart health apps could fall into a more strictly regulated class of medical devices (Prinz and Jacobs 2019; Pramann 2016, p. 228 ff.). Similarly, anonymisation requirements (i.e. requirements that ensure individuals can no longer be personally identified from a dataset, compare European Medicines Agency 2018) are often difficult to implement in the digital health space (Albrecht 2016, p. 25), and some legal uncertainty for providers remains as it is unclear whether future technologies will allow for the de-anonymisation of today's datasets.

Notably, two out of the three SVCs prioritised in this project – namely Future Mobility and Smart Health – cover sectors that are considered "high risk" in the EC's white paper on AI. As the EC proposes tighter regulation for the use of AI in these high-risk sectors (EC 2020a, p. 17 ff.), care should be taken to avoid undue burdens for SMEs active in these sectors ex ante, e.g. through simplified processes for SMEs below a certain-size threshold or the provision of easy-to-use checklists and other materials.

The following examples illustrate what action to address these challenges could look like:

- **Adapt existing regulatory frameworks** (e.g. safety and liability) and/or clarify their applicability to AI-enabled products and services (e.g. regarding their classification in the Medical Device Regulation) – ideally in a consistent manner across Member States so as to minimise obstacles for SMEs that are active in multiple Member States (compare EC 2020a, p. 15). The EC's white paper on AI provides a detailed overview of relevant legislative frameworks that may require adjustments (EC 2020a, p. 13). Any changes should be made in a way that not merely addresses challenges raised by today's AI applications. Instead, regulation should be flexible yet clear enough to also accommodate future AI use cases and related technologies, allowing government action to keep pace with accelerating innovation. The AI HLEG's assessment list for trustworthy AI provides a good example because it focuses on the desired characteristics of the technology overall rather than specifying requirements for individual AI applications.
- **Create regulatory sandboxes** in line with European values and ethical principles that lower barriers for the development and testing of AI applications in well-specified, limited settings to accelerate innovation for mobility and smart health applications and avoid pushing innovation to other continents with lower regulatory standards. This could follow examples in Denmark, Lithuania, the Netherlands, Poland, the UK, as well as China and the US. In Europe, regulatory sandboxes have mainly been used for financial AI applications (e.g. ESMA, EBA, and EIOPA 2018), but examples also exist for clean energy technologies (Germany) and large-scale trial areas for autonomous vehicles (California). In the European context, such regulatory sandboxes could have a limited geographical and temporal scope and could be created, for instance, on a city level, e.g. in alignment with the European innovation partnership on smart cities and communities (EIP-SCC). Moreover, the EC could consider easing regulatory requirements for undertakings

with a research purpose, thus creating a larger-scale regulatory sandbox for pre-commercial projects and allowing for faster, more iterative testing. Adding additional safeguards only when projects prepare for commercialisation could help test and develop technologies faster and potentially at lower cost.

Case example: The UK's Financial Conduct Authority (FCA) has used a cohort process for their regulatory sandbox

The FCA's Project Innovate was launched in 2014, and the first cohort of firms began testing innovation in a live environment in 2016. Tests conducted through the sandbox programme need to have a clear objective and must be conducted on a small scale, i.e. for a limited time with a limited number of customers. The FCA closely monitors the development and implementation of tests and uses different regulatory tools (e.g. restricted authorisation, individual guidance, informal steers, waivers, no enforcement action letters) to facilitate testing.

In an evaluation of the project, the FCA found that the regulatory certainty provided by the sandbox helped firms deliver innovation at speed and improved consumer outcomes (e.g. by pushing incumbents to imitate disruptive innovation). In fact, about 80% of the firms that had successfully tested in the sandbox are still in operation. Also, the participation of large firms applying has increased over time (FCA 2019, p. 5).

Case example: The Dutch regulatory sandbox aims to foster innovation in the financial sector

The Dutch regulatory sandbox for the financial sector was introduced in 2017 and is run by the Netherlands Authority for the Financial Markets (AFM) and the Dutch Central Bank (DNB). Unlike the UK example, firms can apply to join the program at any time (i.e. no cohorts, ESMA, EBA, and EIOPA 2018).

The sandbox is open to all financial service companies that cannot reasonably meet specific rules or policies but are able to comply with their underlying purpose when deploying new products or services. In these cases, regulators will develop sandbox conditions on a case-by-case basis. The Dutch program explicitly aims to foster innovation in the entire financial sector and thus includes cases that do not fir a narrow definition of FinTech (AFM and DNB 2016).

Case example: Germany uses "live laboratories" to explore clean energy technologies

The German version of regulatory sandboxes, so called "live laboratories" ("Reallabore"), was announced in December 2018. The Federal Ministry of Economic Affairs and Energy selected a first cohort of 20 projects (out of 90 applicants) centred around clean energy and in particular hydrogen technologies mid-2019.

The programme will allow the testing of hydrogen technologies under realistic conditions and in industrial settings. It is expected to generate insights on how regulatory frameworks will need to change going forward to enable the large-scale application of such technologies (Federal Ministry of Economic Affairs and Energy 2019a).

Case example: California has defined large-scale trial areas for autonomous vehicles

California's original autonomous vehicles testing regulation was adopted in 2014 and required a 'driver' (i.e. a natural person) to be sitting in the vehicle's driver's seat. This regulation was amended in 2018 to allow for remote control and the 'supervision' of the AV's technology and driving performance. In 2019, the number of companies holding testing permits rose to 60, while the total distance driven by autonomous vehicles increased by 40% to more than 4.6 million kilometres due to a push in public on-road testing by American and Chinese manufacturers (Department of Motor Vehicles 2020).

Notably, testing permit holders are required to report a number of metrics to the state, including safety-relevant incidents. While this creates transparency on technological progress, it also adds to the administrative burden for smaller companies, and the publication of this data may indeed create unintended incentives (e.g. Hawkins 2020).

- **Leverage an extended set of regulatory tools** (e.g. competition policy, trade policy) to promote the development and deployment of AI in line with prioritised SVCs and critical AI applications. For instance, the EC might consider adhering to European standards for AI, such as the AI High-Level Expert Group's guidelines for trustworthy AI (AI HLEG 2019a) as a precondition for access to the EU market (EC 2020a, p. 22, compare also EC 2020b, p. 14). To improve access to data as a key resource for AI development for the European players in focus, the EC will aim to facilitate voluntary data sharing among private sector players and might mandate data sharing among them through EU competition law under specific circumstances, e.g. if a sectoral market failure cannot be addressed through other means or if data access dynamics on platforms lead to imbalances in market power (EC 2020b, p. 13).
- **Create a European helpdesk for SMEs covering AI-related regulations,** which would serve as a virtual first point of contact for SMEs that have questions on AI-related regulations and could be modelled after the successful example of the Helpdesk for European Intellectual Property Rights (IPR)[5]. This helpdesk could produce a portfolio of information materials and distribute them to SMEs through existing networks, such as the Digital Innovation Hubs and the Enterprise Europe Network. Moreover, it could serve as a resource for existing network nodes that do not have the expertise to answer AI-related questions in depth and could connect SMEs to relevant counterparts (such as industrial clusters, city initiatives, or Fablabs[6]) for more detailed discussions where necessary. Finally, the helpdesk could also be integrated with the offering of a potential digital market place for organisations active in the AI space (see Section 5 on collaboration).

Easily accessible external financing for SMEs

Investments in AI applications are costly and require time, especially for SMEs developing (i.e. supply side) and deploying them (i.e. demand side). This leads to challenges for SMEs with regard to public and private financing options, e.g., a lack of transparency regarding available options; complex, resource-intensive processes that need to be navigated; and limited volume of available funding for SMEs that develop AI applications and aim to scale.

While there has been significant improvement in recent years (MGI 2019a, p. 5), these challenges still affect SMEs in all three prioritised SVCs. Challenges in securing sufficient growth capital in Europe limit opportunities to scale business models in Europe (for supply-side SMEs). In 2017, the EU attracted about 8% of global venture capital (VC) investment in AI, compared to around 50% for the US and about 36% for China (OECD 2018). VC funding tends to concentrate on a small number of Member States (MGI 2019a, p. 8). Investors often exhibit home bias, leading to challenges for companies that are not located in AI hubs and tend to focus on early- rather than growth-stage ventures, forcing the latter to look for non-European funding to scale. Time-consuming application processes in the (public) funding landscape may effectively exclude SMEs that do not have sufficient financial and personnel resources to handle them.

Moreover, in the Smart Health value chain, the time between prototype stage and final market access for AI-enabled medical devices might extend even further in the future, putting added financial strain on companies in the sector that cannot earn revenues until their products are certified for market access. The transition period to the updated Medical Device Regulation will end in May 2021, meaning that more products will require certification to gain market access. This is likely to exceed the capacity of existing notified bodies able to handle the respective applications. Several major notified bodies already announced their withdrawal because of extensive investment costs for re-certification (Brennan 2019).

The following examples illustrate what action to address these challenges could look like:

- **Re-allocate or target funding across existing public funding programmes** in line with EC priorities (i.e. focus on AI solutions/applications in SVCs, emphasis on ethical AI). This could also include adjacent support areas, such as earmarking funds for digitisation projects (e.g. in healthcare) as a prerequisite for the rollout of AI applications, or dedicated investments in multi-language processing capabilities to address the challenges posed by Europe's fragmented linguistic landscape.

  While it is mostly bottom-up, the European Innovation Council (EIC) pilot already offers dedicated calls targeting AI-related innovations as part of its Pathfinder activities, such as in the area of AI for extended social interaction.

- **Promote private sector investment,** e.g. by setting up a 'European AI VC scheme', to support companies, notably SMEs developing the identified critical AI applications in their growth phase. This could take the shape of a single, dedicated fund for critical AI applications in SVCs, structured as a public-private partnership with independent management, or multiple smaller investments in separate VC funds. Member State examples include 'aws Gründerfonds' in Austria and 'High-Tech Gründerfonds' (HTGF) in Germany. The grey box below illustrates what this policy action could look like.

Case example: The German HTGF invests in early-stage high-tech firms

The HTGF, founded in 2005 as a public-private partnership, is Germany's largest early-stage investor in innovative high-tech firms (less than three years old, less than EUR 500,000 in equity). Its three funds have a total volume of approximately EUR 900 million and provide initial investments of up to EUR 600,000 (up to EUR 3 million in total). The HTGF has completed more than 550 investments to date and attracted EUR 2 billion of additional investment from third-party investors in its portfolio.

In a similar manner, the EC could top up investments made by a "white list" of VC investors in critical AI applications for prioritised SVCs with additional non-equity capital. Such a white list would contain a preselected group of trusted VC investors that require no further screening. The EC could provide additional debt financing to the company a trusted VC invested in, for example at a rate of EUR 100 debt financing through an EC instrument for every EUR 1000 invested by the VC (i.e. 10% of the investment sum). This could ease capital constraints for SMEs, while the white list could also serve as a signalling instrument for investors. Moreover, similar efforts to make AI investments more attractive (e.g. via preferential tax treatment) could increase the risk appetite of European investors. In both cases, learnings from related programmes such as the EIB venture debt and the EIF AI scheme under InnovFin should be considered.

Case example: In-Q-Tel performs a signalling function for private investors

In-Q-Tel is a not-for-profit VC firm backed by the US intelligence and defence communities. As a strategic investor, it identifies cutting-edge technologies that may be of interest to the US government, ranging from data analytics and cybersecurity to biotechnology. In-Q-Tel rigorously vets the technical capabilities and potential for long-term success and has made early investments in Palantir and the technology used by Google Earth.

The firm invests relatively limited sums and had a budget of USD 490 million for a five-year period from 2012 to 2017. Nevertheless, investments made by the firm have become a 'quality signal' for private sector investors that may not be able to devote the same resources to screening and vetting (Lovelace 2020, iqt.org).

Measures should be complementary to actions undertaken by the EC under the EIC pilot accelerator to support disruptive, market-creating innovations led by start-ups and SMEs. A dedicated fund of at least EUR 100 million for 2019 and 2020 has been set up by the EC to support these promising but not yet bankable innovations through equity and in addition to grants. The EIC pilot accelerator is mainly bottom-up, and a large number of projects selected are related to AI.

Finally, the EC could build a boutique investment agency that takes on a signalling function for private sector investors, similar to In-Q-Tel in the US. This agency would continuously screen the market of emerging technologies in Europe and only invest relatively small sums. Its key added value would lie in the identification of promising companies and its ability to cover a larger geographic and technological scope than individual investors. Thus, its investments could serve as a signal that helps other investors locate potential targets faster, especially in geographies that are currently not well covered by private sector investors.

- **Facilitate coordinated investments** across Member States and industry players, including SMEs. Regarding investments involving multiple member states, the EC could promote the involvement of SMEs providing AI solutions in the preparation of Important Projects for Common European Interest (IPCEI) for strategic (sub-)value chains. On the (regional) industry level, the EC could facilitate joint investments by SMEs with similar or complementary needs for AI solutions. This could take the form of mere match-making (e.g. by providing a kind of directory that allows the identification of SME partners with aligned interests) or active financing (e.g. by guaranteeing private sector financing for SME alliances via the EIB or offering dedicated calls for such alliances).
- **Create a single, digital access point for SMEs seeking EU funding** that is set up in a user-centric way (e.g. one set of application documents across programmes). Currently, there are many different points of contact for SMEs looking to apply for EU funding, ranging from EC agencies to industry associations to regional contact points. To address the resulting confusion for SMEs, all information should be accessible in one place, with current contacts referring SMEs to this single, digital access point. The Point of Single Contact established for businesses, which removes the need for entrepreneurs to connect with individual departments of local public administrations, could serve as a blueprint for such a service.

  This access point for SMEs could, for example, comprise a dedicated ‘account manager’ for each SME, who guides the company through all its financing-related interactions with the EC. This account manager could collect the relevant information from the SME, conduct vetting processes once for all EU programmes and send the SME’s application to relevant programme units as needed. The account manager would remain the SME’s contact to the EC throughout the entire process, which could reduce interaction workload for individual programmes’ staff and could contribute to streamlining administrative processes within the EC. Moreover, this access point could also refer pre-vetted applications to funding programmes on a national level, if applicable.

Illustrative policy action: Establishing a large-scale VC scheme focused on critical AI applications in SVCs

The aim of this action is to specifically address scarcity of funding for growth-stage AI providers. This could take the shape of a single, dedicated AI VC fund (e.g. set up as a public-private partnership with private sector investors and an independent investment team) or multiple smaller investments in separate VC funds led by the private sector, with the choice depending on the desired degree of involvement in shaping the fund's strategy. In each case, the emphasis should be on investments in AI providers in strategically important value chains. The EC's investment for such a venture capital scheme could bundle resources from similar funding instruments that are currently being administered individually. Further, this scheme could serve as a vehicle for private investors looking to strategically strengthen a European industrial network.

With regard to size, this VC scheme could have a volume of EUR 1 billion to 1.2 billion in disbursed investments over a 10-year period. This range is derived by scaling the HTGF's investment volume in Germany to the EU-27 economy (the HTGF invests about 40 to 50% in ventures in the Smart Health (pharma and healthcare), IIoT (e.g. robotics, production, sensors, production efficiency) and Future Mobility value chains, as well as related AI and analytics ventures). Assuming an average investment size of EUR 500,000 to 600,000, which could close the gap between very small, early investments and the larger investments usually covered by the EIB, this VC scheme could cover up to 2,000 individual investments, with some companies receiving multiple sequential investments.

The EC has launched a EUR 100 million pilot equity investment fund for AI and blockchain with the European Investment Fund, effective since 1 January 2020. This first loss piece will leverage further private investments in SMEs and startups in early and growth stage up to EUR 350 million. It also has the potential to significantly scale up investment from 2021 onwards through the InvestEU programme (EC 2020a, p. 7). Learnings from this initiative should be incorporated in the design of the proposed VC scheme, with the aim of developing a clear, complementary portfolio structure. For example, this VC scheme could become one narrowly focused, highly strategic vehicle (addressing critical AI applications in SVCs) within the larger fund for AI and blockchain.

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Secure and easy access to and exchange of data

Access to large, structured datasets is a precondition for the successful adoption of AI, but data cleaning and labelling is labour intensive and expensive. SMEs struggle with both unlocking their own data assets and collaborating across firms, as there are limited common standards for the exchange of data (regarding structural and legal aspects). Moreover, specific types of data pose additional challenges, such as patient health data[7] (e.g. availability of electronic health records across all EU countries) or public sector data[8] (e.g. access modalities, financial barriers). For instance, the capability to exchange electronic health records is not yet available in all EU-27 countries (by the end of 2019, only Estonia, Finland, the Czech Republic, Luxembourg, Portugal, Croatia, and Malta were able to exchange electronic health records; EC 2020e), and no pan-European health datasets are currently available. When it comes to public sector data, access charges may act as a financial barrier for SMEs (especially start-ups), with access modalities presenting additional challenges (e.g. currently rarely via APIs). This has been addressed in the Open Data and Public Sector Information Directive (Directive (EU) 2019/1024, in force since July 2019), the implementation of which is under way. The EC also plans to adopt an Implementing Act on High-Value Datasets for Q1 2021, which would emphasise the free accessibility of such public sector datasets in machine-readable formats via APIs (EC 2020b, p. 13).

The challenges described above affect SMEs in all three prioritised SVCs. In the IIoT and Future Mobility value chains, difficulties accessing public data sources (e.g. geospatial data that is publicly available but has not been cleaned and labelled for machine use) may hamper innovation and limit the welfare potential of AI (Open Data Institute 2018). Moreover, a lack of common infrastructure and exchange conditions (e.g. model contracts) may hamper the potential to benefit from combining private industrial datasets across companies. In the Smart Health value chain, difficulties in accessing large, diverse sets of digital patient data (e.g. for personalised care) may negatively affect product development or even preclude it entirely.

The following examples illustrate what action could look like on a horizontal, i.e. cross-sectoral, level to address these challenges and meet the EC's ambition of aligning the EC's share of the data economy with its economic weight (EC 2020b, p. 4):

- **Improve access to public sector data and publicly funded data[9] on all levels of government** (including cities). This could entail increasing the consolidation, interoperability, usability and compatibility of relevant public sector datasets – already available through the Open Data Directive (Directive (EU) 2019/1024) – through an ambitious push for data cleaning and labelling on the European level. A dedicated unit, which could be led by the EC's Joint Research Centre (JRC), would undertake the necessary steps to make high-value datasets more usable for SMEs, including structuring, validating and possibly labelling the data. This effort should focus on datasets that are of high value for many SMEs, such as the earth observation data already publicly accessible through the Copernicus programme. These datasets should also be made easily accessible to SMEs, e.g. through the EU Open Data Portal, which could also integrate Member States' public sector data in the future. Finally, the embrace of open data approaches in publicly funded research (already encouraged for Horizon 2020 grantees through the program's open science

policy, EC 2019b) and public-private partnerships could be encouraged and even mandated in specific cases. These efforts might start with the prioritised SVCs and critical AI applications related to them but could eventually be expanded to all publicly funded research, in line with the Horizon Europe principle of "open science by default" (EC 2019b).[10]

Similarly, in its European Strategy for Data (EC 2020b), the Commission intends to propose an enabling legislative framework for the governance of common data spaces (Q4 2020) to facilitate decisions that allow reuse of data held by the public sector which is de facto outside of scope of the Open Data Directive, building on experiences from Member States such as Finland, Germany or France.[11]

- **Facilitate the exchange of data** through developing relevant standards and technical infrastructure as well as providing suitable legal support, in line with the proposed cross-sectoral governance framework for data access and use (EC 2020b, p. 12 ff.). A key element would be the creation of (centralised or distributed) common European data spaces proposed in the EC's Data Strategy, which could be financed through the EC's proposed High Impact Project on European Data Spaces and Federated Cloud Infrastructures, with a total EU funding of up to EUR 2 billion, leveraging a further EUR 4 billion in private and public investments from 2021 to 2027 and implementation set to begin in 2022 (EC 2020b, p. 16).

  Moreover, the standardisation of data formats and protocols should be increased (e.g. encouraged through the EC's rolling plan on ICT standardisation) to improve interoperability, possibly guided by the FAIR data principles (Findability, Accessibility, Interoperability, and Reusability; EC 2018b). In the legal sphere, agreements on access rights (e.g. in collaboration with industry-led groups) are needed, and appropriate information on which types of data can be protected or used in which form should be available to SMEs in easy-to-use formats. This might include the provision of model contracts that can be used to agree on conditions for using and exchanging data between stakeholders.

  Furthermore, the Commission also plans to support data sharing in business-to-business (B2B) contexts with the Data Act (2021) in particular by addressing issues related to usage rights for co-generated data (e.g. IoT in industrial settings) from a horizontal perspective.[12] Finally, the EC's Support Centre for Data Sharing (established in 2019) and efforts in Member States, such as the Swedish 'Data Factory' offering technical infrastructure, data and legal frameworks to Swedish firms

and the Gaia-X initiative, could serve as examples.

The following examples illustrate what action could look like in the Smart Health value chain:

- **Accelerate the adoption of digital health data and data sharing** (e.g. through electronic health records) as a precondition for the adoption of AI applications. 22

Case example: The Support Centre for Data Sharing (SCDS) documents data sharing practices

Funded by the EC, the SCDS was launched in 2019 and researches, documents and reports on "data sharing practices, EU legal frameworks, and access and distribution technology" that are relevant to data exchanges between organisations. Its aim is to create transparency on current practices and challenges, which could eventually facilitate the emergence of best practices from the community (https://www.eudatasharing.eu/about-us).

Case example: The MyData movement empowers individuals to control their personal data

Founded in 2018, MyData Global aims to strengthen individuals' rights to self-determination when it comes to their personal data. The organisation's strategy and purpose are based on the MyData Declaration, which emphasises human centric control of data, individual empowerment, portability, transparency, accountability and interoperability.

MyData Global has nearly 90 member organisations and 600 individual members from over 40 countries, many of them in the EU (MyData 2020).

Case example: The Gaia-X project develops a federated data infrastructure

The Gaia-X project backed by an alliance of French and German policy makers, businesses and research institutes founded in 2019 aims to set up a federated, open-data infrastructure based on European values and explicitly includes SME users in its target group. This infrastructure would connect cloud and edge services into a homogeneous, user friendly system. By building on shared components, this setup would allow users to switch between service providers while increasing efficiency for all participants. The project's initiators have welcomed collaboration with similar initiatives across Europe and have called for "a central organisation at the European level [...] to develop a reference architecture, to define standards and to determine criteria for certifications and product quality seals" (Federal Ministry of Economic Affairs and Energy 2019b, p. 3).

Case example: The Data Factory provides datasets and expertise to Swedish businesses

The Data Factory is one of the cornerstones of Sweden's national centre for AI-related research, innovation and education, AI Innovation of Sweden. Funded by the Swedish Innovation Agency Vinnova and the Gotland region, its mission is to accelerate research and innovation by making relevant datasets and competences available to stakeholders.

In two locations in Stockholm and Gothenburg, the Data Factory provides annotated test data and IT infrastructure as well as technical and legal expertise for data management. Importantly, the Data Factory actively works to acquire relevant datasets across different industries and applications, e.g. through donations or own research (ai.se/en).

Member States are part of the eHealth Digital Service Infrastructure and are expected to exchange e-prescriptions and patient summaries by the end of 2021. A broad uptake of digital health data and data sharing across the EU could also drive medical insights and improve citizens' well-being. The public's acceptance of using digital health data is conditional on ensuring effective data protection. It could be further increased by providing individuals with appropriate tools to control access to and use of their data on a granular level. The MyData declaration could serve as an inspiration (MyData 2020).

- **Improve access to existing health data** held by public sector entities for secondary purposes such as research or product validation. This could take the form of a unified access process to the proposed European health data space (EC 2020b, p. 29). For example, Finland has created a data permit authority that can grant access to health and social data which had originally been collected for other purposes and is stored in various government databases, in line with GDPR requirements (Ministry of Social Affairs and Health, 2019).

Case example: The French Health Data Hub makes research data available

Established in 2019, the Health Data Hub will aim to increase the use of health data from the French National System of Health Data (SNDS) for private- and public- sector-led research projects. The hub will gather, organise and provide access to pseudonymised (not anonymised) SNDS data, which is expected to be supplemented with clinical data in the future. Access to this data will require a permission from the French Data Protection Authority in most cases and is intended for research projects of public interest. So far, 10 initial research projects have been selected from more than 180 applications (Le Big Data 2019).

In a similar manner, the proposed Common European Data Spaces for industrial data and mobility data could address specific challenges in the industrial IoT and Future Mobility value chains (EC 2020b, p. 22). Here, the concept of the German Research Data Centre could be expanded to make data accessible not just for academic research but also for private sector research and development efforts, with the intent of making such data usable for SMEs.

Case example: The German Research Data Centre makes data collected by government entities available

The German Research Data Centre is run by the German statistics offices. It makes microdata collected by government entities available to researchers through on-site work stations and scientific use files that can be accessed remotely. The datasets cover a broad range of sectors ranging from agriculture to construction, energy and tax information. The organisation serves as a point of contact for government entities that control relevant datasets and facilitates the permission process for those wanting to access them or combine datasets stored in different government systems. It also provides a remote access environment for these datasets (https://www.forschungsdatenzentrum.de/en).

Case example: Findata promotes the secondary use of health and social data in Finland

Established in 2019, the Finnish Health and Social Data Permit Authority will begin its operations in 2020 under guidance from the Ministry of Social Affairs and Health. Findata will issue 'data permits' for organisations that want to use health and social data collected by the Finnish government for secondary purposes.

Access to these micro-datasets is currently restricted to scientific use by universities and other independent research institutions and subject to access fees (https://www.findata.fi/en/).

Illustrative policy action: Enabling and connecting data platforms

The EC could provide a European platform architecture on which industry-specific and regional data platforms can flourish. Such a focus on data sharing and data cooperation on the industry or regional level creates proximity and relevance and helps overcome the lack of incentives (compare EC 2020b, p. 7) to participate that often accompanies large data platforms. Over time, additional benefits could be generated from connecting these niche platforms and increasing their scale.

The Swedish Data Factory run by AI Innovation of Sweden is an example of a regional data platform. It provides technology, infrastructure and know-how to make data accessible to AI researchers and developers and runs a network of more than 50 partners. Data is donated by partners or collected from open sources and dedicated data projects, and managed in the factory. Based on aggregated datasets, scientists and business partners can train their algorithms, test business models and foster innovation.

AI skill building among SME managers and the general workforce

SME managers struggle to identify opportunities for AI-based business cases due to limited understanding of AI technologies. SMEs also have less access to AI talent on the labour market than large companies, as excess demand leads to a 'war for talent' and drives up wages. For instance, median salaries for data science professionals in the Netherlands start at EUR 60,000 (depending on the area of focus and seniority; Big Cloud 2020), which puts them in the top 5% of household incomes in the country (CBS 2019). Moreover, SMEs tend to have limited AI-related skills in their workforce and face challenges offering in-house skill training due to constrained financial resources, smaller workforce pools and more remote geographic locations.

These challenges affect SMEs in all three prioritised SVCs. SMEs' uncertainty regarding attractive AI-based business cases may lead to missed opportunities and result in a deteriorating competitive position. The scarcity of AI talent (limited availability, high cost) can slow down deployment of AI applications and make business cases less attractive. Finally, skilling challenges in SMEs' workforce may contribute to slow acceptance of AI applications, as staff needs to be trained to use them. For instance, only 57% of the EU population currently have at least basic digital skills – a number the EC aims to increase to 65% by 2025 (European Commission 2020b, p. 20).

The following examples illustrate what action could look like to address these challenges on a cross-sectoral level:

- **Create an EU-wide taxonomy for digital and AI-related skills** to facilitate the identification and monitoring of skills gaps, improve the targeting of curricula and workforce development programmes and potentially establish EU-wide credentials for such skills. Such a framework for competences relevant to AI could build on existing efforts, such as those of the European Committee for Standardization (CEN) [13] Technical Committee 428 on ICT professionalism and digital competences. In addition, the ESCO (European Skills, Competences, Qualifications and Occupations) classification should be updated to reflect AI-relevant skills in more detail.[14] This activity could be undertaken under the Blueprint[15] for sectoral cooperation on skills (part of the Skills Agenda for Europe, EC 2016). Since blockchain, cybersecurity and software services were selected in 2019, AI would be a logical choice in the future.
- **Facilitate the development of a compact AI training offer** for managers of European SMEs in all EU languages and in collaboration with industry associations or public training institutes, focusing on the business relevance of AI technologies. This could build on the example of the Finnish AI Accelerator (FAIA), with a six-month accelerator programme and a playbook on the deployment of AI applications in SMEs. The promotion of such a training offer will be crucial (as many SMEs may

not yet perceive AI as a technology relevant to their business) and could rely on existing networks, such as industry associations and local business hubs.

- **Develop a self-serve training offer for supply-side SMEs** explaining key elements

Case example: Finland's AI Accelerator (FAIA) helps established organisations deploy AI

Established in 2018 by the Finnish Ministry of Economic Affairs and Technology Industries of Finland, FAIA facilitates six-month accelerator programmes that help organisations deploy AI solutions, emphasising group learning and mutual support.

FAIA has also published an "AI playbook" that distils lessons learned from an accelerator batch focused on speech processing, and regularly publishes a list of leading AI companies in Finland. The playbook highlights different use cases and covers data requirements and GDPR considerations, along with other insights from the accelerator programme (faia.fi).

of European AI regulation. It could be targeted at developers who need to comply with relevant requirements in their work as well as managers overseeing them. Such a training offer could incorporate the assessment list developed by the HLEG on AI for trustworthy AI (AI HLEG 2019b) and evolve into a code of ethics for AI developers (compare EC 2020a, p. 6, p. 19 ff.).

- **Build on and expand EU-level reskilling efforts for the workforce** in close collaboration with Member States' initiatives and the private sector, including the Digital Skills and Jobs Coalition,[16] and a digital lifelong learning platform with online training resources for basic and advanced digital skill building, with further information on regional training offers and related funding opportunities. This could draw on numerous examples from Member States, ranging from the Finnish 'Elements of AI' online course, which equips users with a fundamental understanding of AI, to online and offline schools teaching programming skills to participants with diverse backgrounds. The digital lifelong learning platform could also incorporate the offering of MOOC (massive open online courses) providers such as Coursera, Khan Academy, Udacity or Udemy (all located in the US). European providers exist but tend to be less prominent, e.g. Alison (Ireland), OpenClassrooms (France) and OpenSAP (Germany). Moreover, a 'training-in-a-box' package could supply SMEs with (loaned) equipment to train workers and offer dedicated reskilling journeys for different sectors.

Case example: The 'Elements of AI' course makes AI accessible to the public

Elements of AI is part of the Finnish Centre for AI's education programme, which was created by the design agency Reaktor and the University of Helsinki in 2018. The free six-week programme teaches AI basics to users with a wide variety of backgrounds. More than 350,000 users have taken the course so far and 'Elements of AI' is set to become available in all official EU languages by the end of 2021.

A second, more advanced course called "Building AI" will complement the current "Introduction to AI" course in 2020 (https://www.elementsofai.com/).

- **Establish lifelong learning accounts for citizens and employers** with individual entitlements for labour-market-relevant upskilling offers, possibly financed by a European adult training fund. These lifelong learning accounts could aim to steer users towards the most relevant trainings, e.g. by rewarding the completion of certain training modules with additional credits.
- **Attract international AI talent,** e.g. through dedicated visa programmes or fast-track processes. For instance, the UK's Global Talent visas, aimed at attracting workers in the tech sector, provide better opportunities to apply for settlement in the UK after three years of work or study. Additional measures to attract international AI talent could include easier recognition of skills and more standardised visa procedures across Member States, as well as expanding the target group of the European job portal EURES beyond European citizens (MGI 2019a, p. 22). Moreover, lower wage thresholds for visas (e.g. in a dedicated start-up visa) and a preferential tax treatment of employee stock options might help start-ups that can rarely afford to pay high wages.

Case example: The UK's Global Talent visas aim to attract tech talent

The UK introduced the so-called Exceptional Talent visas in 2015. They are targeted at recognised or emerging leaders in specific fields, including digital technology, and require an endorsement from a relevant authority in the field. Holders of Global Talent visas may work for a company or be self-employed, can change jobs without notifying the Home Office and bring family members. The visa is valid for up to five years and has no limit to the number of times it can be extended. Visa holders may also apply for settlement once they have been in the UK for three years (https://www.gov.uk/global-talent).

- **Support upskilling efforts in public administrations on the EU and Member State levels** to ensure that relevant regulatory bodies have the expertise and skills to handle AI-related inquiries and can "effectively and efficiently implement relevant rules" (EC 2020a, p. 6) as well as test and certify AI-enabled products and services (p. 24).

Illustrative policy action: Introducing lifelong learning accounts

Every EU citizen of working age could get access to labour-market-relevant upskilling programmes through an individual learning budget, e.g. EUR 2,000 that can be spent during a period of five years. This is within the (rather large) range of existing individual learning account schemes reviewed by the OECD (OECD 2019). By offering a larger sum that can be spent over a longer time horizon (rather than e.g. EUR 500 annually), longer or more intensive learning offers become accessible.

Citizens would then be able to spend this budget on selected training programmes linked to a learning journey that fits the individual's needs and learning goals. These individual budgets could be managed through a platform for lifelong learning and financed by the EU, Member States and employers, each of which could continuously top up the budget.

Assuming that about 2% of the European labour force (246.7 million people in the economically active population, Eurostat data for 2018) take up the offer of individual learning accounts (compare OECD 2019), this would amount to 4.9 million learners. Providing each learner with the suggested budget of EUR 2.000 would require EUR 10 billion over five years or EUR 2 billion annually.

Going beyond citizens' budgets, employers could also have a dedicated account in the lifelong learning platform through which they would be able to access EU and Member State funds for apprenticeships and other training formats. For example, Singapore reimburses employers for up to 70% of the training costs on selected upskilling opportunities.

Illustrative policy action: Training for SME managers

AI training offers could be piloted in a small target group, such as SME managers, who are pivotal for starting the process of AI adoption and can thus accelerate rollout across Europe. Out of the 25 million SMEs in the EU, only around 1.7 million employ 10 or more people. However, these 1.7 million SMEs account for more than 55% of SME employment in the EU (i.e. they employ more than 54 million European citizens). If a targeted AI training offer were to reach at least one manager in 50% of these SMEs, more than one quarter of SME employees in the EU could be affected indirectly. Moreover, developing an initial training offer for about 850,000 participants (i.e. one manager in 50% of the 1.7 million SMEs) could be an efficient option for piloting training offers in a broader target group, e.g. all EU employees or all citizens.

Collaboration between ecosystem stakeholders

The European AI ecosystem that connects researchers, large industrial players, SMEs and enablers (e.g. business intermediaries, industrial clusters, legal and financial experts) and civil communities should be strengthened. For example, Europe has great AI researchers but lags behind the US in industrialising this depth of knowledge in the form of innovative companies due to less networking between industry and academia. Similarly, SMEs looking to develop or deploy AI applications often need similar competencies and/or resources (e.g. advice when applying for public funding or training their workforce on digital skills) but struggle to share knowledge or form alliances where their interests align because they lack visibility of potential partners.

Ecosystem-related challenges affect SMEs in all three prioritised SVCs. Difficulties in forming alliances may lead to missed opportunities to deploy AI applications more effectively or at a lower cost by bundling SMEs' purchasing/negotiating power. The rather local focus of SMEs' networks may hamper dissemination of best practices and the establishment of truly European networks of partners, customers or suppliers. Further, SMEs' limited exposure to cutting-edge research may contribute to low translation into industrial applications. The uptake of AI applications by businesses requires AI-centred ecosystems to bring together main players (SMEs and large firms, AI solutions providers and users, start-ups, researchers, policymakers and civil society), coordinated investments and focused skill building.

The following examples illustrate what actions to address these challenges could look like:

- **Build on and complement the network of industrial clusters, Digital Innovation Hubs, innovation parcs and technology centres** across the EU-27, clarify the roles of different network nodes and expand the service offering tailored to SMEs as well as prioritised SVCs and critical AI applications within them. As proposed in the EC's white paper on AI, this could include expanding the role of the Digital Innovation Hubs to cover more services for SMEs, e.g. support with conformity assessments regarding European AI regulation (EC 2020a, p. 23) or mapping existing capabilities in the European ecosystem. Inspiration for the service offering could also be drawn from Member State initiatives such as Finland's AI Accelerator (FAIA), which supports collaboration among SMEs looking to develop or deploy AI applications (see above).
- **Foster SME-AI alliances** to bring together SMEs (AI providers and AI users) large industries, start-ups, research partners and public authorities (e.g. for innovation procurement of AI-powered solutions) along SVCs to i) strengthen SMEs' reach and bargaining power and ii) foster a stronger market for European AI applications. These alliances could support the development and industrial deployment of the most critical AI solutions by facilitating data sharing, sharing resources, supporting innovation procurement and sharing networking opportunities. A case study involving 68 German SME managers revealed key motivations for SMEs entering cooperations for technology purchasing, namely to reduce financial commitment and to distribute risk among multiple partners. The study also identified major challenges for SMEs, i.e. the fear of opportunistic or dishonest partners, the risk of losing confidential information, and the high effort required for coordination (Müller et al. 2017). The EC could help SMEs, through the existing networks mentioned above,

overcome these challenges by sharing best practices and model agreements to reduce the effort required to set up an alliance and ensure that SMEs have access to legal recourse if confidential data is misused. Further, the EC could support organizations that facilitate SME alliances as neutral third parties, which might be better suited for handling the required coordination effort. The Danish Digital Hub's deep learning service, which brings together Danish companies and deep learning scientists, could serve as an example.

Case example: Digital Hub Denmark offers deep learning as a service

The public-private partnership between the Danish government, the Confederation of Danish Industry, the Danish Chamber of Commerce and Finance Denmark aims to create a strong digital ecosystem for Denmark. To achieve this mission, the organisation helps Danish businesses in building data and AI capabilities in projects lasting 6 to 12 months, with a co-investment of up to 50% from Digital Hub Denmark.

*Currently, support is planned for 20 to 40 such projects. The first projects were set to launch in late 2019, with a second wave planned for 2020 (*http://digitalhubdenmark.dk/want-to-be-a-digital-frontrunner/).

- **Build a digital marketplace for European organisations working with AI.** This marketplace could be open to both AI providers and demand-side companies as well as research institutes, data providers and enablers (e.g. industrial clusters, test facilities, providers of legal services). Registered organisations should be able to share their business needs and/or offerings and discuss business cases, challenges and related questions with interested peers and potential partners. By creating transparency on who else is in the market and allowing organisations to connect in meaningful ways, the EC could increase connectedness between currently distant network nodes (e.g. across countries) and help deepen more local networks. This digital network could also feature tangible success stories of SMEs deploying AI solutions and might be expanded with a series of local AI networking events tailored to SMEs (and possibly focused on critical AI applications in the prioritised SVCs) to facilitate the exchange of relevant experiences, for example as part of the network of industrial clusters through the European Clusters Collaboration Platform, and the Digital Innovation Hubs to be supported by the Digital Europe Programme.
- **Create incentives for closer collaboration between researchers and SMEs.** For instance, the EC could encourage the inclusion of SME partners in suitable EU-funded research projects or offer dedicated calls for research collaborations between universities and SMEs. Moreover, the EC could help lower the cost of attending relevant AI conferences for start-ups and SMEs, e.g. via learning grants or by subsidising a contingent of tickets that is reserved for these companies. This could contribute to greater exchange between academics and smaller industry players.

Finally, the EC could expand the current pilot program for European SME Innovation Associates to allow SMEs to employ researchers who want to transition to the private sector. The programme currently finances the salary of a highly skilled “Innovation Associate” for one year, if the SME would otherwise be unable to access or afford these skills. Such a programme could further ease SME’s limited access to research talent.

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Endnotes

[1] This briefing uses the EC's definition of AI as 'systems that display intelligent behaviour by analysing their environment and taking action − with some degree of autonomy − to achieve specific goals' (EC 2018a). In line with the MGI's definition, intelligent behaviour is understood to refer to the result of cognitive functions that are associated with humans – including all aspects of perceiving, reasoning, learning and problem solving. Moreover, the notion of autonomy in the EC's definition is understood to encompass the full range from mere decision support systems (i.e. humans making the final decision) to fully autonomous systems.

[2] This briefing follows the EC's definition of SMEs as enterprises that employ fewer than 250 persons and that have an annual turnover not exceeding EUR 50 million, and/or an annual balance sheet total not exceeding EUR 43 million (EC 2003). This includes companies that self-identify as start-ups if they fall within the outlined size bracket.

[3] Strategic value chains (SVCs) are defined by the Strategic Forum for IPCEI as holistic ecosystems of new technologies and innovation that are of strategic European interest for competitiveness and technological autonomy. The Strategic Forum identified six value chains as strategically important from a pool of 36 due to (i) their relevance for a larger number of EU Member States and (ii) the potential for coordinated investments across Member States. Three of these SVCs were selected as focus areas due to their high AI potential.

[4] Most of this research was prepared before the UK left the EU, hence market research data covers the EU-28.

[5] www.iprhelpdesk.eu; International IPR Helpdesks are also available (currently covering China, South-East Asia and Latin America, with India in preparation)

[6] www.fablabs.io

[7] Health data could be held by the public sector, the private sector, or individual patients.

[8] This report uses the term 'public sector data' to refer to datasets collected and/or stored by public sector entities that may or may not be publicly available.

[9] Publicly funded data refers to datasets collected in projects and other initiatives funded by the public sector, e.g. in the context of research.

[10] Horizon Europe "will go further in mandating open access to research data by default, yet according to the principle 'as open as possible, as closed as necessary'" (EC 2019b, p. 2).

[11] The enabling framework will look at secondary use of data held by the public sector, facilitating decisions on which data can be used, how and by whom for scientific research purposes in a manner compliant with the GDPR. Furthermore, it will make it easier for individuals to allow the use of the data they generate for the public good, if they wish to do so ('data altruism'), in compliance with the GDPR.

[12] The Commission will also explore the creation of a legal framework (Data Act) to foster business-to-government data sharing for the public interest, support B2B data sharing and evaluate the IPR framework with a view to further enhanced data access and reuse.

[13] https://standards.cen.eu/index.html

[14] For example, ESCO currently lists "principles of AI" in sector specific skills and competences but returns no relevant results for "deep learning" (https://ec.europa.eu/esco/portal/skill).

[15] https://ec.europa.eu/social/main.jsp?catId=1415&langId=en

[16] https://ec.europa.eu/digital-single-market/en/digital-skills-jobs-coalition

EA-01-20-282-EN-N

Publications Office
of the European Union

doi: 10.2826/47005