Boosting the use of Artificial Intelligence in Europe's micro, small and medium-sized Enterprises

STUDY

European Economic
and Social Committee

Boosting the use of Artificial Intelligence in Europe's micro, small and medium-sized Enterprises

Study

General information

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Abstract

The diversity and potential of AI applications are nearly limitless. Today, a growing number of businesses and citizens unknowingly rely on AI-driven solutions to enhance their work and life. As these innovative technologies become increasingly mainstream, MSMEs should adopt AI to maintain their competitive advantage. This study will shed light on the opportunities and challenges of AI uptake for Europe's MSMEs with an in-depth sectoral and EU Member State analysis. Effective actions are proposed that could boost AI uptake in MSMEs and include:

- Supporting education and training systems to ensure AI skills demanded by the labour market are acquired and general knowledge on AI is gained, which in turn enables civil society members to be responsible and informed users of AI devices and applications
- Ensuring MSMEs, the largest employers in Europe, have a targeted support system from finance and infrastructure to data availability and interoperability, allowing for a successful pan-European AI adoption
- Raising awareness about issues such as cybersecurity and the potential impact of data bias
- Guiding best practices, promoting success stories, and sharing experiences that can serve as a starting point for a broad AI uptake among MSMEs

The study presents a toolbox for both policymakers and MSMEs to support the uptake of AI within MSMEs and preserve their economic relevance in Europe.

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Executive Summary

This study sheds light on the opportunities and challenges of AI uptake for Europe's MSMEs, with specific attention to the most vulnerable groups such as micro-enterprises, family companies, enterprises in remote areas and mono-entrepreneurs. The study conducted from 10/2020 to 06/2021 is based on both a sectoral analysis focused on agriculture, construction, healthcare, legal services & accounting and an EU/Member States analysis. It presents a toolbox for both policy makers and MSMEs to support the uptake of AI within MSMEs and preserve these businesses' economic relevance in Europe.

Background

The current diversity and potential of AI applications are nearly unlimited, and many businesses and citizens unknowingly use AI-driven solutions at present. As these innovative technologies become increasingly mainstream, MSMEs need to adopt AI to maintain their position vis-à-vis existing and emerging competitors. Nevertheless, several obstacles lead to an adoption gap between markets and/or between large corporates and MSMEs. These result from a variety of factors such as the lack of investment support, networking, partnerships or policy-making and at the citizen-level, cultural inertia and a lack of trust form barriers towards AI.

Opportunities in AI uptake for MSMEs

AI functionalities such as prediction, automation, and generation of insights offer a wide range of opportunities and use cases ranging from optimised operations to customer engagement, or from transformed products and services to employee empowerment.

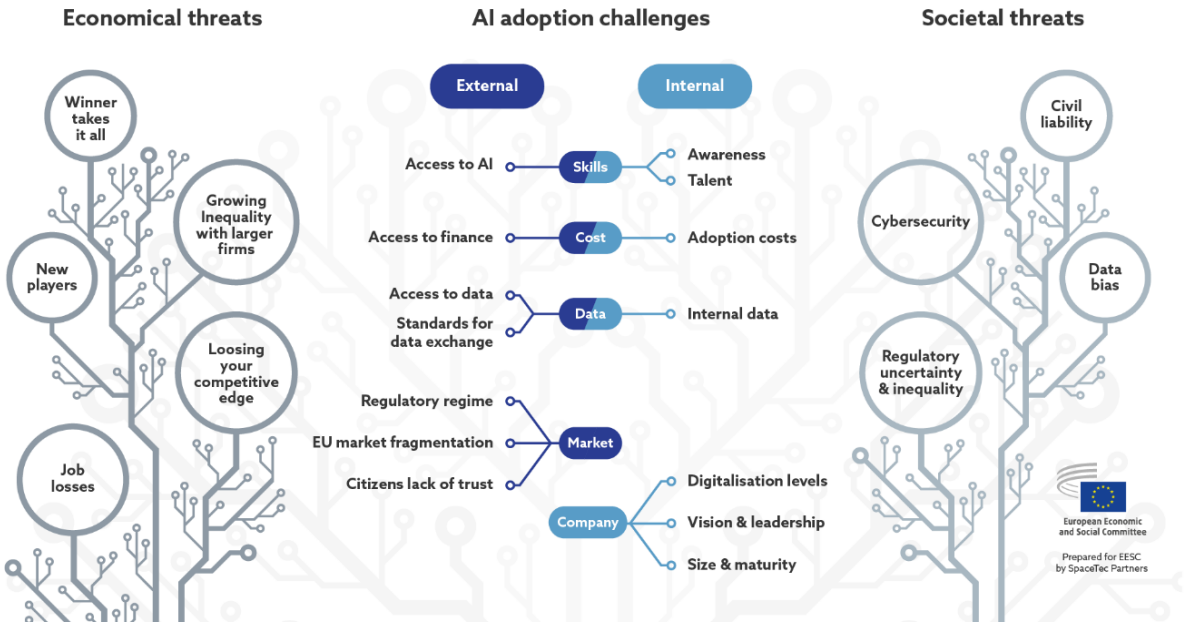
As MSMEs need to address administrative burdens, AI-driven automation and insights could make those administrative tasks more manageable by processing large volumes of data and documents. And where the management of MSMEs suffers from a lack of time due to their limited staffing, AI-driven automation can optimise operations and improve time management.

Specific applications are, however, very sector-dependent. Sectors with manual intensive labour such as agriculture and construction benefit from robotisation and automation and correspondingly increased safety of workers. AI-driven applications have the opportunity to support or take over rather mundane tasks associated with the processing of information in document-rich sectors such as the liberal professions accounting and legal services. Within the healthcare sector, a sector of high priority within the EU due to the ageing population and shortage of healthcare professionals, AI has the potential to drive a major change and enable more efficient patient management, new procedures, better treatments and potentially also predictive medicine.

A portion of the accounting sector has already successfully adopted applications based on Machine Learning, a subset of AI. AI-enabled bookkeeping automates the most time-consuming and mundane work, freeing up accountants to focus on consulting and advising. While third parties such as financial institutions pose a potential threat in capturing part of the market by harnessing AI accounting technology, the industry as a whole sees excellent opportunities in and benefits of AI uptake.

Perceived threats and challenges for MSMEs

The very emergence of AI also comprises a series of economic and societal threats to Europe's smallest enterprises.



Economic threats of AI consist of a series of factors with potentially disruptive effects on complete MSME sectors, for example, due to the increased market dominance of existing or even new players.

Societal threats can be identified in incomplete, compromised, biased or discriminatory data sets. Major ethical concerns exist regarding the transparency and human-driven nature of AI, especially for the use of automated decision making based on personal data. Civil society in the EU has expressed its concerns for citizens' privacy and the use of AI and biometrics for citizen monitoring in preventive policing applications. Uncertainties also exist concerning the legal liability for damage because of an AI-driven action.

The **external or internal challenges** that MSMEs encounter on their journey towards an AI-enabled business fall within five major groups: skills, cost, data, market and company. Overarching challenges for MSMEs can be identified despite the inherent differences in the studied sectors. The main challenges are **missing awareness of AI benefits** by company management and **lack of skill amongst existing (technical) staff**, in addition to **missing or inaccessible data**. Also, external market conditions, such as too restrictive or too broad legal frameworks, hamper the successful adoption of AI technologies by MSMEs.

Industry associations play a **crucial role in overcoming AI uptake challenges** by raising awareness on digitalisation, providing education such as MOOCs with sector-specific use cases, and first guidance on best practices in the AI uptake. In 2019, Belgium technology business association AGORIA launched a **free online course called "AI in Business"** to accelerate the use of AI within the Belgian industry by increasing the digital literacy of all employees. The course also contains over thirty application examples to inspire AI uptake. Their "**AI Discovery Sessions**" help companies define the AI use case and provide matchmaking with potential AI consulting and developing companies.

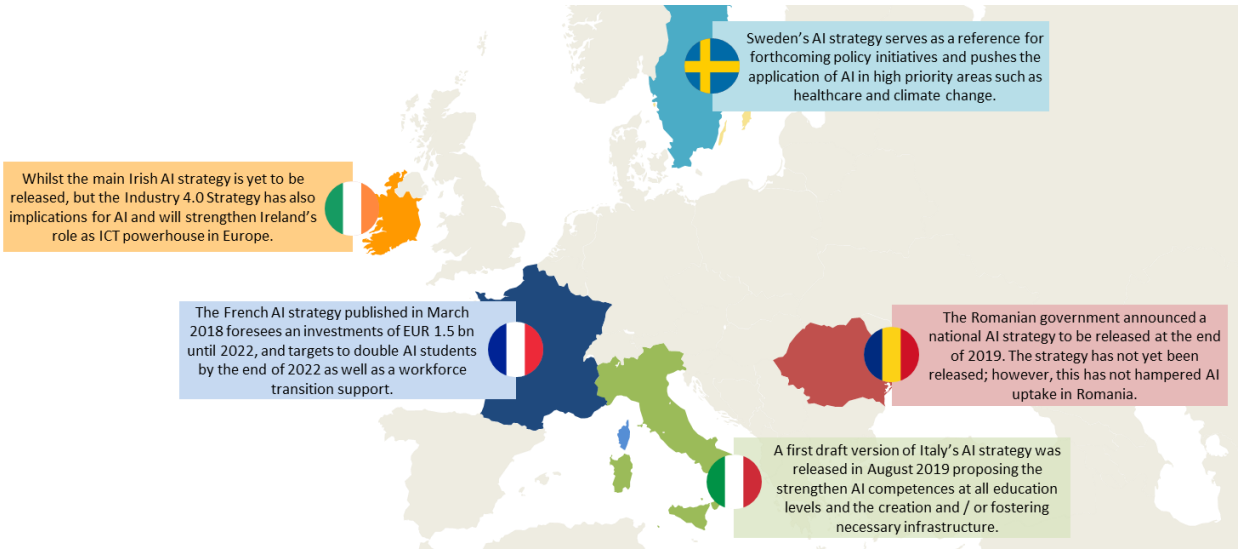
EU & Member State analysis

The European Commission released in 2016 the **Communication on the European Cloud Initiative** which, whilst not directly addressing AI, delivered important first steps for future AI endeavours. The first dedicated AI-related publication by the Commission followed in 2018. With the **Communication on Artificial Intelligence for Europe**, the Commission highlighted AI as a crucial driver for the future European digital society and as a central part of a future globally competitive economy.

In the following years the following key steps have shaped the EU's approach towards AI and its uptake:

- The **Coordinated Action Plan** (2018) coordinates AI-related investments and actions between the Member States and the European Union.
- The **European AI Alliance** (2018) serves as a multi-stakeholder forum for all European AI-related aspects, their development and impact.
- The **High-Level Expert Group on Artificial Intelligence** (AI HLEG, 2018) has the general objective to support the implementation of the European AI strategy by elaborating recommendations on future-related policy development and ethical, legal and societal issues related to AI.
- The **AI Watch initiative** (2018), a "Commission Knowledge Service to Monitor the Development, Uptake and Impact of Artificial intelligence for Europe".
- The **AI4EU** (2019) consortium is building the first **European AI-on-demand platform** to "lower barriers to innovation, to boost technology transfer and catalyse the growth of start-ups and MSMEs **in all sectors** through open calls and other actions".
- **Communication on A European Data Strategy**, as well as a **White Paper on Artificial Intelligence** (both 2020). The two documents build on each other and indicate how the Commission will further support and promote the development and uptake of AI across the EU Member States.

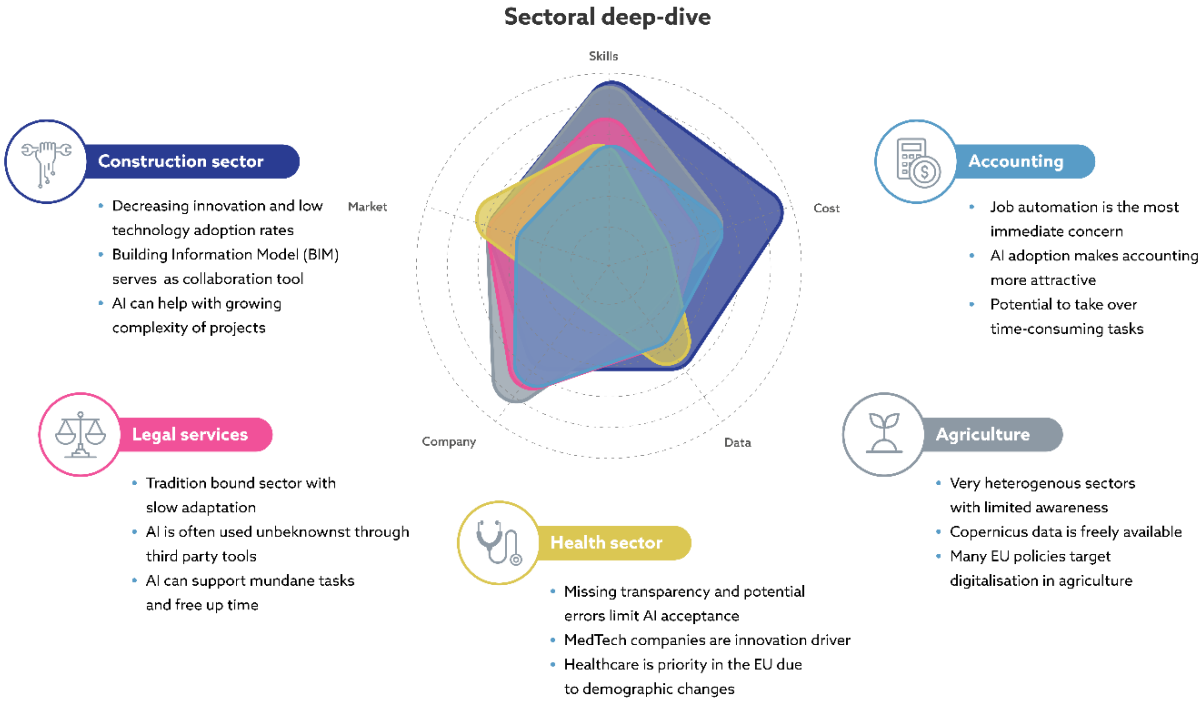
The national AI policy levels and strategies are **shaped by the different markets environments and their starting position**. A balanced set of Member States was selected from those with no dedicated AI policies to the Member States with an extensive AI strategy:



Opportunities for AI uptake arise in all countries fuelled by strong policy-making and/or local market conditions such as attitude towards AI, educational emphasis on digital skills and AI and low or high number of ICT / AI specialists employed.

Sectoral analysis

The sectors agriculture, construction, healthcare, legal services and accounting were chosen as they are very diverse with different use cases and AI uptake challenges:



A deep dive into five sectors confirms that AI accelerates recurring and mundane tasks, increases worker safety and security, and can highly improve efficiency and effectiveness in everyday work. Likewise, overarching challenges for MSMEs can be identified despite the inherent differences in the studied sectors. The main challenges are **missing awareness of AI benefits** by company management and **lack of skill amongst existing (technical) staff**, in addition to **missing or inaccessible data**.

- Skill: Increased **MSME management awareness** to understand the AI business case, interpret complex AI algorithms, and define AI needs is necessary. Access to **external expertise** through **B2B partnerships, accessible AI and AI-as-a-Service** will be critical.
- Cost: MSMEs are particularly vulnerable since **they lack the financial resources to invest in new technology. Access to finance** to invest in these transitions would enable MSMEs to make the required transformations.
- Data: MSMEs possess less internal data than large enterprises. To resort to external data, **high-quality public and private data sets need to be accessible**. When **sharing data with a provider of AI products or services, data ownership** is of great concern.
- Company: As size and maturity matter, MSMEs have **natural disadvantages vis-à-vis large corporates** to enable AI uptake in their daily operations.
- Market: The European market is fragmented at the levels of AI **technology provision, data access and standardisation and access to finance**. The language barrier is especially limiting for MSMEs as potential applications often only exist in English.

MSMEs views on potential policy toolboxes

The integrated policy toolbox to support AI uptake is driven by MSMEs' policy-making needs:

> - *Think small first: Formulate policies tailored towards MSMEs that can be adapted for large enterprises later.*
> - *Decrease regulatory requirements: Propose policies that enable easy adoption into MSMEs' business practice.*
> - *Raise awareness: Improve the coordination and synergies of policy instruments and initiatives and enable an MSME platform to overcome the communication gap.*
> - *Create a business-friendly environment: Provide AI upstream stakeholders with enabling rules, a reliable regulation framework and the freedom to develop their AI applications.*
> - *Foster a pan-European approach: Stimulate the single market on the European level and tailor policies towards the current needs of member states from AI development to uptake.*

Toolbox for policy makers

Through the various stakeholder interviews on both the demand and the supply sides as well as the mapping exercises detailed insights into the specific challenges of MSMEs have been collected. Potential policy measures have been selected targeting either support to the overall AI development, which indirectly benefits also MSMEs through better access to AI solutions, as well as measures that support the AI uptake within MSMEs directly. The policies are grouped into measures addressing the uptake challenges in skills, data, cost and market:

Boost the AI uptake in SMEs

Educate on AI & build the necessary skills in the MSME workforce to remain competitive

- Educate on AI, its opportunities and threats to bridge the current knowledge gap
- Promote success stories and share best practices of AI in SMEs to encourage a broad AI uptake among MSMEs
- Build and expand digitalisation & AI uptake networks towards MSMEs to leverage the knowledge of the AI leaders
- Educate the public at large to enable a responsible and informed use of AI devices and applications
- Enlarge the pool of AI-savvy students and researchers to enable a development and uptake across all sectors and levels
- Provide dedicated and recurring training opportunities for existing workforce with special attention to MSMEs

Expand financial instruments for MSMEs to support the AI implementation in their digitalisation effort

- Inform about existing finance instruments provided by the EU and its MS to create equal access to finance for MSMEs
- Stimulate the creation of start-ups focused on MSME use cases to increase the access to products and services
- Increase funding opportunities for AI uptake to encourage the investment in AI-enabled products and services
- Build new technology leaders via targeted institutional procurement by leveraging the creative & well-educated talent available
- Incentivise AI uptake with vouchers for educational programs or technical and business support by experts

Enhance centralised access to open data to train and develop AI solutions whilst protecting data ownership and control

- Facilitate open access to public data at national and European level to support the training of AI applications
- Make access to public data easier by a centralised and user-friendly data access portal to reduce the bureaucratic burden and dispersion of data
- Whitelist certain sensitive data sets for R&D to stimulate the creation of AI-enabled services in priority areas such as healthcare
- Provide clear rules for data governance to increase access to data and provide control for MSMEs over the data they generate

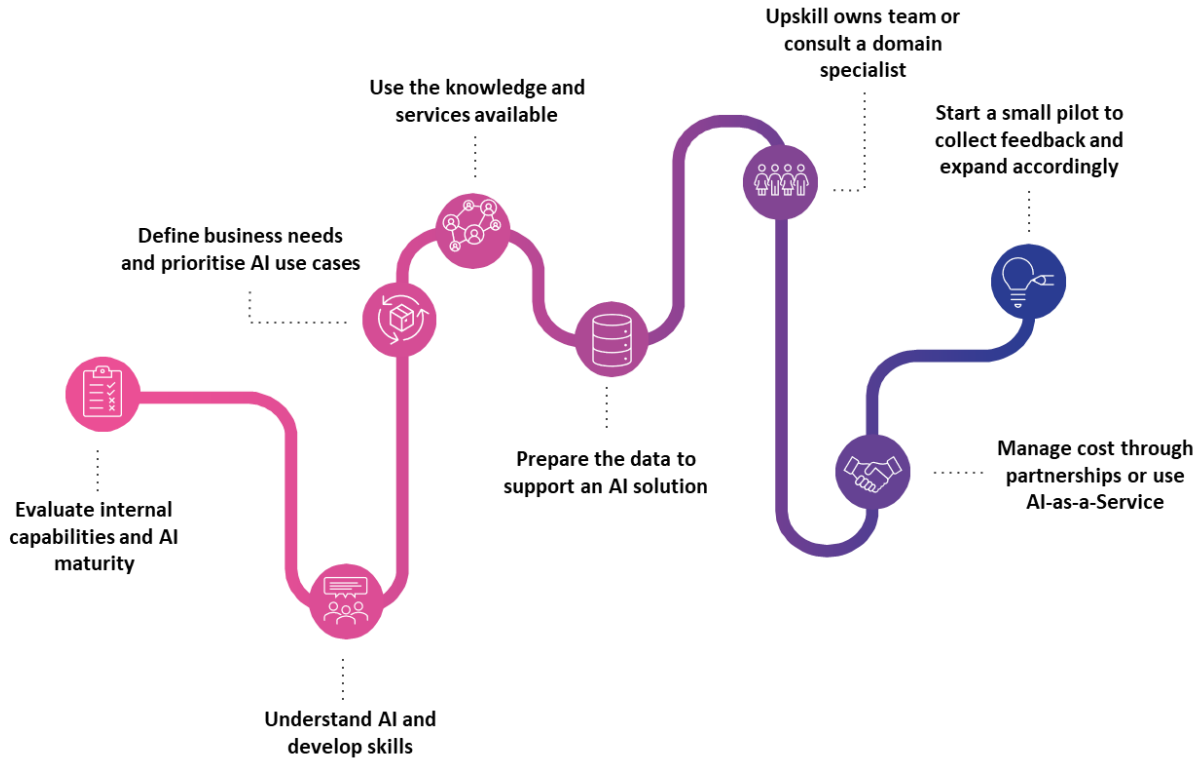
Ensure a transparent single market for AI solutions to reduce risks and increase transferability for MSMEs

- State ambitions within the field of AI to drive innovation, development and adoption in the private sector
- Decrease the fragmentation within the European market to foster pan-European AI uptake
- Ensure clear and innovation friendly rules for AI technology and its applications to enable sustainable business development
- Encourage a European digital infrastructure to build a European-based digital ecosystem based on European values
- Provide a monitored experimental environment, also called "sandbox", for potentially risky AI applications
- Create certification for trustworthy AI and provid transparent information on AI solutionsto reducescepticism
- Ensure transferability to empower MSMEs to choose the service provider of their choice without loosing access to valuable data

Toolbox for MSMEs

For businesses, practical AI applications can manifest in all sorts of ways depending on your organizational needs and the business intelligence insights derived from the data you collect. Enterprises can employ AI for everything from mining social data to driving engagement in customer relationship management to optimising logistics and efficiency when it comes to tracking and managing assets.

The MSMEs toolbox is comprised of eight main steps towards successful AI adoption:



The main element of the MSME toolbox is the AI Journey by applied AI, tailored towards MSMEs. It is a tool to help guide the way towards successful AI adoption, highlighting potential pitfalls and guiding the development and implementation for a MSMEs AI strategy.

Abbreviations and acronyms

Acronym	Description
AI	Artificial intelligence
AIaaS	AI-as-a-Service
Bn	Billion
CT	Computer tomography scan
EC/COM	European Commission
ECLP	European Centre for Liberal Professions
EESC	European Economic and Social Committee
EHDS	European Health Data Space
EIB	European Investment Bank
EP	European Parliament
EU	European Union
EUR	Euro
GDP	Gross domestic product
GDPR	General Data Protection Regulation
GNSS	Global navigation satellite system
HLEG	High-Level Expert Group
ICAEW	Institute of Chartered Accountants in England and Wales
IoT	Internet of things
JRC	DG Joint Research Centre (European Commission)
ML	Machine learning
MRI	Magnetic resonance imaging
NACE	Statistical Classification of Economic Activities in the European Community
NLP	Natural language processing
ROI	Return on investment
SFTB	Small family and traditional businesses
MSME	Micro-, small- and medium-sized enterprises
OECD	Organisation for Economic Cooperation and Development
R&D	Research and development
UTM	Unmanned aircraft system traffic management

1. AI as an opportunity and a threat for MSMEs

Artificial Intelligence has a tremendous potential to transform industries throughout the world, as advances in data availability, computing power, and new algorithms have resulted in the rapid growth of AI applications from its early adopters in the high tech and financial services sector. AI implementation is not just limited to those early adopters and tech giants. To remain competitive, Micro, Small, and Medium-Sized Enterprises (MSMEs) could also benefit from AI.

However, several obstacles lead to an adoption gap between markets, and between large corporates and MSMEs, such as the **lack of support for investment, networking, partnership, clear policy definition, and innovation centres**. Other challenges also exist for MSMEs, with one of the key challenges being the cultural inertia found in some countries, where they are not willing to adopt changes to their business models. An example of this is found in Greece, with Greek companies being 11 times more likely to have zero AI initiatives planned compared to organisations globally.

Opportunities in AI uptake for MSMEs

AI is a key component of the **ever-increasing digitalisation of MSMEs**, with AI being able to provide new business models, opportunities, and even methods of operation. AI is the conversion of the **exponential increase in computing power and storage, the explosion of data, and the advancements in algorithms**. AI development has been around for decades, but there have been several key milestones in the last decade in terms of data and devices such as in 2014 when the number of mobile devices exceeded the number of humans on the planet and in 2017 when 90% of the world's data had been produced in the two years leading up to it. These numbers have only increased since then and highlight that the modern world is increasingly driven by data. Global investment in AI is increasing rapidly, with the worldwide spending on AI systems seeing an increase of over 40% on a year-on-year basis in 2019.

Challenges of AI uptake for MSMEs

The early adopters of AI have generally been **either large corporations or small highly specialised start-ups with access to the technological know-how** required for the earlier forms of AI implementation. Recent developments and market trends show that AI is rapidly expanding from the initial early adopters, with a greater variation in the sector, location, and company size being seen compared to the earlier stages. MSMEs often struggle with the adoption of new technology due to **a lack of understanding** of the topic, a **lack of capacity** in terms of man-hours, or **a lack of knowledge** of the support processes available.

Without action, MSMEs will be left behind in terms of AI adoption, raising the gap with larger players who can leverage the vast performance and process improvements that AI provides. **MSMEs are the segment with the greatest threats, but also the segment that has the greatest opportunities**. Therefore, concrete measures are required to ensure that MSMEs are not left behind in the shift to AI while grasping this as an opportunity for the future.

This study addresses the opportunities and challenges of Artificial Intelligence in Europe's Micro, Small and Medium-sized Enterprises (MSMEs), with specific attention to micro-enterprises, family companies, enterprises in remote areas and mono-entrepreneurs. It envisages to:

- Analyse **opportunities and challenges for MSMEs** concerning the use of Artificial Intelligence (AI)
- Measure the **gap between MSMEs and larger corporates** in the utilisation of AI
- Analyse **existing policies and approaches** at the EU and Member State level to support MSMEs to facilitate the use of AI by MSMEs
- Analyse five **sectoral case studies**
- Define a **toolbox for policy makers and MSMEs** to foster awareness and uptake

AI does not have a single and unanimously decided definition. In the context of AI Watch – the European Commission's knowledge service to monitor the development, adoption and impact of AI – the Commission's DG Joint Research Centre (JRC) drafted a technical report to decide upon an Operational Definition and Taxonomy of Artificial Intelligence. The report undertook a qualitative analysis on 55 key documents from 1955 until today, including AI definitions from a perspective of policy, research and industry. It eventually selected the working definition of the High-Level Expert Group on AI, which offers a comprehensive and complete definition, incorporating elements of perception, understanding, interpretation, interaction, decision making, adaptation to behaviour and the achievement of goals.

Exhibit 1: Non-exhaustive overview of AI definitions

Source	Definition
HLEG on AI[1], 2019	Software (and possibly also hardware) systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge, or processing the information, derived from this data and deciding the best action(s) to take to achieve the given goal. AI systems can either use symbolic rules or learn a numeric model, and they can also adapt their behaviour by analysing how the environment is affected by their previous actions.
European Commission White Paper on AI[2], 2020	Collection of technologies that combine data, algorithms and computing power.
European Commission Coordinated Action Plan on AI, 2018	Systems that display intelligent behaviour by analysing their environment and taking action — with some degree of autonomy — to achieve specific goals.
European Defence Agency, 2020[3]	The capability of algorithms to select optimal or quasi-optimal choices to achieve specific goals.
Microsoft & EY, 2018[4]	The ability of a machine to perform cognitive functions which are normally associated with humans, including reasoning, learning, problem-solving, and exercising human behaviour such as creativity.

This study will make use of the HLEG-definition, which is comprehensive and clear to the extent that it avoids overlap or confusion with other technologies. It is furthermore used on an operational basis by AI Watch, ensuring consistency between the analyses in this study and the day-to-day monitoring of AI policy initiatives in the EU.

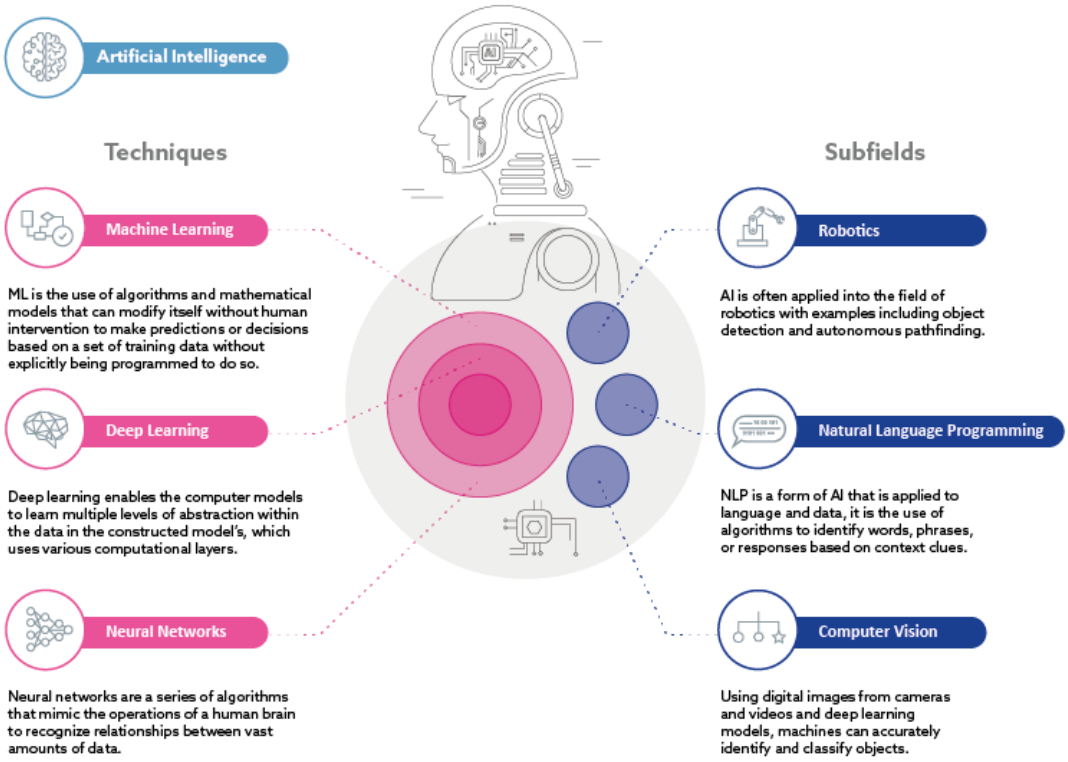
AI systems perceive their environment through data acquisition, interpreting the data to reason, process and predict or decide on best actions. They furthermore can learn from practice and adapt their behaviour. This definition covers a range of technologies, as demonstrated in Exhibit 2.

Exhibit 2: Overview of AI techniques

Overview of AI Techniques	
Machine Learning (ML)	Learning patterns from large amounts of data has been the most successful way to mimic intelligence so far. ML gives examples of how to perform a task and teaches thereby how to emulate that task. ML is such a popular technique for modern AI that they are often interchanged.
Statistical	Statistical learning collects statistics from the examples that it sees to try to probabilistically generalize to unseen inputs.
Deep Learning	Deep learning and neural networks are a more powerful, non-statistical way to learn from data.
Rule-Based Systems	An early technique defining exactly what the computer should do at each step.

Machine Learning combined e.g., with NLP allows AI-programmes to learn from past mistakes, to interpret corrections and to optimise text analysis for the future:

Exhibit 3: AI terminology definition



From a user perspective, AI-driven solutions can be divided into six categories of functionalities. They **predict, automate, generate insights, personalise and prescript**, as demonstrated by Exhibit 4.

Exhibit 4: AI functionalities

Functionalities	Definition	Examples
Prediction	Anticipate events & outcomes	Predictive maintenance, proactively engage customers, identify leads with a high likelihood of conversion
Automation	Handle tasks without human intervention	Chatbots
Generation of insights	Identify and understand patterns and trends	Based on internal/external data, requiring sophisticated data infrastructure
Personalisation	Tailor content and user-experience	Personalised service to guests in hotels + recommendations
Prescription	Suggest solutions to defined problems	NLP to suggest a template for the next response re customer enquiries

From an enterprise perspective, the abovementioned AI functionalities offer a wide range of opportunities and use cases. Businesses use AI solutions to optimise operations, engage customers, transform or create new products and services or to empower employees.[5]

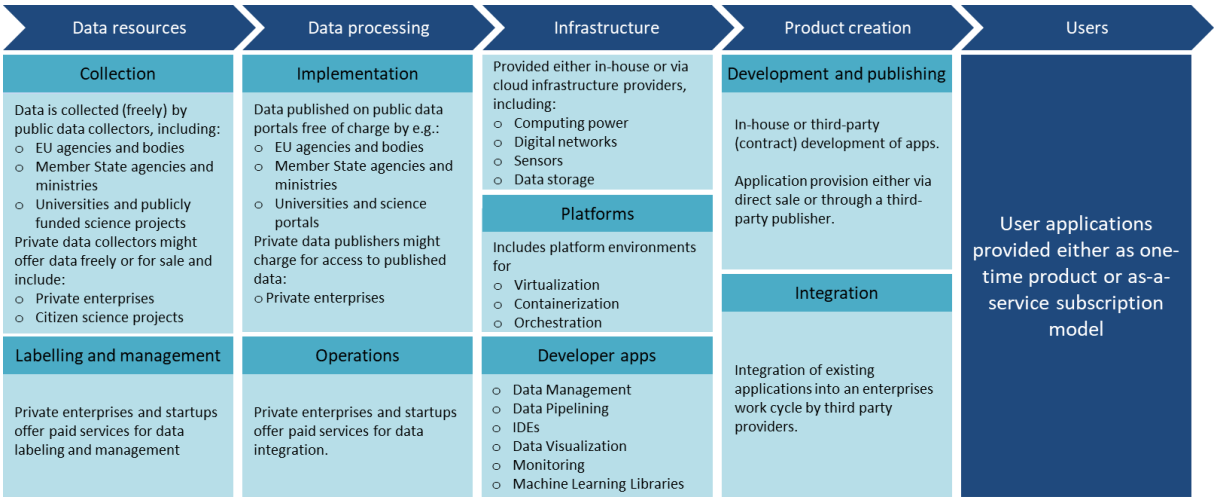
Exhibit 5: AI use cases for enterprises

	Optimise Operations	Customer Engagement	Products & Services Transformation	Employee Empowerment
Prediction	Predictive maintenance	Anticipate customer needs	Anticipate non-performing products	Sales & client forecasts to make informed decisions
Automation	Automation in manufacturing or administrative processes	Increase response speed through chatbots	Speed up innovation cycles and R&D processes	Processing large sets of documents at minimal time
Generation of insights	Anomaly detection such as fraud	Insights in customer satisfaction and preferences	Detection of new product opportunities	Analysis of customer behaviour datasets
Personalisation	Enhanced efficiency of processes through personal NLP recommendations for correspondence	Enhance user experience and add sentiment	Cost-effective tailoring of software solutions	Personalised digital tools for office management
Prescription	Recommended re-routing of trucks in supply chains	Suggest products and services	Identification of market opportunities	Identification of best next actions

Artificial intelligence is not a new technology. Categories of AI software have been under development since the creation of the first computers 50-60 years ago. The enormous and exponential progress in computing capacity and data labelling over the last decades have enabled the capacities of AI that we see today.

At a high level, the value chain of AI consists of data (data collection and preparation), the necessary infrastructure and the product creation:

Exhibit 6: AI value chain



The current diversity and potential of AI applications are nearly unlimited, and many businesses and citizens probably use AI-driven solutions without being aware of this being the case. Examples include:

- **Smartphone usage**: NLP-driven text processing, word and grammar suggestions
- **Digital entertainment**: Social media algorithms, ML-driven suggested songs/series for audio-visual entertainment programmes such as Netflix and Spotify, speech recognition by Alexa sound systems
- **Industry**: Smart robotics performing sophisticated tasks in manufacturing
- **Transport**: Use of AI for autonomous cars, AI enabling UTM for thousands of UAV operations
- **Security**: Facial recognition applications to identify suspects from public cameras, predictive policing based on datasets of past convicts
- **eCommerce**: Personalised product offers to digital shoppers, sales forecasts to employees
- **Healthcare**: Rapid screening of X-rays, CT and MRI scans for anomalies, predictive healthcare to assess patient risks for heart disease

However, Artificial Intelligence is no panacea. Data sets can be incomplete, compromised, biased or even discriminatory. Major ethical concerns exist with regards to the **transparency and human-driven nature of AI**, especially for the use of automated decision making based on personal data. Civil society in the EU has expressed its concerns for citizens' privacy, and the use of AI and biometrics for citizen monitoring in applications such as preventive policing. Uncertainties also exist concerning the legal liability for damage as a consequence of an AI-driven action.

Adding to this, **the emergence of AI-driven solutions has very specific consequences for Europe's MSMEs**. They encompass several economic and societal threats, but also a range of opportunities to foster their competitiveness. This study will shed light on these developments and propose a toolbox for policy makers and MSMEs.

2. Methodology & scope

2.1 Study methodology

This study made use of a variety of sources, starting with a landscaping exercise. Initial **desk research** reviewed the existing literature on the use of AI by MSMEs in the EU, potential applications, existing use cases across industries and the existence of AI ecosystems in the diverse Member States. The desk research drove the mapping of the **technological state of the art**, to gain a high-level understanding of the positive and **negative impacts of AI on MSMEs across Europe**, its adoption levels and the diversity of existing policy approaches throughout the EU.

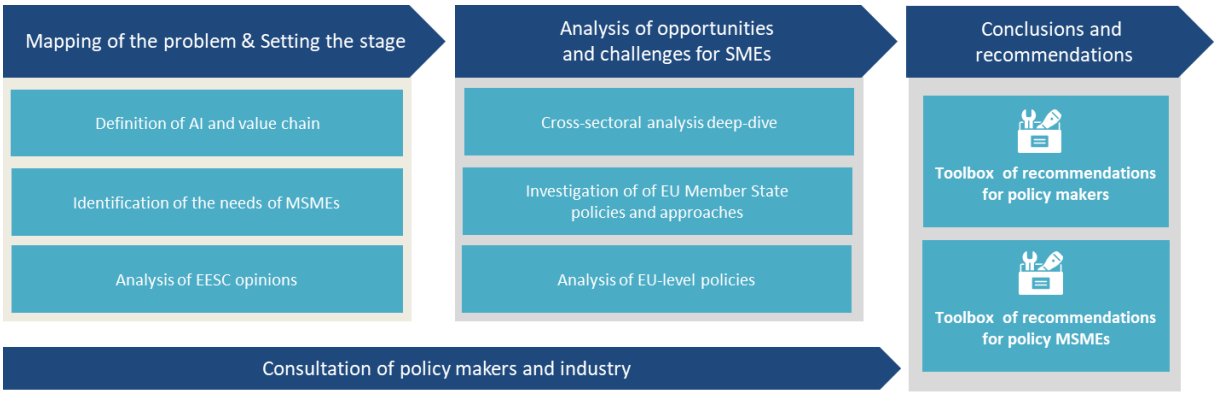
In parallel with the landscaping exercise, a scoping activity mapped and selected existing MSME definitions, with particular attention to the needs of MSME sub-groups such as micro-enterprises, SFTBs, mono-entrepreneurs and enterprises in remote areas. This was complemented with an initial analysis of EESC work and opinions related to AI in MSMEs.

The understanding gained in the landscaping and scoping exercises fed into the analysis of **AI opportunities and challenges for MSMEs**. This analysis investigated the **potential and added value of AI for MSMEs in five sectors**, focusing in particular on concrete challenges in terms of AI adoption by MSMEs in each sector. The cross-sectoral mapping is complemented by a look at the **diverse policy approaches - including five Member State case studies - as well as EU-level policies supporting MSMEs**.

Beyond the literature study, the study identified upstream and downstream stakeholders, which were **consulted through interviews and questionnaires** for sector-specific insights and opinions on potential policies. **Quantitative and qualitative data** were collected supporting the proposed recommendations.

A **toolbox of concrete measures** for policy makers and MSMEs was defined listing concrete recommendations based on the analyses in the report. Areas requiring further research or strategy development have been identified and initiatives already working on the topics listed.

Exhibit 7: Study methodology



2.2 Typology of company size

The study focuses on MSMEs: MSMEs represent 99.8% of the total number of enterprises in the EU's non-financial business sector, employ almost 67% of the EU's employees and generate almost 57% of the total value-added. Of the MSME enterprises, 93% are micro-SMEs.[6] Article 2 of the Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises (SMEs) recommends the following MSME definition:

- **Staff headcount**: fewer than 250 persons
- **Annual turnover**: not exceeding EUR 50 million and/or
- **Annual balance sheet:** total not exceeding EUR 43 million

Within the MSME category, more granular definitions are:

- **Small enterprises** employ fewer than 50 persons and have an annual turnover and/or balance sheet below EUR 10 million
- **Micro-enterprises** employ fewer than 10 persons and have an annual turnover and/or balance sheet below EUR 2 million

The prefix of the Recommendation furthermore mentions that "*the criterion of **staff numbers** remains undoubtedly **one of the most important [criteria],** and must be observed as the main criterion*". It thereby raises the fact that the use of an enterprise's turnover as the sole financial criterion could lead to inconsistencies, as some sectors have relatively higher or lower revenue per employee figures than others.

Companies with a staff count higher than 250 are therefore counted as large enterprises, even if their turnovers fall below the threshold. This risks creating a grey zone, where enterprises facing market failures do not qualify as MSMEs despite their low turnovers, rendering them ineligible for MSME-specific support. In addition, MSMEs are a no monolith and consist of a diverse and heterogenous group of enterprises, including:

- **Micro-businesses**, which are the most widely represented in terms of the number of firms
- **Small family and traditional businesses** (SFTBs)
- **Enterprises in remote areas**
- **Mono-entrepreneurs**

To reflect the dynamic and diversified nature of MSMEs, EESC opinions have called for work to explore a revision of this definition, suggesting to:

- Allow a level of **flexibility** to MSMEs to choose which two of the three criteria to meet, rather than imposing the staff headcount criterion as the only main criterion
- Take measures to update the thresholds of Article 2, e.g., by **aligning these with the most recent approach in Directive 2013/34/EU24**, which bases the definition of micro-undertakings, small and medium-sized undertakings only on two of the three criteria (Article 3)

This study will follow this approach. Where needed, it will take certain flexibility with the interpretation and definition of MSMEs, not only focusing on staff numbers but also annual turnover and the annual balance sheet. Particular attention will be paid to micro-enterprises (<10 staff and < EUR 2 million turnover or balance sheet), but also SFTBs, enterprises in remote areas and mono-entrepreneurs. Therefore, this study will discuss MSMEs, accentuating the existence and importance of Micro-Enterprises, which constitute 93% of all MSMEs in Europe.

2.3 Sectoral Scoping

To allow for a clear analysis of the several identified sectors, this study has delineated sectoral definitions using sources from Eurostat[7], the European Centre for Liberal Professions[8], the Cambridge Dictionary, the Business Dictionary, as well as the investment encyclopedia Investopedia. The definitions and their sources were picked based on their relevance to the study's needs and were altered where required:

Exhibit 8: Definitions of sectors

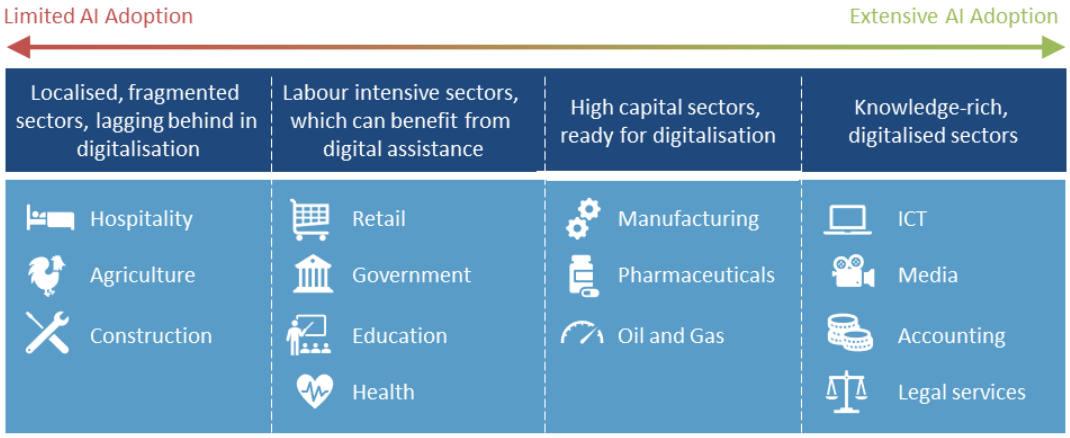
Sector	Working Definition
Construction	Sector engaged in the preparation of land and construction, alteration, and the repair of buildings, structures, and other real property.
Liberal professions	Marked by an intellectual character, require a high-level qualification and are usually subject to clear and strict professional regulation. In the exercise of such an activity, the personal element is of special importance and such exercise always involves a large measure of independence in the accomplishment of the professional activities. The sector can include e.g., lawyers; auditors; tax advisors; notaries; architects; dentists; and pharmacists.[9]
Legal services	Including all work done by lawyers for a client. Excluding public servants such as judges and state attorneys
Accounting	Accounting is the recording of financial transactions along with storing, sorting, retrieving, summarizing, and presenting the results in various reports and analyses. Can be done inside a company or via a third-party provider.
Financial services	A sector of business services relating to money and investments, for example, those offered by banks.
Health	The healthcare sector consists of businesses that provide medical services, manufacture medical equipment or drugs, provide medical insurance, or otherwise facilitate the provision of healthcare to patients. Medical services are provided by various entities, so-called healthcare providers, including e.g., hospitals, doctors and therapists. Pharmaceutical companies and manufacturers of medical products are also active players in the health sector.
Manufacturing	Agglomeration of industries engaged in the chemical, mechanical, or physical transformation of materials, substances, or components into consumer or industrial goods
Agriculture	Encompasses the whole range of activities involved in manufacturing and distributing the industrial inputs used in farming; the farm production of crops, animals, and animal products; the processing of these materials into finished products; and the provision of products at a time and place demanded by consumers/supply chains.
Food	Network of all activities pertaining to the supply, consumption, and catering of food products and services across the world. Finished food products and partially prepared instant food packets are also a part of the food industry
ICT	Information and communication services include the production and distribution of information and cultural products, the provision of the means to transmit or distribute these products, as well as data or communications, information technology activities and the processing of data and other information service activities.

The **AI adoption level across sectors** was analysed, leading to a balanced and diverse list of 5 sectors, ranging from those favouring AI uptakes to sectors lagging in digitalisation. The study focuses on sectors **with MSME relevance and the diverse use of different data sets and data challenges**.

In the case of the sectoral analysis the following criteria were analysed:

- **MSME Relevance**: Extent to which MSMEs are represented in the sector, and the degree to which they are under challenge in the current market circumstances
- **AI Potential**: Criteria reflecting the level of AI potential of a sector to ensure a balance in the diversity of AI uptake challenges, ranging from access to talent, capital intensity, data access and business culture to overall awareness or even access to AI technology
- **AI Uptake**: The existing and potential sectoral AI MSME uptake levels, and the presence of relevant AI case studies as identified in the literature study

Exhibit 9: Sectoral benchmarking incl. selected sectors



2.4 Geographical coverage

A balanced set of Member States was selected from those with limited AI adoption to leaders, using the following criteria:

- **Country Features**: Member State-specific features, such as its size (inhabitants), GDPR, the ratio of MSMEs to total businesses, geographic balance North-South and East-West, sectoral relevance
- **AI Policy Approaches**: Criteria reflecting the level of AI Policy Approaches within different Member States, ensuring a balance in the diversity of policy approaches, and balance of Member States with a strong or a limited set of policy initiatives
- **AI Uptake**: The extent to which Member States have or do not have a domestic AI capability, existing and potential AI MSME uptake levels, and the presence of relevant AI case studies as identified in the literature study

Exhibit 10: Benchmarking of MS incl. selected states

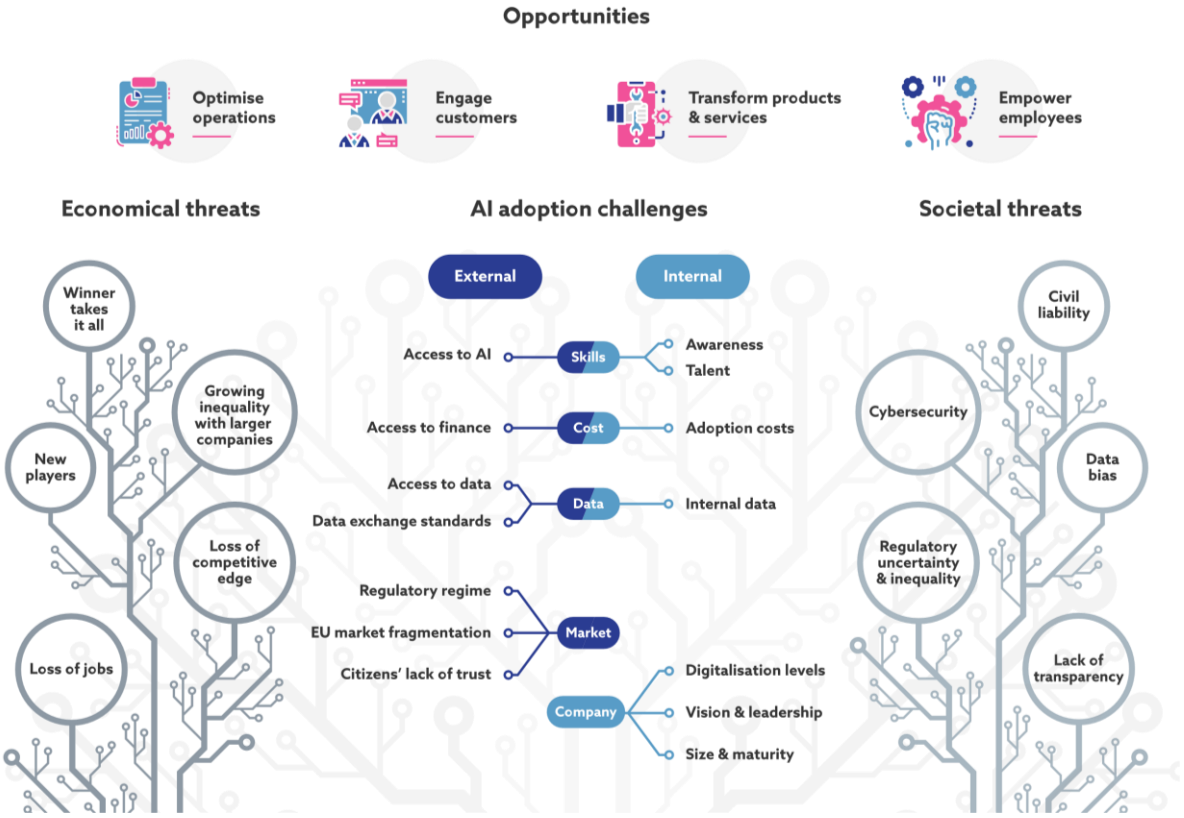
3. Assessment of AI uptake dimensions

3.1 The use of AI: opportunities and challenges for MSMEs in Europe

3.1.1 Impact, opportunities and challenges of AI for MSMEs

AI-driven solutions provide a plethora of opportunities for MSMEs to optimise business operations and competitiveness. At the same time, they generate a **set of complex economic and societal challenges**. Nevertheless, as AI becomes increasingly mainstream, MSMEs need to adopt innovative technologies and move forward to maintain their position vis-à-vis emerging competitors. This brings the question of which factors stimulate or impede AI uptake by European MSMEs, which will be mapped in the next chapters.

Exhibit 11: Opportunities and challenges



MSMEs often struggle with the adoption of new technology due to a **lack of understanding** of the topic, a **lack of capacity** in terms of man hours, or a **lack of knowledge** of the support processes available. Some AI uptake challenges are imposed by external factors, while others are internal challenges, which will be mapped in the next chapters.

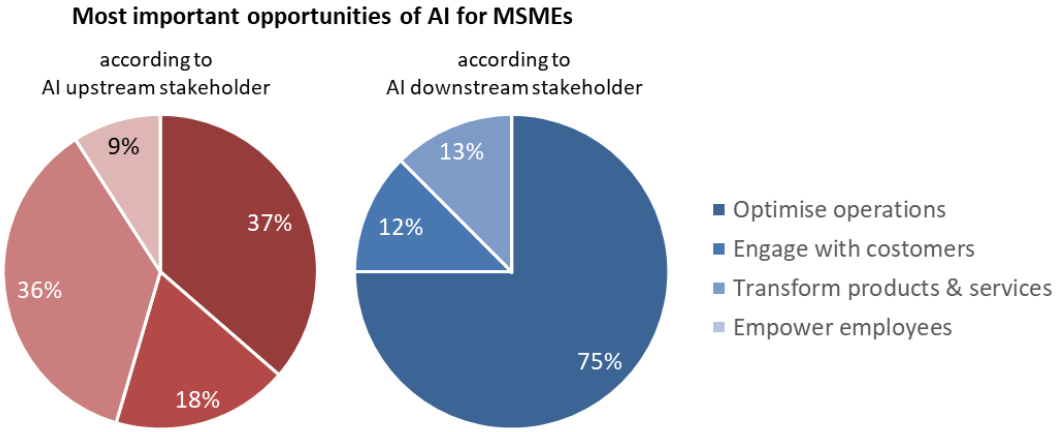
3.1.1.1 Opportunities of AI for MSMEs

The plethora of AI-driven use cases, ranging from **optimised operations to customer engagement, or from transformed products and services to employee empowerment**, are of relevance to MSMEs and large enterprises alike. Specific applications are however **very sector-dependent**. Such in-depth analysis with sectoral case studies is provided in 3.2, focusing on construction, legal services, health, accounting and accounting. As the overall topic of AI for MSMEs is still relatively unexplored, these case studies shall explore MSME-specific opportunities of AI in their sectors.[10]

Exhibit 12: AI-driven opportunities

Despite their homogeneity and sector-specific conditions, MSMEs face several shared challenges, which could be addressed by AI-driven solutions. Whereas MSMEs face **intensified competition through globalising markets**, multi-language **NLP-driven customer interfaces** could facilitate an MSME's market expansion efforts in third markets to punch above its weight. As MSMEs need to address **administrative burdens**, AI-driven automation and insights could make those administrative tasks easier, by **processing large volumes of data and documents**. And where the management of MSMEs suffers from a **lack of time** due to their limited staffing, AI-driven automation can **optimise operations and improve time management**.

Exhibit 13: Most important opportunities of AI for MSMEs according to AI upstream and downstream stakeholders



> - *There are already powerful tools available to optimise operations that are not based AI, the **most value comes from transforming your products & services** using AI.*
> - *I like to see AI tools as a way to **enhance human abilities** and performance.*

3.1.1.2 Threats of AI to MSMEs

Apart from the wide diversity in applications and use cases of AI for MSMEs, the very emergence of AI also comprises a series of economic and societal threats to Europe's smallest enterprises. **Economic threats of AI** consist of a series of factors with potentially disruptive effects on complete MSME sectors and include:

- A **growing inequality with larger firms** since MSMEs and SFTBs have less access to resources to invest, while they face organisational constraints to access AI and to recruit the necessary talent
- Increased commercial pressure as a result of **additional competition from 3rd players**. Non-traditional global players may leverage AI technologies to access news sectors through online platforms (e.g., big tech multinationals such as Uber competing with transportation MSMEs), even if they are based on the other side of the globe. MSMEs are particularly vulnerable to such extra competition, which is a reality they already face as a result of globalisation
- The large-scale disruption of complete sectors, due to the "**winner takes all**" dynamic of AI-driven business models[11], allowing enterprises to operate at a large scale and to acquire a large market share at high speed
- **Decreasing competitiveness**, as AI-driven businesses are able to develop completely new AI-based business models and services, making the traditional business models of MSMEs less competitive or even redundant; can conquer market shares at high speed, and can use AI for accelerated R&D processes with which MSMEs are not able to catch up. The fact that AI is becoming a critical element to remain competitive – and increasingly mainstream amongst larger enterprises – further enhances this threat
- **Job losses**, as a result of increased automation, the decreasing competitiveness and additional competition from third players, and **additional talent and skills requirements** to operate and interpret AI-driven technologies

Exhibit 15: Economic threats posed by AI to MSMEs in Europe

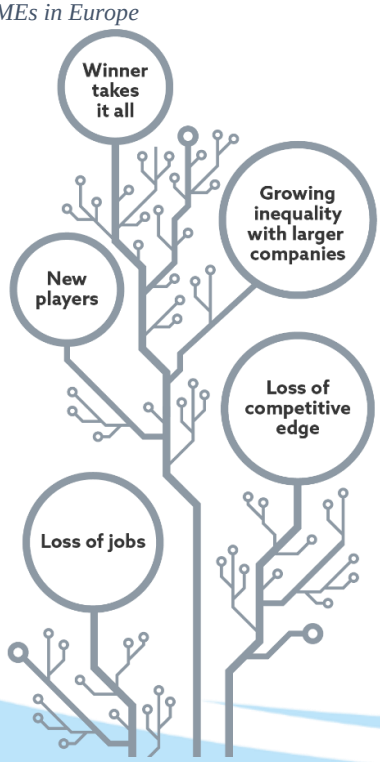
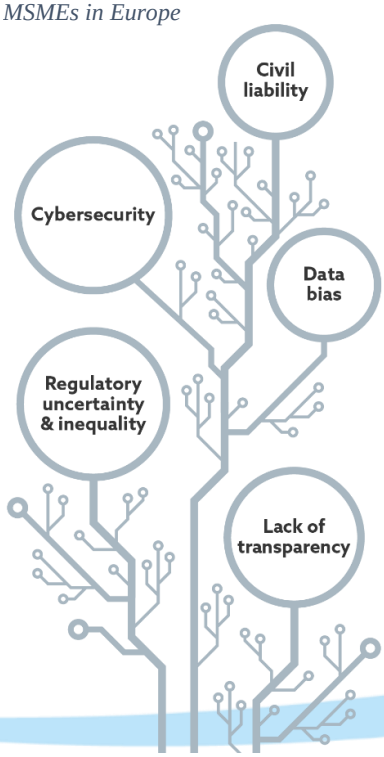


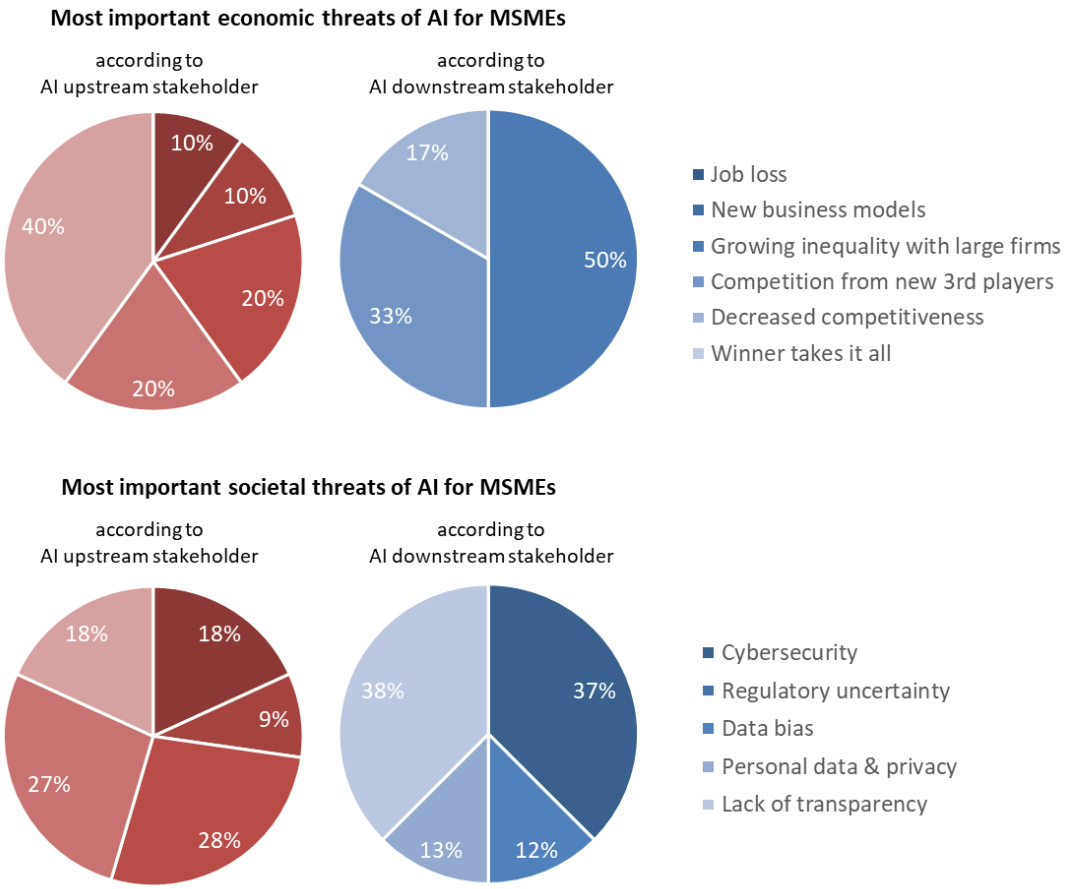
Exhibit 14: Societal threats posed by AI to MSMEs in Europe



Also, the widely discussed **societal challenges created by AI** could pose a threat to MSMEs, including:

- The current lack of a **regulatory framework** for AI creates uncertainties and risks at the level of **civil liability**. For example, it is unclear who is responsible if an AI-driven technology causes damage to third parties. This uncertainty increases the risk for MSMEs to use AI and requires a high level of investment in time and research to investigate related risks and requirements. In addition, MSMEs do not have the ability and capacities to shape their environment and bargain with regulators.
- Uncertainties with regards to regulatory standards include issues such as **cybersecurity**, the use of **personal data** (and GDPR-compliance), the required **levels of transparency** to use personal data e.g. predictive or prescriptive algorithms as a "black box" for automated decision-making, as well as ethical questions with regards to **facial recognition**, **privacy** and a **potential data bias**.

Exhibit 16: Most important economic and societal threats according to AI upstream and downstream stakeholders



3.1.1.3 Impacts of AI on existing MSME challenges

In recent years, MSMEs have faced a series of **complex challenges**, rendering them a vulnerable category of enterprises. Challenges include:

- Accelerating innovation and digitalisation and resulting new business models
- Increased skillset demands
- Limited access to financial markets
- Administrative burdens
- Intensified competition through globalising markets
- Organisational issues like a lack of time and a forward-looking management
- Absence of skills to anticipate and adapt to changing trends
- Little ability to shape their external environment, while they miss the bargaining power to enforce their needs[12]

In particular, **SFTBs have faced difficulties**, as they are not well equipped to adapt to a fast-changing business environment, lose competitiveness as they face changing business models (e.g., digitalisation), have limited access to resources (e.g. financial, human capital, information), face organisational constraints and have little ability to shape their external environment.

SFTBs are furthermore characterised by their desire of passing the business onto the next generation inside the family, instigating a level of **rigidity and compromising their agility** to address a rapidly changing and competitive market and society.[13] Their lack of dynamic middle management is a bottleneck to drive internal innovation processes, challenging SFTBs to change their development strategies and to recruit employees also in management positions.[14]

Also, the so-called **mono-entrepreneurs** (which represent nearly 50% of MSMEs), are vulnerable as they are relatively excluded from support measures.

Exhibit 17 summarises the opportunities and threats posed by AI in view of MSME-specific challenges.

Exhibit 17: AI opportunities and threats to existing MSME challenges

MSME Challenges	AI Opportunity	AI Threat
Accelerating innovation and digitalisation and resulting new business models	Leveraging of AI for market expansion despite the limited size	Added pressure for MSMEs to catch up with the pace of AI-innovations
Increased skillset demands	Outsourcing of skills-intensive tasks (e.g., multi-language customer interfacing) to AI technology	Additional AI skills and awareness requirements
Limited access to financial markets		Additional investments required in AI solutions and process adaptation to remain competitive
Administrative burdens	Automation of administrative tasks and processing of large volumes of administration	Additional administrative pressure to ensure GDPR-compliance, verify regulatory context, current high risk of processing personal data due to legal uncertainty
Intensified competition through globalising markets	Leveraging of AI for market expansion despite limited company size	Additional competition from non-traditional third players
Organisational issues like a lack of time and a forward-looking management	AI-driven automation to optimise operations and improve time management	Added pressure on management to onboard AI-driven processes and skills training
Absence of skills to anticipate and adapt to changing trends		Disadvantaged position of MSMEs to adapt to new AI-driven trends and services. Risk of unequal competition with big tech and large enterprises
Little ability to shape their external environment, while they miss the bargaining power to enforce their needs	AI-driven insights and predictions to monitor market and policy developments and to identify business opportunities	Disadvantaged position of MSMEs to monitor or influence the ongoing regulatory process on AI, risking a one-size-fits-all approach, in particular to micro-enterprises and SFTBs

3.1.1.4 Challenges to AI adoption by MSMEs

To remain competitive vis-à-vis large innovators or new market players, and to capture the opportunities of Artificial Intelligence, it is essential that MSMEs can adopt AI technologies and services. MSMEs by nature are sufficiently agile to benefit from open innovation.[15] Their simple organic structures and shorter lines of communication and hierarchy should allow for a faster reaction to changes in the market, environment or technology.[16] At the same time, MSMEs are a heterogenous group of companies. Micro-enterprises, mono-entrepreneurs and SFTBs for instance benefit from fewer economies of scale, less financial and operational capacity and a level of managerial rigidity compared to large enterprises.

Large businesses are more likely to be AI adopters

According to a recent survey by the European Commission, 39% of large enterprises in the EU use two or more AI technologies compared to only 21% of micro-sized and 22% of small enterprises.[17] Large enterprises benefit six times more from the analysis of data from smart devices and sensors, and MSMEs threaten to become a victim rather than a beneficiary of Industry 4.0.[18]

This limited AI uptake is driven by a series of obstacles, presented by Exhibit 20. Some of these are **internal**, as a result of company-specific challenges and processes. Others are **external**, as a result of market-specific realities.

Any impactful adoption of AI technology starts with AI awareness

Even if an MSME does not directly work on AI at the technical level, its executives must at least have a basic **understanding of what AI is**, which technologies and solutions exist and what it can do, in order to consider the costs and benefits to the enterprise.[19]

MSMEs often face organisational problems and lack dynamic **middle management**[20,21], complemented with a certain **scepticism towards new and emerging technologies, including AI** [22] This is exactly the level at which new technologies and processes can be advocated and implemented, and where larger enterprises have an advantage due to their economies of scale and capacities to drive such processes.

Due to this **awareness gap** amongst executives, MSME owners and managers simply do not know where they could apply digital solutions in their daily operations and activities.[23] At the level of AI implementation, technical and IT staff are often in the lead of these processes focusing on the technical side, whereas the business case is insufficiently considered. Therefore, the business case and ROI of AI applications are unclear.

MSMEs require the right talent, skills and expertise to adopt AI solutions

It takes a considerable effort to successfully implement AI solutions.[24] **Complex algorithms are difficult to understand and trust**[25]. This is particularly critical for smaller companies. Up to 42% of micro-enterprises have flagged the difficulty to understand algorithms as an adoption issue, versus only 36% of large enterprises. The development of a tailored AI-driven solution, therefore, requires **profiles that combine technology with domain-specific expertise**.

Such profiles are extremely hard to find, are expensive and are typically more eager to join start-ups.[26] The **recruitment of new staff with the right AI skills** is the most pressing challenge for AI adoption to companies in Europe, faced by 56%-58% of MSMEs but also 59% of large corporates.[27] MSMEs are particularly vulnerable to this reality, as they do not possess the financial resources to compete with large companies for skilled manpower.[28]

Apart from the recruitment of new staff, up to 46% of MSMEs also indicate the **lack of skills among existing staff** as an uptake problem (versus 44% of large enterprises).[29] The needed AI skills in the order of importance are in **programming, big data management, machine learning or modelling, cloud computing and robotics.** These are mostly required by large companies and less by MSMEs.

To get their AI adoption started, MSMEs look at external solutions and expertise, underlining the importance of **B2B partnerships** to access AI know-how. Nevertheless, MSME employees still require the skills and training to work together with AI solutions in their daily activities.

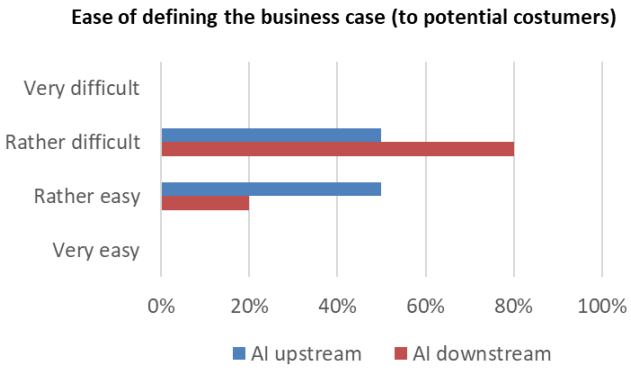
Adopting AI technologies is costly – but for which benefits?

The relatively high cost to implement AI solutions is beside the lack of available talent the second most pressing obstacle to AI adoption. Between 51%-53% of MSMEs indicates the **cost of adoption** as a major obstacle (compared to 55% of large corporates), whereas 48%-50% of MSMEs see the **cost of adapting operational processes** as an adoption obstacle (compared to 49% of large enterprises).[30]

Although the cost of AI adoption is an equally large problem for large enterprises as for MSMEs, smaller enterprises are particularly vulnerable since **they lack the financial resources** to invest in new technology.[31]

Aside from the absolute costs to adopt AI technologies, also the relative cost-benefit, the **ROI and the business case are often unclear to MSMEs**. On the one hand, company owners and executives do not possess the skills and know-how to assess where to apply AI solutions.[32] At the same time, the relatively high cost of in-house developed AI solutions, or the high cost of new operational processes, often fail in the AI business cases.

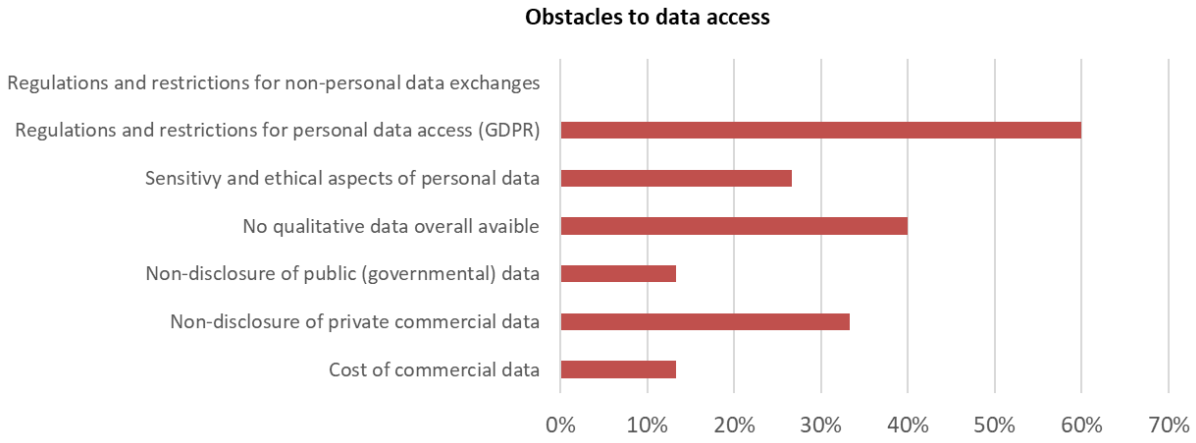
Exhibit 18: Ease of defining the business case



AI needs to be fed with data. But which data?

To train algorithms, (lots of) data need to be fed into the system. The impact of AI can be slowed by the lack of data in specific situations or sectors. Due to their smaller size and operations, MSMEs have a **natural disadvantage vis-à-vis larger enterprises** in this regard. In a recent survey, 20%-21% of MSMEs pointed at the lack of internal data as an obstacle to AI adoption, compared to only 16% of large enterprises. This is a sizable difference. Companies can also use external data to train their algorithms, provided that they have access to such data sets.

Exhibit 19: Obstacles of data access



Digitalisation levels determine the speed, cost and feasibility of AI adoption

Large quantities and volumes in data do not suffice. An enterprise must have **effective data management** practices. **Data sets must be collected, integrated, harmonised, tagged and classified**. The cost, speed and efficiency of such processes also depend on the existing data infrastructures and legacy systems. The onboarding and integration of data sets can be a costly process and may compromise an MSME's business case for AI early in the process.

This harmonisation requires an appropriate **data infrastructure** and may demand the **modernisation of internal legacy systems**.[33] Such a process can be time-consuming, costly and long-term. In large enterprises, middle management contributes to such impulses, but this level is missing in MSMEs.[34]

Figures show that **insufficient or incompatible IT infrastructure** is an obstacle to AI adoption for 39% of micro-enterprises, 35% of small enterprises and 33% of medium-sized enterprises vis-à-vis 36% of large enterprises. This indicates that **micro-enterprises are disproportionally affected by this AI adoption obstacle** which is not surprising, as MSMEs are known to face challenges in anticipating and adapting to digitalisation trends.[35]

Vision and leadership drive AI adoption processes

MSME managers often lack the awareness and know-how to assess AI use cases in their firms, rendering them unable to identify the business case and ROI. At the same time, when AI solutions are explored, enterprises delegate technical staff rather than executives to discuss their implementation. MSMEs, where executives have a level of AI leadership and vision, have a higher chance of successfully adopting AI solutions. This can be complemented by an **open and agile culture**, where experimentation is encouraged, combined with innovation and learning orientation and centralised decision-making.[36]

To implement such a vision, MSMEs require an **appropriate organisation, culture and business models**. Old organisational structures and the lack of sophisticated middle management are an impediment to drive successful AI adoption.[37] SFTBs, micro-businesses and mono-entrepreneurs are particularly rigid in this regard as a result of their family and tradition-bound development and the lack of forward-looking management.[38]

Size and maturity matter

Large companies can benefit from their **economies of scale**, have the budget and capacity to implement complex and long-term processes, and have the financial resources to **purchase tailored AI-driven solutions** or to embark on the **"war for talent"** to recruit AI experts.[39] In addition, large enterprises can leverage their financial resources to invest in market expansion, investigate complex regulatory regimes and bargain with regulators.

MSMEs, on the other side, lack the middle-level management to drive long-term AI adoption processes and often miss the financial means to develop AI solutions in-house. They are furthermore particularly vulnerable to a complex regulatory environment and are unable to shape their environment. MSMEs possess fewer data volumes, need to deal with an outdated IT infrastructure and lack the skills to understand complex algorithms. However, MSMEs do possess the advantage of **high agility**, allowing them to move faster and to adopt AI relatively quickly. More mature companies tend to have higher expectations of AI to transform their products and services[40], and traditionally dispose of more data.[41]

Access to AI expertise is key but lacking

As indicated in the point "**MSMEs require the right talent, skills and expertise to adopt AI solutions"**, MSMEs require talent, skills and expertise to develop AI solutions. The existing difficulty and cost to recruit AI expert profiles is a severe obstacle to AI adoption. However, external solutions and expertise under the form of **accessible AI and B2B partnerships** appear to provide an alternative.

The in-house development of AI solutions is most common with large enterprises (28%) and far less with micro-enterprises (19%). MSMEs rather resort to **ready-to-use systems** (57%-60%) or hire external providers to develop solutions (35%-38%).[42]

This demonstrates the **dependency of MSMEs on existing AI software and services and the availability of external providers** in their markets. Therefore, the existence of an AI-providers market, ecosystem or cluster is a prerequisite for MSMEs to access AI-driven solutions. As a consequence, AI adoption also depends on the **availability of and access to local AI expertise**. However, the currently **fragmented EU market of MSMEs in AI tools** has led to little market awareness on the side of potential customers and clients.[43]

Access to finance could mitigate costly adoption processes

The costs of AI adoption and the costs of new operational processes threaten the business case of AI in MSMEs, posing an adoption obstacle. MSMEs often lack the financial resources to invest in new technologies and are at a disadvantage vis-à-vis larger corporates. Access to appropriate financing could mitigate this disadvantage. However, banks are often not well-tailored to the needs of vulnerable MSMEs such as SFTBs and mono-entrepreneurs. At the same time, **public or external financing is lacking**. Between 36% and 38% of MSMEs have flagged this as a major external obstacle to AI adoption compared to only 32% of large enterprises.[44]

Access to external data could mitigate the lack of internal data

Whereas MSMEs by nature possess less internal data than large enterprises, AI systems could resort to external data to train their algorithms. Such **external data needs to be accessible**, however, and this is not yet the case. Between 26% and 27% of MSMEs indicate the **lack of access to high-quality private data** as an AI adoption obstacle compared to 33% of large enterprises. This is also the case for the lack of access to public data, which is considered as an AI uptake obstacle by 20%-23% of MSMEs.[45]

Standards for data exchange

Strict standards for data exchange (e.g., the GDPR-regulation and data protection laws) are considered as a (potential) AI adoption obstacle by 32%-34% of MSMEs, compared to 40% of large enterprises. [46] This reality signals that, while regulatory restrictions protect consumers and their personal data, and reflect EU values, **data exchange standards that are (too) strict could also stifle AI adoption**.

Regulatory Regime

Between 28% and 31% of MSMEs indicate that the **need for new laws and regulation** is an obstacle to their AI adoption. [47] A major case in point is the current level of uncertainty with regards to **liability rules for damage caused by artificial intelligence**, which differ across the Member States and for which an EU-wide approach is still pending. Between 31%-34% of MSMEs sees this as a major external obstacle to AI adoption, compared to 38% of large enterprises.[48]

Other domains for which a regulatory regime is still pending include the **IP framework to enhance access to and use of data, downstream domain-specific regulations** (e.g. use of AI in healthcare or transport for autonomous driving), but also **ethical concerns** related to the human agency and oversight, technical safety, privacy and data governance, transparency, diversity, non-discrimination and fairness, societal and environmental well-being and accountability.[49]

Fragmented EU market

The EU market is fragmented at different levels. In terms of **AI technology providers**, the fragmentation has led to little market awareness on the side of potential customers.[50] Europe features local and asymmetric ecosystems which are no competition to the bigger players from the US and China.

In terms of **data access and data standardisation**, data exchange standards and restrictions, regulatory regimes and AI adoption strategies are Member State-driven, leading to fragmentation. A level of harmonisation – and economies of scale – are an obstacle to widespread AI adoption, as large datasets are a prerequisite to train AI technologies. At the **technological level**, Europe's **cultural and linguistic diversity** may pose additional barriers to AI adoption. NLP algorithms strongly depend on language, and a successful system in a market with language A is not easily transferred to a market with another language B.

Citizens lack trust in AI

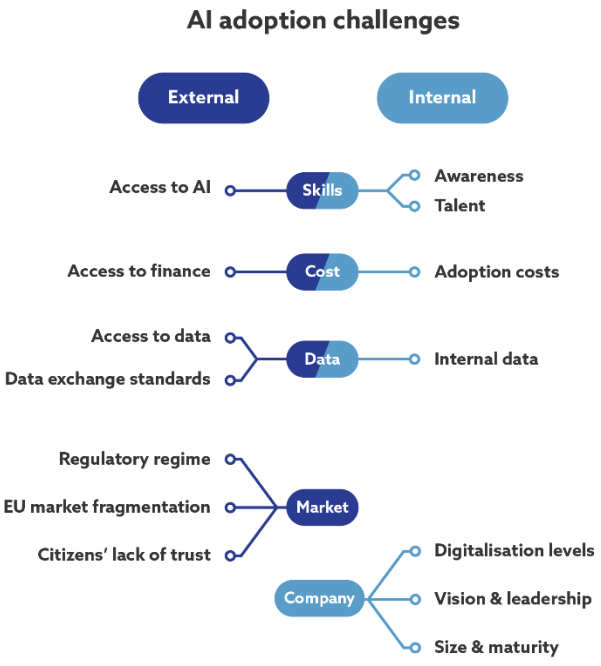
MSMEs have also pointed at the **lack of trust amongst citizens** as an obstacle to adopting AI in their daily operations (27%-29% of MSMEs), or even the **reputational risks** linked to using AI (16%-19% of MSMEs).[51]

> - *AI can support us to speed up decision making processes, however we should never think that an AI can run itself without human maintenance and intervention.*
> - *AI needs to be tackled as a service because of the properties of AI systems: Retraining and supervision is necessary as the AI has a constant drift.*

The abovementioned internal and external obstacles to AI adoption come down to five categories, namely:

- **Skills**: AI awareness, availability of trained employees, recruitment of skilled experts, or access to technology providers for B2B partnerships and AI development
- **Cost**: cost to finance AI adoption and internal transformation processes, and the access to external financial means to invest in such processes to define a successful business case for AI
- **Data:** availability of internal data sets, and the implementation of data management practices. Access to external (private and public) data sets, and the presence of predictable but sufficiently flexible standards for data exchange
- **Market:** market-specific conditions, including a predictable and transparent regulatory regime, harmonised across the Member States. The clarity in terms of liability and AI ethics, thereby contributing to the trust and confidence by citizens, and the reputation of businesses using AI in their operations.
- **Company:** company-specific conditions, including digitalisation levels and the presence of (outdated) IT legacy systems, organisational aspects such as leadership, AI management and a future-oriented vision, but also the size and the maturity of a company.

Exhibit 20: Challenges to AI adoption by MSMEs

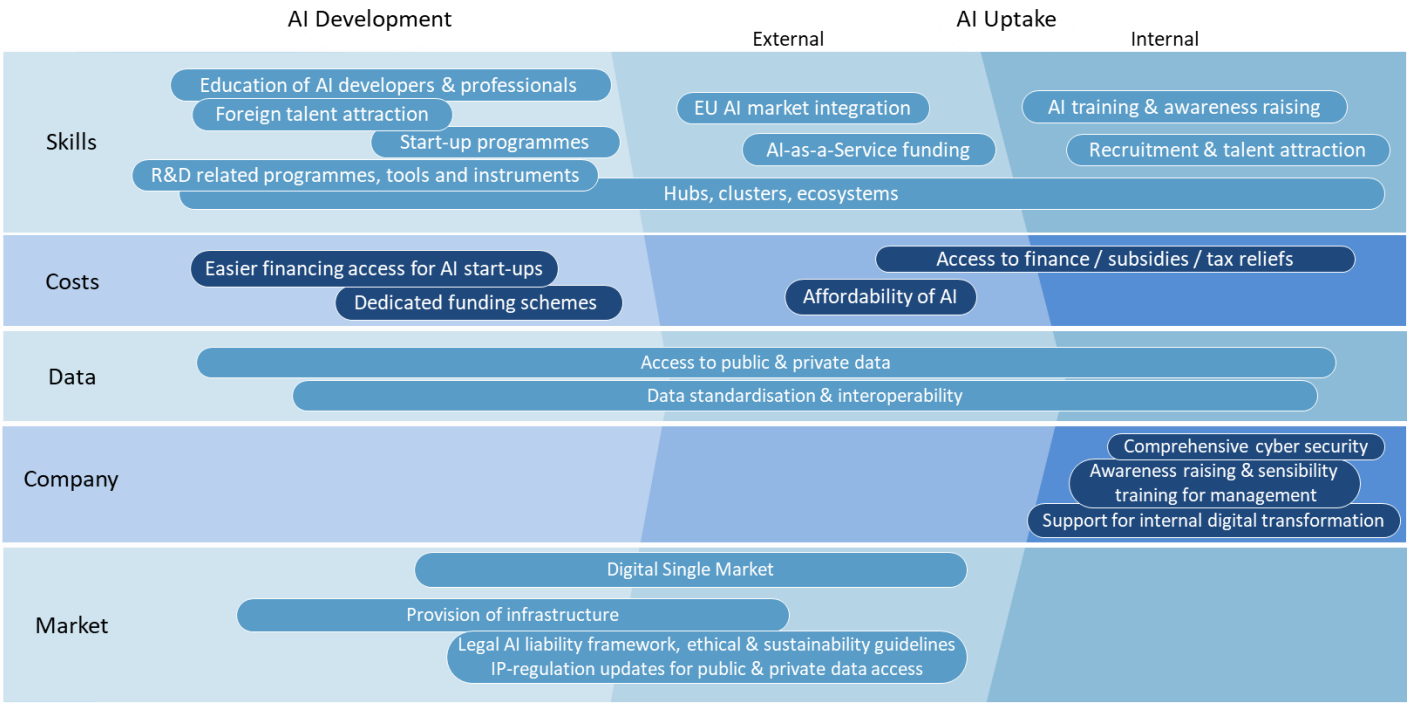


3.1.2 Policy initiatives and approaches

Exhibit 21 presents a high-level mapping of existing policy initiatives and approaches, aiming to facilitate AI adoption by MSMEs. The initiatives address the diverse internal and external uptake challenges identified in chapter 3.1.1.4 and are categorised under the same denominators of **skills, costs, data, company and market conditions**. This mapping served as a basis to perform a deep-dive assessment of the AI MSME uptake approaches by five EU Member States in section 3.3.

As one of the identified external uptake challenges focuses on the **availability of external AI expertise**, through accessible AI, B2B partnerships, ready-to-use systems and the presence of external providers, it could be argued that the existence of **an ecosystem of AI development and AI expertise is a prerequisite for AI uptake**. Policy initiatives to stimulate AI development have hence been included in the equation.

Exhibit 21: Mapping of policy initiatives & approaches



A detailed explanation of each potential policy measure can be found in Subsection 5.3.

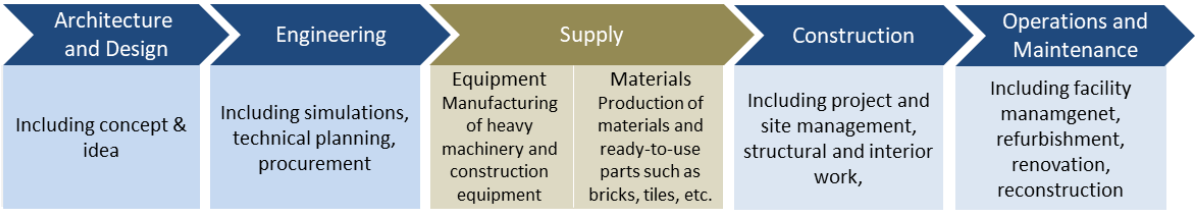
3.2 Sector specific reflections on AI uptake

3.2.1 Construction sector

Context

The construction sector includes activities related to the development and construction of buildings, civil engineering projects and so-called specialised construction activities, including e.g., demolition activities, floor and wall covering, roofing activities and painting.[52] MSMEs constitute 95-99 % of all companies in the European construction sector[53], which can be found along the whole construction value chain excluding the supply of equipment and materials (see Exhibit 22). Enterprises with less than nine employees represented 94% of all enterprises active in the sector, while large enterprises represented less than 0.5%.[54]

Exhibit 22: Value-chain of the construction sector



As "one of the pillars of the EU economy", in 2017, the European construction sector employed over 18 million people and added a value of 9% to the EU GDP.[55] The revenue of the European construction industry was expected to rise from EUR 2 bn in 2016 to over 2.5 bn in 2020.[56]

Despite its strong numbers, the European construction sector is facing numerous key challenges:

- Construction MSMEs are characterised by **decreasing innovation**, decreasing efficiency **and low rates of technology adoption**[57]
  - Companies in the sector have difficulties keeping up with the **fast-developing digital shift**.[58]
  - An example of digital innovation in the sector is Building Information Modelling (BIM), which allows for digital planning, lifecycle and supply-chain modelling of buildings and infrastructure and to integrate 3D modelling inputs from architects, engineers, and manufacturers in one single model. However, BIM implementation is **led by large companies** and MSMEs have limited BIM experience. As of 2016, 29% of EU construction companies used BIM 3D.[59]
  - Despite safety increases, **high numbers of accidents per year** are the main driver of construction delays and cost overruns.[60] Around 90 % of so-called megaprojects face significant delays.[61]
- The construction sector was affected severely by the **2020 Covid-19 pandemic** as many construction projects were put on hold during the pandemic, putting a hold on the constant growth of the construction industry for the first time since the financial crisis of 2008.[62] After an unprecedented decline in March and April, construction production picked up again in the subsequent months. In September 2020 95.7 % of the pre-crisis level of February 2020 had been regained.[63]

- In general, fragmentation within the construction industry arises from two areas within the traditional construction process; the construction work process where the most significant division is in the separation of the design and construction phase, and the construction structure itself. The fragmentation process in traditional contracting practice further hinders the creation of a joint data set, the use of a common tool and system to exchange information and the integration of construction knowledge among contractors.

AI risks & threats

To make the best use of future AI applications in the construction sector and exploit their full potential, risks & threats must be considered.

As in every other sector data, ownership and security are an essential piece and its proper handling also holds risks & threats. **Data ownership needs to be clearly communicated** already during the early planning stages to avoid later possible disputes between clients, (sub-)contractors and partners. If not addressed accordingly, data ownership disputes can lead to delays and cost overruns.[64]

In the case of personal **data protection**, GDPR standards must be maintained at all times to avoid fines and even criminal prosecution. This accounts especially for AI applications with facial recognition of workers, or where personal data is used in the planning process.[65] Especially MSMEs who are not yet well educated in the use of AI systems should therefore seek legal advice to comply with data ownership and data protection regulations before deployment.

Further, AI systems need protection from cyber-attacks with according **cybersecurity** systems. Failure in providing required systems can lead to data breaches of potential personal and sensitive data (e.g., bank and payment details), as well as sabotage of automated systems.[66]

Future **predictions of job losses due to AI vary**. Some see AI as a potential cause of massive job losses, predicting human-free construction sites as soon as 2025, and up to 600.000 labour job losses until 2040.[67] Others argue AI is unlikely to replace the human workforce, instead only altering work processes and supplementing the already existing human workforce with error reduction and increased site safety. Life-long learning and social security measures must be taken into account in any case to catch those who could potentially face AI-induced job losses.

Exhibit 23: Use case: AI-assisted applications

Use case

Building Radar: AI-assisted applications

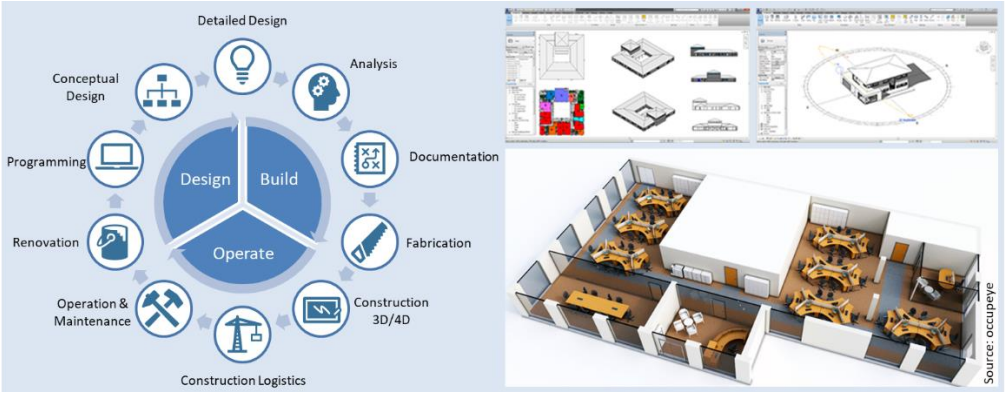
Munich-based start-up Building Radar uses AI and machine learning to help construction companies identify new possible construction contracts, help them to keep track of the building progress and detect possible shortcomings and delays in the process.

AI is collecting and analysing construction offers online identifying about 5000 new construction projects from 100000 sources every day. The company uses e.g., satellite imagery and BIM data to keep track of construction processes. Building Radar claims that its solution helps construction companies to identify new possible contracts 103 days earlier, giving them a competitive edge.

AI potential and added value

Keeping in mind above mentioned risks & threats, as well as the overall slow adaption of digitalisation in the sector, the global AI in the construction market, is currently anticipated to generate revenues of up to EUR 2 bn by 2026.[68] The main driver of digitalisation in the sector is Building Information Modelling (BIM). It serves as the focal software platform for integrated design, modelling, planning, and collaboration, thereby "providing all stakeholders with a digital representation of a building's characteristics in its whole lifecycle".

Exhibit 24: Building-Information-Model (BIM)



AI impacts all segments of a typical value chain of the construction sector:[69,70]

- **Project lead & project management automation:** Construction lead technology finds new construction projects automatically allowing to improve the sales and leads strategy. Drone supervision of construction progress and construction sites using computer vision allows for project management automation.
- **Generative design process:** Generative design, an AI-based design exploration process, develops design variations and checks the architectural statics and other parameters of the building (e.g., compliance with building regulations, fulfil all functional requirements), which is otherwise a very time-consuming process.
- **AI-enabled engineering:** AI-supported BIM systems allow for the digital planning as well as lifecycle and supply-chain modelling of buildings and infrastructure. The design of mechanical, electrical, and plumbing systems, but also other aspects such as energy efficiency and statics can be modelled.
- **Reduction of delays:** AI-enabled software can effectively plan construction execution, update construction sequences, and manage task incl. the necessary communication with all involved stakeholders to reduce delays. AI tracked progress based on the BIM can automatically oversee and compare digital twins in BIM models with actual progress made on a site to flag possible delays and shortcomings early.
- **Optimisation of supply:** By integrating the product manufacturer(s) into the Building Information Management (BIM) software of a project, AI automation can help product manufacturers to predict and deliver exactly needed quantities of materials and products based on real-time data, thus limiting excess material and optimising supply chains.
- **Optimisation of construction site logistics:** At construction sites, approximately one-third of the time is spent on transports, rearrangements, downtimes, and the search for materials. AI enables faster detection of necessary tools (e.g., image processing and analysis can be used for tool tracking) and materials and a shift towards a just-in-time delivery of construction supplies.

- **Increased site safety and reduced accidents:** With AI-enabled drones and cameras and the use of image processing and analysis site safety can be increased, e.g., by scanning the construction side for safety hazards (oil spills, blind spots, …) or violations to safety regulations An AI-based solution can also be taught to inform staff whenever a possible safety hazard appears.
- **Robotisation and autonomous driving:** The construction industry relies primarily on manual-intensive labour with little to no automation. AI has the potential to simplify the use of heavy machinery drastically. Robotisation and automated vehicles can automate material provision and conduct various labour tasks such as floor tiling or masonry.
- **Predictive Maintenance through sensors on-site:** Using sensors, AI systems can keep track of building and infrastructure statistics and predict system failures and required maintenance.

These applications provide an added value in different dimensions of construction projects. Ranging from operations optimisation to employee empowerment, AI covers a wide array of functionalities as demonstrated below:

Exhibit 25: AI functionalities and construction use-cases

	Optimise Operations	Customer Engagement	Products & Services Transformation	Employee Empowerment
Prediction	▪ Predictive maintenance through sensors on-site ▪ AI for BIM systems flagging possible delays and shortcomings early ▪ Flagging of potential hazards	▪ AI-supported BIM systems to better predict possible cost and time overruns		▪ Predictive risk assessments and prediction of safety violations ▪ Increased site safety through image processing and analysis to spot potentially hazardous areas
Automation	▪ Project lead & project management automation ▪ Robotisation and autonomous driving		▪ Additive manufacturing (3D printing) to automate prefabrication ▪ BIM integration of manufacturers to predict required material quantities	▪ IoT to improve coordination & communication at a construction site
Generation of insights	▪ AI for BIM systems providing oversight to site progress ▪ Faster detection of needed tools and material	▪ Real-time overview of project status for customers		▪ Predictive maintenance through sensor utilisation
Personalisation	▪ Communication of construction progress and changes to relevant involved stakeholders	▪ The quicker design process enables a more involved costumer	▪ Generative design process that adapts to all requirements	
Prescription			▪ Automated simulation of the design of engineering elements, to fit all requirements of the building	

However, AI technology is oftentimes not mature enough for many use cases in the construction industry. Moreover, in many manual tasks, AI can only be used indirectly once the data is available.

Exhibit 26: Use-case: solving the data problem

Use case

SDaC: Addressing the data problem in construction

How does the construction sector tackle the problem of missing data?

"Smart Design and Construction" (SDaC) is a consortium under the lead of the German Karlsruhe Institute of Technology, which aims at collecting and standardising already existing and future construction sector data on one platform. The open API approach allows AI software developers to draw from the data pool and publish related apps within the platform. The platform is especially aiming at supporting MSMEs by providing them with data gathered by larger firms.

AI uptake levels and challenges

The adoption of AI technologies in the construction sector is relatively low. A recent European Commission study revealed that 36% of companies in the construction sector have at least one AI technology adopted (compared to 42% across sectors), with 23 % at least two AI technologies. However, only 16 % of construction companies plan to use more AI in the future.[71] These uptake numbers, as well as the following ones from the same study, have to be used with caution as it has to be assumed that they include, e.g., the use of Google services.

Several challenges to AI uptake in the sector can be identified:

- **Skills**: Construction sector workers are typically not knowledgeable or lack access to digital tools that could facilitate their work.[72] The BUILD-UP initiative is an EU project focusing on the education of craftsmen, however not focusing on new technologies. The construction companies would need talented data scientists and developers to create the required and tailored AI software. However, these professions tend to **demand high salaries which MSMEs might not be able to provide**.[73] A growing start-up market or commercial-off-the-shelf solutions, delivering pre-made AI software solutions could help MSMEs to bypass the need for their staff.
- **Cost**: Due to the fractured construction sector there is a **lack of investments to support and enable R&D for digitalisation** in the construction sector.[74] As mentioned, high salaries for AI experts can be a hurdle to MSMEs. By providing pre-made AI software "ready-to-use", MSMEs can bypass the need for expensive AI staff. By providing the software solutions via "as a service" models, MSMEs can avoid extensive one-time investments into new solutions.
- **Data**: Lack of standardised software and data exchange formats, leads to issues in communication.[75] To implement AI technology effectively, tons of **specialised data** would be required which is currently not available. Companies within the construction sector should therefore share collected data for easier development of AI solutions.
- **Company**: European MSMEs in the construction sector are characterised by **decreasing innovation activity** and **low rates of technological adoption by MSME companies**. Executives of MSMEs are often aware of the potential of new technologies but lack the capability to digitalise their business due to difficulty envisioning the potential digitised future of their business, low digital maturity-level of the craftsmen and limited human resources.[76]
- **Market**: Construction entities have a strong focus on a specific lifecycle phase and supply-chain level resulting in a lack of cooperation between companies, leading also to a limited number of R&D investments by construction firms for digitalisation.[77] The EU directive (2014/24/EU)49 on public procurement is the only policy instrument that clearly refers to the use of digitalisation

technologies, namely the BIM, in the construction sector. Current policy is insufficient to help and foster MSMEs to get more digital. **A better-suited policy** is required to tackle the aforementioned challenges and boost AI uptake alongside overall digitalisation amongst European MSMEs.

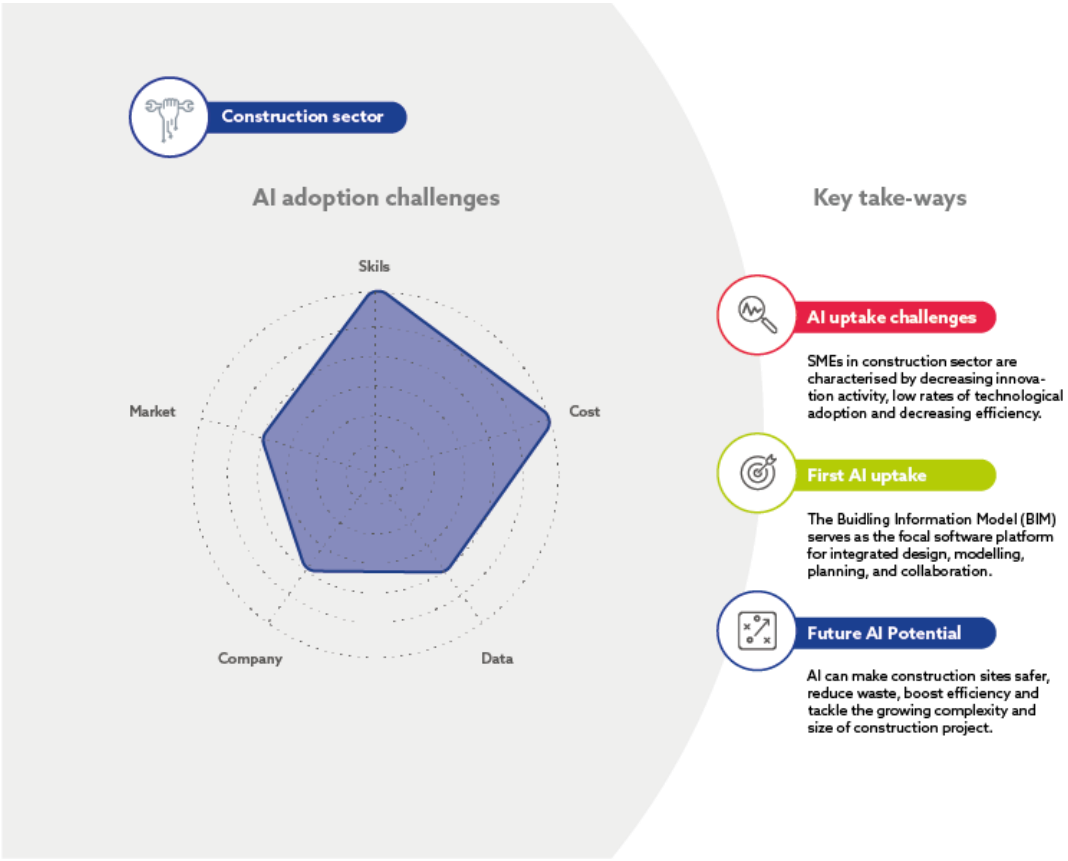
Conclusions and Best Practices

The sector generally is characterised by limited innovation. Due to highly specialised MSMEs operating usually within specific geographical areas, the sector is also very fragmented and only very **limited networking** is happening. The most significant challenges within the construction are the **lacking digital skills** within the highly manual sector and the cost of potential AI adoption. The large number of people involved in construction projects continues to pose a challenge for digitisation and data standardisation.

Apart from the BIM, which is mandatory for large, public construction projects, no digitalisation is highly adopted within the sector. As typical software products have high licenses cost, the willingness to change is also limited.

The **funding for R&D is very limited.** First initiatives such as "SDaC" and "AI meets BIM" focus on driving the use of AI in the construction sector. If BIM standardisation is extended to include AI techniques, planning, production or consumption data can be analysed automatically. But also the opportunity to make construction sites safer and reduce manual labour shows exciting developments for the future of the sector.

Exhibit 27: AI adoption challenges for construction MSMEs



3.2.2 Liberal professions: legal service market

Context

The legal service market includes activities such as legal representation and advisory services, general counselling and advising (including the preparation of legal documents), excluding state advocates and judges. [78] These operate in every sector of the legal spectrum including commercial, criminal, legal aid, insolvency, labour/industrial, family and taxation law. In Germany, which legal services sector is comparable to other western countries, less than 10% of lawyers work in a law firm with more than 10 employed lawyers, indicating a significantly higher proportion of MSMEs than the general economy.

With a market share of over 40 % and the highest revenue generation of the service market, the legal market is one of the largest service markets in the world[79] and the European legal service market is the second in size, following North America.[80] Recently, the European market has experienced a major boost because of the ongoing Brexit discussions, adding up to a market size of roughly EUR 170 bn in 2018[81]. Compared to other industries, the legal services market is relatively independent of the economic cycle and the seasons and has steadily grown with a CAGR of 2.6% between 2014 and 2018.

AI risks & threats

While AI and the involved changes may feel threatening to the legal services sector, the technology has also the potential to boost the legal profession and increase the opportunity for justice for many people. However, the following risks and threats must be considered:

- The dynamic role of a lawyer — one that involves strategy, creativity, and persuasion — cannot be reduced to AI-enabled software. However, legal AI technologies are expected to disrupt the business models of legal services firms by creating new and enhanced services, bringing new ways to engage and interact with clients, but also **challenging their current structure and economic model**. Lega platforms like "flight right" and "Blitzer" disrupt the market and challenge the current system by enabling everyone to access low-cost legal assistance.
- AI in the legal sector raises ethical concerns about competence, diligence, and oversight. AI software is often also termed as "**black box**", as the process is inaccessible to humans. This raises the question of how much to rely on technology that is **not transparent** without negligence of the diligence necessary in the legal sector. As there are multiple approaches to explain AI systems, this risk will not be present in the future.
- AI technologies are also **subject to bias** as it inherits biases from the provided data. Some AI software has been proven to reinforce racial and gender discrimination through e.g., weak facial recognition abilities of people of colour.[82]Due to further potential for injustice, algorithmic accountability will be necessary to ensure protection against potential consequences.
- Beyond data quality issues, significant **data privacy and cybersecurity concerns** also arise with the use of massive quantities of data by AI systems.

Exhibit 28: Use-case: AI-enabled legal research

Use case

Doctrine: Changing the legal services sector with AI

Laws and the links between them are not being published in ways computers can easily process. By applying cutting edge deep learning and natural language processing (NLP) technologies to extract structure out of the law and leveraging a semantic information retrieval system, French start-up Doctrine organises the world's legal information.

AI potential and added value

As of now, it is not predicted that AI will push aside existing personnel. It is more likely that AI will support them in rather mundane tasks and increase time efficiency as virtually all of a lawyer's tasks involve the processing of information. Possible areas of AI integration can be grouped into document analysis (e.g., contract analysis, document review, e-discovery and due diligence), legal research and practice automation[83]:

- **Contract and compliance analytics**: Negotiating and signing a contract is only the beginning. NLP-powered solutions can extract and contextualise key information. Sales, procurement, regulatory and finance functions can leverage and capitalize AI-enabled analytics.
- **Contract reviewing:** AI can detect complex dependencies and relations better than average lawyers. AI systems can automatically ingest proposed contracts, analyse their contents using natural language processing (NLP) technology, and determine which portions of the contract are acceptable and which are problematic.
- **AI-enabled due diligence**: One of the primary tasks that lawyers perform on behalf of their clients is thoroughly assessing a legal situation to correctly advise clients. As the process can be very time-consuming and tedious using AI can be used to extract relevant data, manage documents and compile reports.
- **Legal research assistance:** Legal research was historically a manual process that involved searching through physical caselaw volumes to find relevant precedents. AI-driven legal research technology has the potential to leverage advances in NLP to transform legal research including semantic models and the provision of nuanced perspective e.g., on how cases relate to one another.
- **Automating divorce settlements:** Divorce settlements usually follow a very specific pattern. AI bots could fully automate these processes, with human intervention only required were necessary.
- **Litigation prediction:** AI-supported prediction of case outcomes based on patterns from relevant precedent and cases with a similar fact pattern. This could be used to fast-track settlement negotiations and minimizing the number of cases that need actually go to trial.
- **AI-enabled pricing models:** Clients are increasingly requesting fixed-fee engagements or alternative fee agreements from law firms. Using AI companies can use their billing data to better understand their range and distribution of cost and offer competitive prices.
- If law firms immediately used all new legal technology, attorneys' working hours would decrease by approximately 13 per cent.[84]

Exhibit 29: Use-case: AI-enabled patent management

Use case

iamIP: AI-enabled patent management

By tradition intellectual property, although having great importance, is considered boring, tiring and expensive with its paper-based and manually handled processes. The patent engineers and founders of iamIP have encountered various frustrations on a daily basis in their work with intellectual property globally such as no transparency, difficulty to collaborate and share important information, complex workflows and a lot of data that was difficult to handle manually.

As 100.000 new patents are published every week; making the complexity ever-increasing; proper tools are necessary to handle the complexity of the task. iamIP's patent software has a proprietary patent database with more than 100 million individual patents.

Exhibit 30: AI functionalities and legal service use cases

	Optimise Operations	Customer Engagement	Products & Services Transformation	Employee Empowerment
Prediction	▪ Litigation Prediction		▪ Litigation Prediction	
Automation	▪ Contract reviewing ▪ Contract & Compliance Analytics	▪ Automated Divorce Settlements	▪ Automated Divorce Settlements ▪ Low-cost legal assistance (e.g., flight right)	
Generation of insights	▪ Contract reviewing ▪ Contract and compliance analytics			▪ Legal research assistance
Personalisation			▪ Customisation of legal service and actual cost spent	
Prescription		▪ Contract analysis		

Current AI uptake levels and challenges

Developments of data-driven technologies, including AI, are expected to bring a "significant disruption to long-established practices [in the legal services sector]".[85] However, when thinking about respective technology, some major challenges can be identified which could hinder a sufficient AI uptake:

- **Skills**: Legal services firms are reluctant to use AI-based technologies as this requires a significant transformation of established practices and structures that restrict innovation in business practices, as well as a skill gap and fears about data security and handling.
- **Cost:** There is huge cost pressure on law firms and fierce competition. Legal technology can enable law firms to work more efficiently and hence offer more competitive prices to their prospects and customers. Many law firms use third-party tools for legal research based on accessible information for all and accidentally use AI. Custom tools built on the knowledge within a firm, are limited to large firms due to their relatively high cost.
- **Data**: As legal services usually include sensitive client data, the legal sector holds similar challenges to sensitive data protection as the accounting and health sectors (see below), making the gathering of sufficient and qualitative AI training data a challenging task. Law firms are "document rich and data-poor" and public data such as judicial decisions and opinions are either not available or so varied in formats as to be difficult to use effectively. Poor quality or flawed datasets can also cause AI systems to output biased results.
- **Company**: The firms in the legal services market are characterized by great heterogeneity in terms of size and focus (including specialisation, clients and region). The legal service market is "**profoundly under digitised**", **traditionally bound** and notoriously **slow to adopt new technologies and tools**.[86] Innovation has tended to be considered a low priority by professional services firms, leading to a generally resistant approach in the sector to the potential for new technologies to change traditional business practices.
- **Market**: There are many concerns that AI algorithms are inherently limited in their accuracy, reliability and impartiality, potentially requiring a legal and ethical framework at the market level to guide investments. Also, the liability is unclear. At the level of access to AI solutions, the legal service market is overlooked by entrepreneurs, limiting the possibilities of adopting new AI tech. [87]

There is no clear data available on current AI uptake levels in the legal services sector, however keeping in mind the above-mentioned challenges and the state of an "under-digitized" landscape, we expect effective AI uptake to be quite minimal.

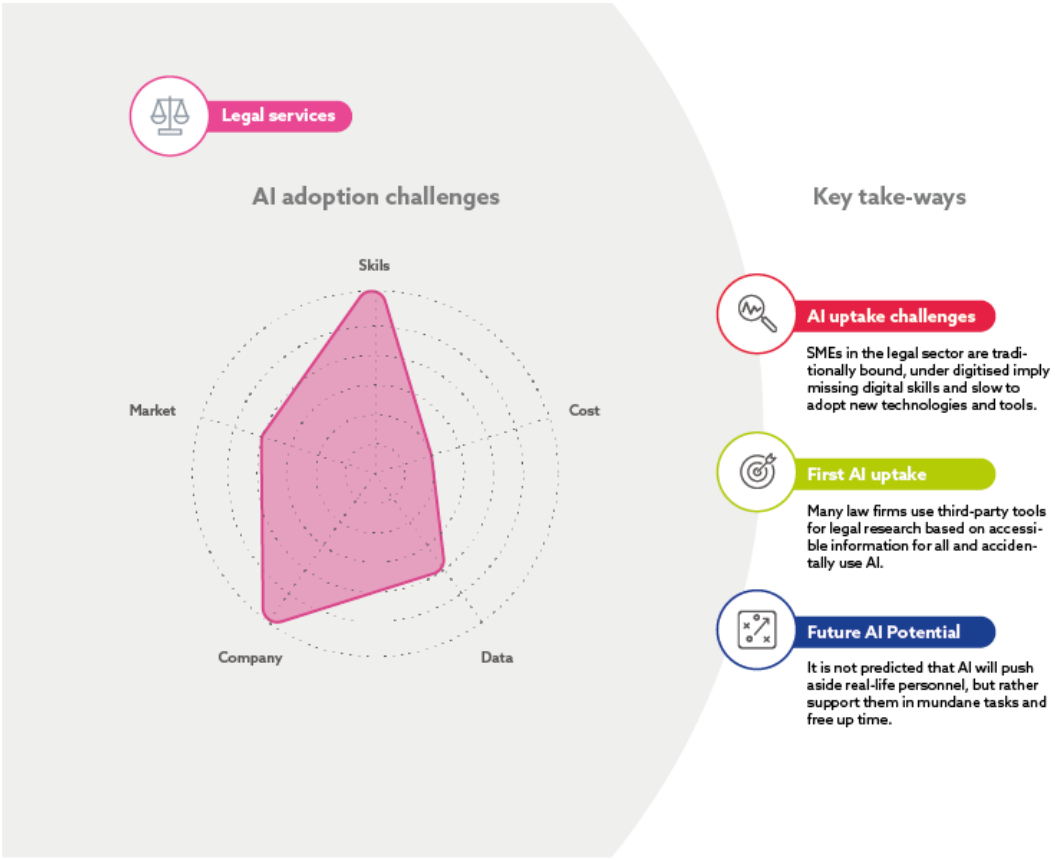
Conclusions and Best Practices

The legal services sector is a very **traditional sector with a low digitalisation level**. While for legal research external tools are used, that in some cases have AI adopted, new technologies and tools are slow in the uptake. However, the text-heavy sector has ample data for AI uptake. Many rulings and court papers are open access and can be the basis for AI-enabled systems.

More complex languages such as Polish or Greek are a limiting factor for the use of AI, as the tools are primarily used for English. The **professional standards of lawyers limit the sharing of data** such as contracts so that high importance is in the accessibility and standardisation of governmental data as a basis for AI tools. AI uptake is further limited by the different legal system in each Member State, limiting the cross-national uptake of AI services and the interest of AI start-ups to develop a solution.

Instead of a reduction of jobs, support by AI tools seems likely, as rather mundane, but also complex tasks, can be done by AI applications, freeing up personal. While the data bias is a great concern, **AI is also seen as an "equalizer"** opening access to less expensive legal services for the public.

Exhibit 31: AI adoption challenges for legal services MSMEs

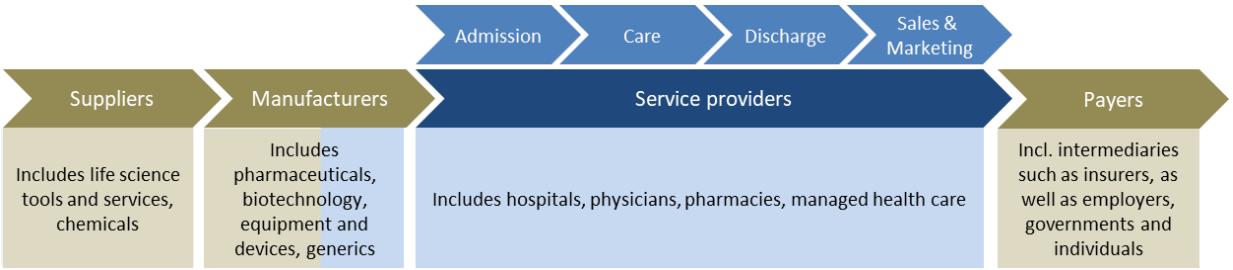


3.2.3 Health sector

Context

The health sector's value chain stretches from the supply of medical services, equipment or drugs, to the provision of healthcare to patients. MSMEs are mainly active within the medical devices sector and within the main segment of service provision:

Exhibit 32: Health sector value chain



Medical services are provided by various entities, so-called healthcare providers, including e.g., hospitals, doctors, and therapists. The following Exhibit lists the categories with a larger MSMEs share:

Exhibit 33: Medical services with larger MSME share

Categories	Examples
Medical technologies	Products, services, or solutions used to save and improve people's lives (…) from prevention to diagnosis to cure[88]: Medical devices (MDs), in vitro diagnostics (IVDs), digital health
Medical doctors and dentists	Medical consultation and treatment done by general medical practitioners and medical specialists, including surgeons, dentists etc. [89]
Other human health activities not conducted by medical doctors or dentists	Nurses, midwives, physiotherapists, or other paramedical practitioners in the field of optometry, hydrotherapy, medical massage, occupational therapy, speech therapy, chiropody, homoeopathy, chiropractic, acupuncture etc
Medical laboratories	X-ray laboratories and other diagnostic imaging centres Blood analysis laboratories
(Residential-) Care activities	Provision of residential care combined with either nursing, supervisory or other types of care as required by the residents incl. convalescent and nursing homes, facilities for alcoholism or drug addiction treatment or mental retardation facilities and assisted-living facilities

Compared to other sectors, the health sector has been relatively resilient in the face of the global economic downturn – reflecting increased demand for health service providers because of Europe's ageing population.[90]

Medical technology companies

Today, Europe counts more than 32,000 medical technology companies, of which 95% are MSMEs.[91] The European medical technology sector in 2020 employed over 730,000 people (0.3% of total employment in Europe). The sector holds an extremely high productivity rate, where every employee adds a value of an estimated EUR 160,000.[92] The European medical technology market was estimated at roughly EUR 120 bn as of 2018.

Innovation is very high in medical technologies. In 2019, the sector had the second-highest number of new patent applications with the EPO after the digital communications sector, even exceeding the field of computer technology.[93] MSMEs are identified as the main driver of these innovations and act as a catalyst for the growth and competitiveness of the European health sector.[94] A study from 2011 found out that many of these innovative MSMEs are later acquired by larger pharmaceutical companies. [95]

Exhibit 34: Use case: AI & big data for digital health

Use case

Snke OS: AI & big data for digital health

New technologies continue to emerge, driving a digital transformation in the healthcare data economy. Brainlab, a Munich based digital medical technology company, founded a subsidiary called SnkeOS in 2020 to develop the first digital platform for surgery, rooted in current Brainlab software. Snke OS™ is a universally deployable digital B2B platform that delivers a broad & comprehensive operating system to power applications for third party development for a broad range of clinical applications. It allows to run AI and drive use cases across the healthcare value chain to help scale and innovate in surgery.

Medical service providers

The organisation and delivery of healthcare services are undergoing a major change in many countries. The growth of new technologies, including the expansion of e-health, enables distance diagnostics services based on new medical appliances and diagnostic techniques.

Whilst MSMEs play a major role in the health sector, they face numerous challenges in the field today:

- **R&D costs and long innovation cycles**: Because of high R&D costs and long development cycles, MSMEs are very dependent on long-term bank loans. Missing bank loans hinder the development of MSMEs, especially when overextending on multiple markets within the EU.
- **Data privacy & sensitivity**: Market authorisation for health-related products and EU data privacy laws can be very confusing for MSMEs in particular.[96]
- **Increased demand for health services**: The impact of demographic change within the European Union is likely to be of major significance in the coming decades. The ageing population puts a greater demand on medical care. Population ageing will require a transformation of healthcare service providers, requiring new approaches to streamline healthcare services and optimise costs.

AI risks & threats

While AI offers several possible benefits, there also are several risks specific to the health sector:

- The most important risk, especially in the health sector is, that AI systems will sometimes make errors (e.g., recommendation of the wrong drug, failure to notice a tumour in a scan), which results in patient injury or other healthcare problems. While many injuries occur due to human error, these are limited to a single provider or even instance, while an AI systems error may affect many patients. **Liability and accountability** in the case of an AI-enabled decision are important questions that must be solved.
- Training AI systems require large amounts of data from sources such as electronic health records, pharmacy records, insurance claims records, or consumer-generated information like fitness trackers or purchasing history. Even the basic use of AI is linked to a potential increase in the tracking and recording of daily activities as well as health data. Both the use of health

data but also the prediction of health issues, which is legally restricted, can be considered as a **violation of privacy**. The issue of privacy comes hand in hand with **data security** and necessary **ethical standards**.

- As AI systems learn from the data on which they are trained, and they can incorporate biases from those data. Even if AI systems learn from accurate, representative data, there can still be problems if that information reflects **underlying biases and inequalities in the health system**.
- Some medical specialities, such as radiology, are likely to shift substantially as much of their work becomes automatable. As the use of AI becomes more widespread the human knowledge and capacity will decrease over time, such that providers **lose the ability to catch and correct AI errors** and further develop medical knowledge.

AI potential and added value

AI is changing the way medical technology is working, and thus also changes the way human health services are provided. One of the major areas of AI applications in health right now is **medical image analysis**, using deep neural networks and machine learning processes, which by now comes close to human accuracy levels.[97] Another major part of AI applications today is the **automatic interpretation of laboratory results**, including blood testing, electrocardiograms, temperature, oxygen saturation and blood pressure.[98]

The following areas for AI solutions in the health sector can be identified:[99]

- **Patient management:** Process automation can assist with a wide range of tasks in healthcare like appointment requests, patient registrations and billing. Successful adoption means an unburdening of staff in regards to routine tasks while prioritising tasks for the human staff that require creativity, judgement and empathy.
- **AI-enabled optimisation of health operations:** AI solutions that optimize "back-end" processes in healthcare, including procurement, logistics, staff scheduling, automated medical notes, and patient experience analysis.
- **Automated health monitoring:** The automatic monitoring of the status quo, developments and predictions of the health status of a patient, based on AI-enabled predictive analytics, enables a quicker intervention by medical providers.
- **AI-enabled patient-facing solutions ("virtual nurse")**: These solutions include any direct AI interaction with patients, including personalised health coaching and lifestyle advice, the delivery of therapies, chatbots, non-critical interventions and information provision.
- **System checking and triage:** As health care is faced with staff shortages and overwhelming patient loads using a triage system based on AI can automate a critical bottle neck. During COVID a successful trial was done with an AI-based chest x-ray system.[100]
- **Medication management:** Use cases within the autonomous pharmacy range from pro-active identification of risk of shortages, dealing with shortages (e.g., prescription of alternatives) to medication adherence.
- **Precision medicine:** Doctors can use precision medicine to more accurately predict which treatment and prevention strategies will work best for a particular patient. Researchers could even develop drugs tailored towards an individual.
- **Robot-assisted surgery:** With AI robots can be automated rather than programmed by an engineer, allowing to improve the control accuracy needed for e.g., hair transplant surgery.

Exhibit 35: AI functionalities and health use cases

	Optimise Operations	Customer Engagement	Products & Services Transformation	Employee Empowerment
Prediction	▪ Medication management			
Automation	▪ Patient management ▪ Clinical trial design & executions ▪ Robot-assisted surgery	▪ Delivery of therapies ▪ Chatbots ▪ Information provision		
Generation of insights	▪ AI-enabled triage			
Personalisation		▪ Personalised health coaching and lifestyle advice	▪ Personalised treatments	
Prescription	▪ Medication management	▪ Patient management		

AI uptake levels and challenges

In Europe, 47% of all companies in the health sector have at least one AI technology adopted (compared to 42% across sectors) and 21% of all companies have adopted at least two AI technologies. 19% plan to use AI technology in the future. [101] Challenges for AI uptake in the health sector correlate with the general hurdles MSMEs face when developing or adopting AI technology. However, there are some peculiarities:

- **Skills:** Increasing interest in AI in the healthcare sector was observed, which was further accelerated by the COVID-19 pandemic. In parallel, strong growth in health H2020 projects, also in combination with AI is happening since 2017. However, the health sector is still in an early adoption phase. For effective use a stronger collaboration between healthcare professionals and computer scientists, as well as an upskilling of healthcare workers is necessary.
- **Cost:** Public expenditure on health and long-term care has been increasing over the last decades in all EU Member States and is expected to rise even further. In 2015, it accounted for 8.5% of GDP in the EU and could reach up to 12.5% of GDP in 2060. A substantial part of the increase has been attributed to the introduction and funding of new technologies in healthcare, including digital ones.[102]
- **Data**: As for all AI applications, a **very high number of data** is needed to develop AI software. Algorithms cannot extrapolate but are subject to pattern learning, thus making an unbiased data base crucial. Some of the required patient data is highly sensitive and private and subject to high regulation within the EU, putting especially smaller MSMEs in front of structural challenges.[103]. To train AI systems extremely high encryption, data security and privacy have to be maintained. First initiatives such as the "Health Data Hub" in France tackles the data availability issue.
- **Company**: Complexity and missing transparency of AI applications could limit acceptance by medical personnel, especially when facing vital decisions.[104]
- **Market**: Many countries in Europe have set healthcare as one of their priority sectors due to factors such as an ageing population and a shortage of health care professionals. The EC has

also identified health as one of the key applications for AI in several policy documents. The EU has now committed to a European Health Data Space (EHDS) in the EC's Data Strategy and the GDPR has provided a legal framework for the processing of health data including across borders. However, being a Member State competence there remain many different national rules that make health data sharing over EU borders difficult.

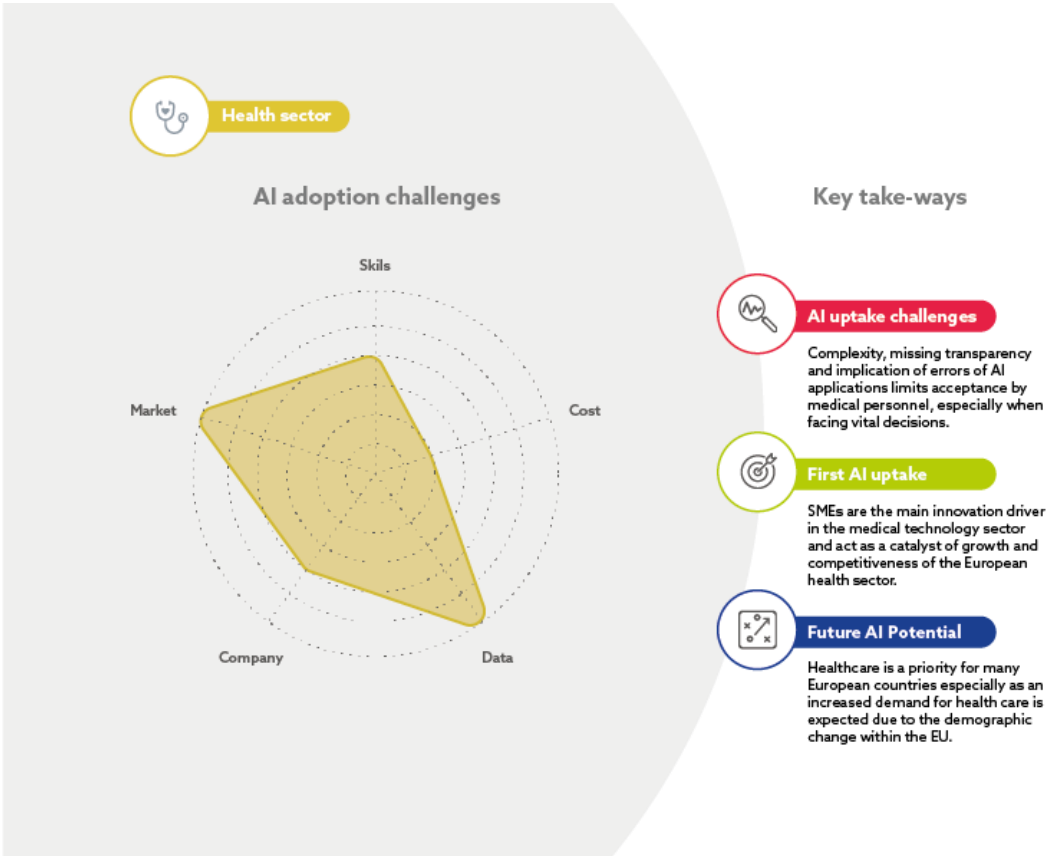
Conclusions and Best Practices

While AI in the Health sector could be the answer to the looming Healthcare crisis of the ageing European society – both **AI and Health are an R&D priority** within the EU – data **privacy issues and the missing lack of reliability and transparency** are the most significant challenge within the sector. As the health sector is heavily regulated at the EU and MS level to protect public health, the general AI uptake is mostly limited to support services and applications with reduced risk.

While the medical technology sector is one of the most innovative sectors within the EU, improvements in several areas such as data access, interoperability and ownership as well as evaluation of these technologies are necessary to unlock the full potential of AI.

As **errors by an AI-enabled product or service** in comparison to other sectors, can have potentially massive real-life consequences, the acceptance of the medical personal is also limited. The consensus is that AI-enabled products and services should always be seen as a supporting tool, with the final decision made by a medical expert.

Exhibit 36: AI adoption challenges for health sector MSMEs



3.2.4 Liberal professions: accounting

Context

Accounting usually includes activities such as the recording of commercial transactions from businesses or others, the preparation or auditing of financial accounts, the examination of accounts and certification of their accuracy, the preparation of personal and business income tax returns, and other advisory activities and representation on behalf of clients before tax authorities. [105]

In 2018, 640 000 enterprises operated in accounting services within the European Union, with a turnover of approximately EUR 165 bn.[106] Accounting services are dominated, in almost every EU Member State by small and medium-sized enterprises, and in particular, by micro-enterprises.

AI risks & threats

As AI grows more sophisticated and ubiquitous, risks and threats must be considered.

With job automation, it is expected that **half of the accountants' workload will be performed by machines**. With this will come a change in the traditional accountancy skills needed in the coming years. As AI deals more and more with the processing and transactional tasks, accountants are freed up to focus more on advisory, analysis and business partnering. Accountants will need to **reskill for roles at the nexus of tech and accounting**. These could include roles focused on training machine-learning models, or data governance, reviewing data quality, standards, and ethics across all parts of the organisation. The more immediate threats **are 3rd parties such as financial services or AI start-ups offering AI-enabled accounting services** and eliminating the need for accounting services.

The data necessary in accounting, especially M&A data, is of high interest to hackers, who might be looking to benefit from investment decisions based on intelligence about a looming deal. **Data security and risk management** are therefore big issues. While AI can be used to find cyber-attacks sooner, cyber criminals use AI to get around data security defences.

Exhibit 37: Use case: disrupting the accounting market

Use case

Bokio: Disrupting the accountancy market

Accounting tasks are often a daunting prospect for many MSME owners due to their time-consuming, perplexing, and often costly nature. Archaic legacy bookkeeping processes significantly compromise the productivity and overall financial stability of many small businesses.

The Swedish based start-up Bokio utilises artificial intelligence to simplify bookkeeping for small businesses, sole traders, and freelancers. Bokio acts as a digital assistant, providing support for a wide range of administrative tasks including invoicing, employee expenses, reporting and VAT returns. Its user-friendly interface is designed so that first-time business owners can make use of the software without requiring any previous experience in accounting.

AI potential and added value

AI in accounting holds the potential of taking over tedious and time-consuming tasks, improving overall time efficiency, and giving accountants room to put forward their thinking on more critical and creative tasks at hand. First estimations do not see AI as a threat to job positions in the accounting sectors, but rather as a support to the existing work force.[107]

In the accountancy sector, three main areas benefit from AI: invisible accounting, continuous audit, and active insight. Possible application of AI in accounting include:[108]

- **Client management:** Intelligent automation can mimic human interaction, such as basic client communication (AI chatbots).
- **Data management:** AI can take over repetitive and time-consuming tasks including document analysis and handling, as well as monthly and quarterly close procedures. AI automatically manages the process of gathering, sorting and visualising pertinent data in a way that helps the business run more efficiently. AI can also minimise accounting errors, often caused by human oversight.
- **Real-time reporting:** AI can provide real-time status of financial matters since it can process documents using natural language processing and computer vision faster than ever making daily reporting possible and inexpensive.
- **AI-enabled fraud detection:** AI can handle the review of financial data very quickly while detecting anomalies such as duplicate invoices or determine links between seemingly innocuous payments and other known risks.
- **AI-enabled compliance checks:** When scanning documents natural language processing can be used to check for compliance with rules and laws (e.g., taxation).
- **AI-enabled drones for auditing:** By using computer vision, the inventory (e.g., number of vehicles in a production plant under audit) can be monitored during the auditing process.
- **Revenue forecasting using big data analytics:** AI can assist with business decision-making, based on actionable insights derived from customer demographic, past transactional data, and external factors. Cash flow forecasting predicts when the business might run out of money and take actions to protect against the situation ahead of time.

Exhibit 38: AI functionalities and accounting use cases

	Optimise Operations	Customer Engagement	Products & Services Transformation	Employee Empowerment
Prediction	▪ Revenue forecasting using big data analytics			
Automation	▪ Document analysis and handling	▪ Client management		▪ Data management
Generation of insights	▪ AI-enabled fraud detection ▪ AI-enabled compliance check		▪ AI-enabled drones for auditing	
Personalisation				▪ Real-time reporting
Prescription	▪ AI-enabled compliance checks			

Current AI uptake levels and challenges

The adoption of artificial intelligence (AI) tools in accountancy are in its nascent stage, but developments are happening fast. AI tools in audit can now do the job of 30 accountants in a quarter of the time and with greater accuracy.[109]

- **Skills:** Firms are at different stages of using AI, though many are already well advanced in using AI systems in certain service lines like auditing. Resistance to change from teams within the organisation is a key risk as many may choose to adopt a "wait-and-see" attitude.[110] A significant amount of reskilling needs to take place to help accountants and auditors work effectively with AI.[111]
- **Cost:** A significant financial and time investments are necessary to adopt AI. Hence, most companies that implement AI applications in their accounting systems focus on areas that will have the most significant financial and business impacts. More sophisticated AI technologies are still in the infancy stage and the first implementations will therefore be unlikely to reap immediate benefits until they reach further maturity.
- **Data**: Like in almost all sectors, there are still large amounts of data is missing or in analogues, format to develop and train automated systems.[112] Significant efforts are therefore needed to extract, transform, and house the data appropriately and securely. Obtaining such data will also require systems and processes to be established and integrated to ensure that external data harnessed will complement existing data.
- **Company**: Most companies in accounting are in the middle of the maturity level in terms of applying digital solutions and the management of digitalisation within the accounting system. Insufficiently optimised processes represent the greatest obstacle to implementing digitalisation in accounting.[113]
- **Market**: Like the problems the health sector is facing, data collection also holds high hurdles regarding data privacy. AI systems would have to scan personal bank information, cash flows, and in terms of fraud detection even through personal mail traffic. The processing of data for AI automation, therefore, has to meet high privacy and encryption standards or might not even be subject to processing.[114] Data acquisition is further limited in the accounting sector as many companies are keeping data (not only for privacy reasons) shut.[115] Legislation governing AI is still considered to be in its infancy. Systems that analyse large volumes of consumer data may not comply with existing and imminent data privacy regulations and therefore, pose risks to organizations.

Exhibit 39: Use case: intelligent document management

Use case

QFRS: The awarded* MSMEs accounting tool for the future

Greek MSME Quantum BITS combines IT and Accounting in-house and found the need to have timely access to valid financial information regarding their business, presented in a professional yet comprehensive way. Quantum Financial Reporting Service (QFRS) is a cloud-based data analysis web app developed by their in-house IT experts. It uses AI algorithms to automatically transform raw accounting data to financial reports accompanied by dynamic, graphical illustrations. The web app enhances MSMEs decision-making providing a reliable source of information as well as an improvement of their extroversion by producing professional and highly customizable infographics simply by the click of a button!

* QFRS app won the Gold award at the Greek Accounting Awards 2020 (Category: Data Analytics)

Conclusions and Best Practices

AI within the accounting sector could potentially become a disruptive force, changing the sector fundamentally. AI-enabled book keeping could **free up accountants from time-consuming and mundane tasks** and enable them to focus on consulting their clients. Estimations show, that about half of the tasks currently performed within the accountancy sectors can be performed by AI-enabled software. But, these applications could also be offered by 3rd party players such as financial institutions or AI start-ups, shifting the work from an accounting firm to an accounting application.

While **applications can easily be used cross-national within the EU**, the data of accounting companies belong to their clients. Barriers in trust have to be broken first and the potential also has to be demonstrated to the clients demonstrated before a broad AI uptake will happen. Another challenge is the necessary amount of data to effectively use AI. Especially MSME accounting firms provide services often to various companies from a wide range of sectors, making it not easy to use the data to enable predictions. Also, the awareness about the necessary data security is limited and has to be improved as financial data is of high interest to hackers, e.g., to judge the financial health of a competitor.

Exhibit 40: AI adoption challenges for accountancy MSMEs

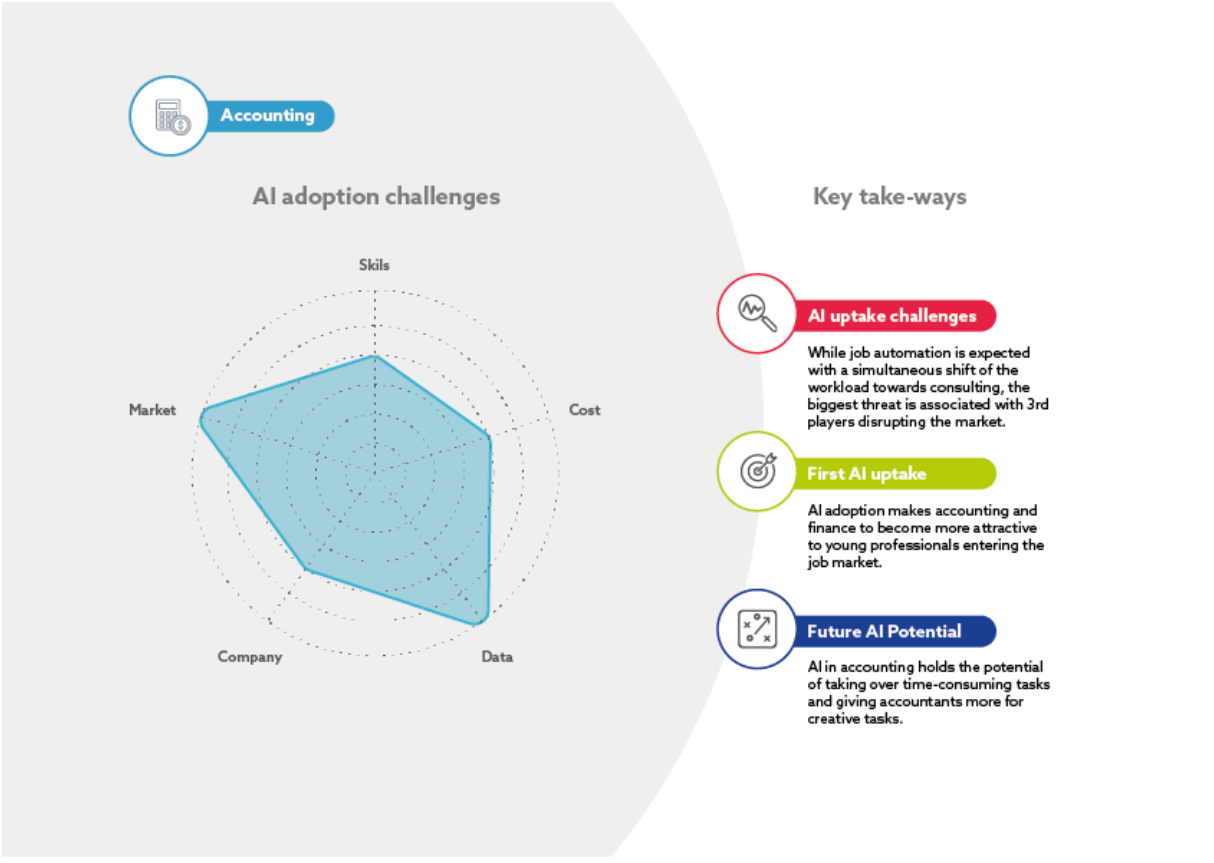


Exhibit 41: Use case: intelligent document management

Use case

parashift: Intelligent document management

parashift

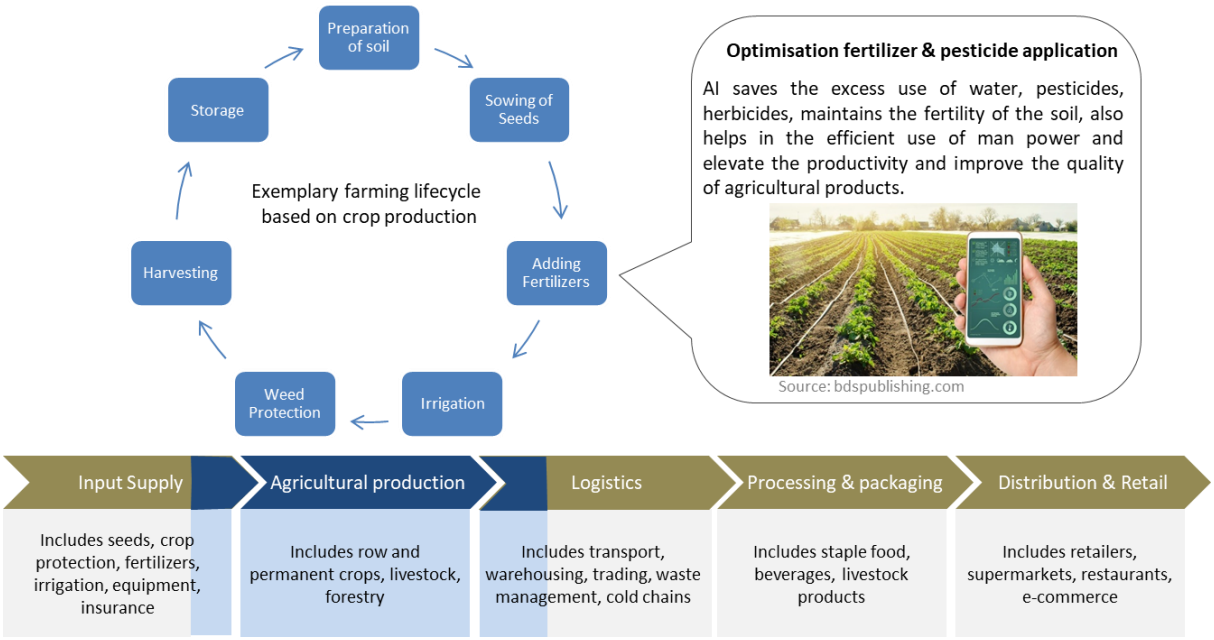
Swiss start-up parashift has built a machine learning platform that's capable of reading all kinds of accounting documents and extract documents entirely autonomously. Parashift eliminates the need for data validation and frees up highly skilled accounts from the simple tasks of manual data entry and lets them focus on more important work. Its software is accessible through a SaaS platform and APIs to ensure fast integration into other software components and workflows.

3.2.5 Agriculture

Context

The agriculture value chain encompasses activities from manufacturing and distributing the industrial inputs over the production of crops, animals, and animal products to the provision of products to the consumers. **MSMEs are mainly involved in agricultural activities** spanning from crop and animal production, to harvesting and processing, to plant propagation and similar related service activities such as hunting and trapping. [116] The latest numbers available indicate 10.3 million agricultural holdings in the EU in 2016, with farm numbers in "steep decline for many years".[117] With 9.2 million people employed agriculture accounted for about 4.4 % of total employment in the EU in 2018 and created a gross value added of EUR 181.5 bn in 2019.[118]

Exhibit 42: Agricultural value chain incl. an exemplary farming lifecycle



The structure of agriculture in the EU Member States varies depending on topography, natural resources and (former) economic system. In general, the number of small and medium-sized farms has diminished, while the number of large farms (above 100 hectares) has risen, hinting at a consolidation of the farming sector.[119] Whilst there are no clear numbers of MSMEs in the EU agricultural sector, most EU farms are "small in nature; two-thirds were less than 5ha in size in 2016[120], with more than 60% of skilled agricultural, forestry and fishery workers being self-employed.[121] Furthermore, the **majority of the EU's farms are classified as family farms** (96.0 % in 2016).[122]

Agriculture faces many challenges:

- One of the biggest challenges which the agricultural sector is facing is demographic: Only one in ten EU farm managers are younger than 40 years old (11 %).[123] A **lack of young, progressive farmers** raises concerns about realising EU agricultural innovation policies or increased food demands. Gaining access to land is widely reported to be the single largest barrier facing young people attempting to enter the agricultural sector in Europe.
- **Climate change**, which is increasing the risks of floods, droughts and diseases already impact agricultural production in parts of Europe's southern and Mediterranean regions. Adapting to

climate change must be made a top priority for the European Union's agriculture sector if it is to improve resilience to extreme events.[124]

- **Price volatility** is a normal feature of the agricultural markets given the seasonal production cycle but has increased due to uncertainties in the economic and natural environment. The specific challenges which volatility present are numerous and translates to increased risk for all participants in the agricultural supply chain especially for MSMEs and a less stable income for farmers.[125]

AI risks & threats

Agriculture is one of the **most difficult fields** to contain for the purpose of statistical quantification. Even within a single field, conditions are always changing from one section to the next. There's unpredictable weather, changes in soil quality, and the ever-present possibility that pests and disease may pay a visit. Agriculture takes place in nature, among ecosystems of interacting organisms and activity, and crop production takes place within that ecosystem environment. They are subject to climatic occurrences such as weather systems, which impact upon hemispheres, and from continent to continent. Therefore, understanding how to manage an agricultural environment means **taking many hundreds if not thousands of factors into account**. The problem with deploying machine learning and artificial intelligence in agriculture is that not two environments will be exactly alike, which makes the testing, validation, and successful rollout of such technologies much more laborious than in most other industries.

Exhibit 43: Use case: AI-enabled dairy farm management

Use case

Cainthus: The worlds most advanced technology for dairy farms

Large scale dairy operations often struggle with labour shortages, farm profitability and feed management, while keeping animal health and welfare at a high level. Ireland based Cainthus has developed state-of-the-art artificial intelligence that automatically turns visual inputs from cameras into real-time insights. The system monitors variability in feeding activities and herd behaviour: If cows are relaxed and can show their normal behaviour, it directly results in increased health and welfare, better milk production and hence better farm profitability. Good nutrition and ample access to feed is the starting point for the good health and well-being of your cows.

These insights are displayed daily on any device available on the farm. The information delivered is reliable and non-biased. The technology is easily scalable, it doesn't require any hardware on the cows and unlike other technologies, very little maintenance is needed. The software clearly shows where actions are needed to improve the farmers' overall profitability and productivity.

AI potential and added value

Digitalisation plays a crucial role in today's agriculture and includes AI and machine learning, IoT, cloud as well as blockchain applications.[126] Regarding AI in agriculture, a wide range of agriculture-related tasks in the entire food supply chain can be improved:

- **Use of weather forecasting:** With the help of AI farmers can analyse weather conditions by using weather forecasting which helps them plan the type of crop that can be grown and when seeds should be sown.
- **Soil and crop health monitoring**: The type of soil and nutrition of soil plays an important factor in the type of crop is grown and the quality of the crop.

- **Analysing crop health by drones:** Drone-based imaging solutions for monitoring crop health helps to identify pests and bacteria and timely use of pest control and other methods to take the required action.
- **Precision Farming and Predictive Analytics:** AI-enabled technologies predict weather conditions, analyse crop sustainability, and evaluate farms for the presence of diseases or pests and poor plant nutrition on farms with data like temperature, precipitation, wind speed, and solar radiation.
- **Agricultural robots:** Depending on the type of robots its trained to control weeds and harvest crops at a faster pace with higher volumes compared to humans or to check the quality of crops and detect weed while picking and packing crops at the same time.
- AI-supported **supply chain management**, easing the interaction between farmers and e.g., restaurants and suppliers.

Numerous future application possibilities can be also identified by connecting earth observation with AI applications. [127] As an example, the EU earth observation programme Copernicus, the European GNSS Agency in cooperation with the European Environment Agency, actively promotes the development, use and future uptake of earth observation applications for agriculture, including AI, as part of their "Farming by Satellite" initiative.[128]

AI has been proven to increase efficiency and production levels, mainly regarding labour shortage (automated robots), whilst reducing the environmental impact from agriculture, due to better use of fertilisers, pesticides and systemised irrigation processes.

Exhibit 44: AI functionalities and agriculture use cases

	Optimise Operations	Customer Engagement	Products & Services Transformation	Employee Empowerment
Prediction	▪ Predictive analytics to sustainably grow plants ▪ Use of weather forecasting to optimally plan to farm			
Automation	▪ Automated supply chain management ▪ Robotisation and autonomous driving		▪ Automated green houses	
Generation of insights	▪ Soil and crop monitoring via and analysis of crop health via AI-enabled software ▪ Monitoring of the health of cows based on their activity		▪ Recognition of plants ▪ Advice for improving output	
Personalisation	▪ Communication of progress with all involved stakeholders to ensure fresh products	▪ Communication with customers ensuring transparency		
Prescription			▪ Precision farming enabling optimised operation based on field conditions	

Exhibit 45: Use case: AI-enabled farming management

Use case

xFarm: Addressing crop productivity

xFarm is a start-up that aims at the digitisation of agriculture, providing innovative tools that can support farmers and food supply chain's stakeholders in the management of their companies. Created by farmers and tailored to the agricultural sector, its focus is on ease of use, intuitiveness, and complete adaptability to agricultural realities. The digital ecosystem includes a free agricultural application, available on both mobile and desktop and integrated with advanced premium modules, a dashboard Analytics dedicated to professionals and a line of IoT sensors selected, optimized, and connected by xFarm.

AI uptake and challenges

The use of digital technologies in the agricultural sector is still in an early phase: 39 % of European agriculture companies have at least one AI technology adopted (compared to 42% overall), 24% at least two, while 18 % plan to use AI technology in the future.[129]

- **Skills:** Farmers are typically not knowledgeable or lack access to digital tools that could facilitate their work. The cross-cutting objective of CAP 2020+ is to foster and share knowledge, innovation, digitalisation in agriculture and rural areas and encourage uptake.
- **Cost:** Among the main challenges associated with precision agriculture is technical accessibility and affordability. Precision agriculture is often combined with expensive high-technology machinery which represents significant up-front investment costs for farmers.[130] As income is generally low these associated high start-up costs are a serious challenge. Between 2014 and 2020 56% of the farmers intended to invest, with 40% of the farms having planned to invest in machinery and equipment. Farmers with intentions to invest have significantly larger farms in terms of utilised agricultural area.[131]
- **Data:** Copernicus remote sensing data is free and highly useful for agriculture. On an individual basis, a farm does not have enough data for AI. Companies that provide services, and receive in return data (such as dates of planting, etc.) can aggregate and combine these with EO data.
- **Company:** The demographic situation (see above) implies further hurdles for future AI uptake. Academia has in the past proven a correlation between age and uptake of digital technologies – the older a person, the lower the chances of uptake of digital technologies.[132] This could imply that older farmers (who constitute the majority of farmers) could stand sceptical towards the uptake of AI technology.
- **Market:** As the agricultural sector in Europe is very heterogeneous, there is a big difference in the technology uptake between large-sized and small-sized farms.[133] In the agriculture value chain, small farmers have often limited skills and knowledge of how to use their data.[134]

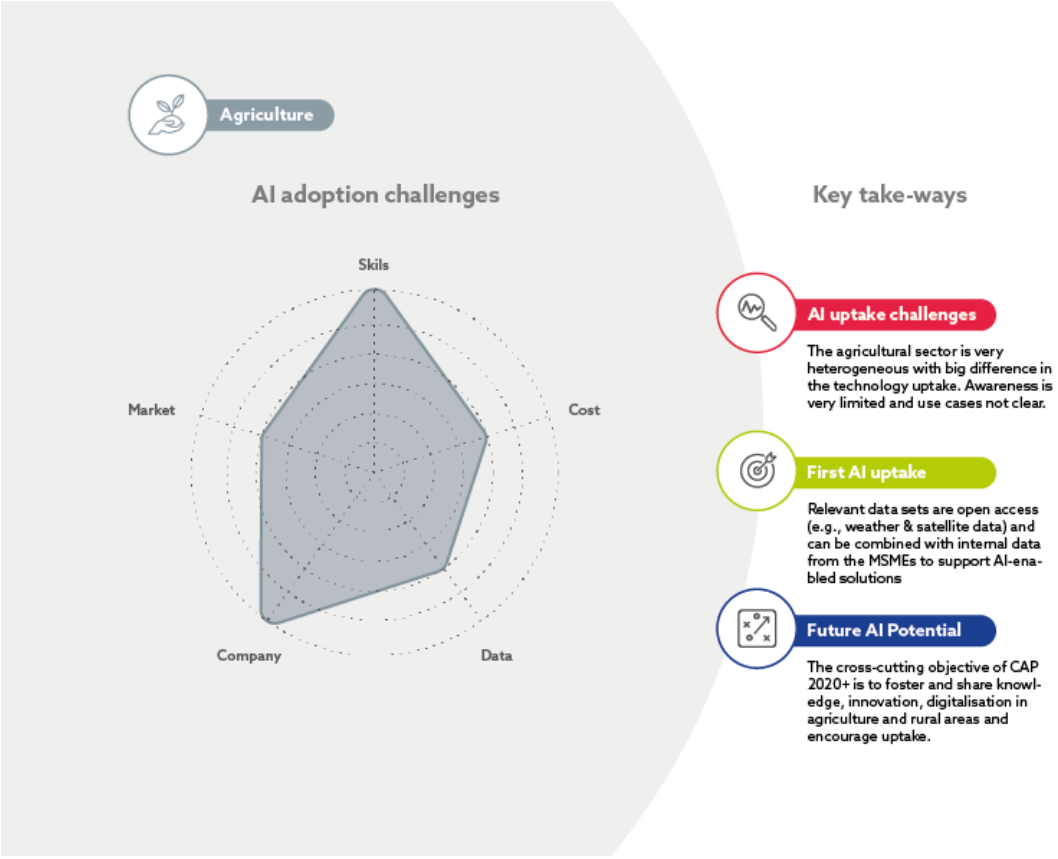
Conclusions and Best Practices

The main AI adoption challenges for the MSMEs in the agricultural sectors are **lacking awareness** of the overall potential of digitalisation and AI. The use case is oftentimes not clear to the MSMEs with further limits in regards to language skills as most applications are only available in English. The uptake challenges are **associated with geographical location as well as the type of farming** done by the MSME. While e.g., highly-developed countries like the Netherlands have good awareness and uptake, especially the Southern European farmers lack oftentimes basic digital skills. As the sector is **highly heterogeneous** and consists of many small family businesses with the head of the household as boss, the interest to change is limited.

The agricultural sector has the advantage of an **enormous amount of open data** from free satellite data from the European Copernicus missions to weather data that can be aggregated. This almost unlimited amount of variables of weather and climate can also be a massive challenge for current AI software. Other data sets such as those collected by milking robots are on the other hand collected by large technology providers raising the **issue of data governance**.

The cross-cutting objective of the CAP 2020+ is to not only support the sector financially to ensure food security but also support the farmers by fostering and sharing knowledge about sustainable farming but also digitalisation. These measures are at the moment designed by the member states, promising also the uptake of digital tools that include AI.

Exhibit 46: AI adoption challenges for agriculture MSMEs



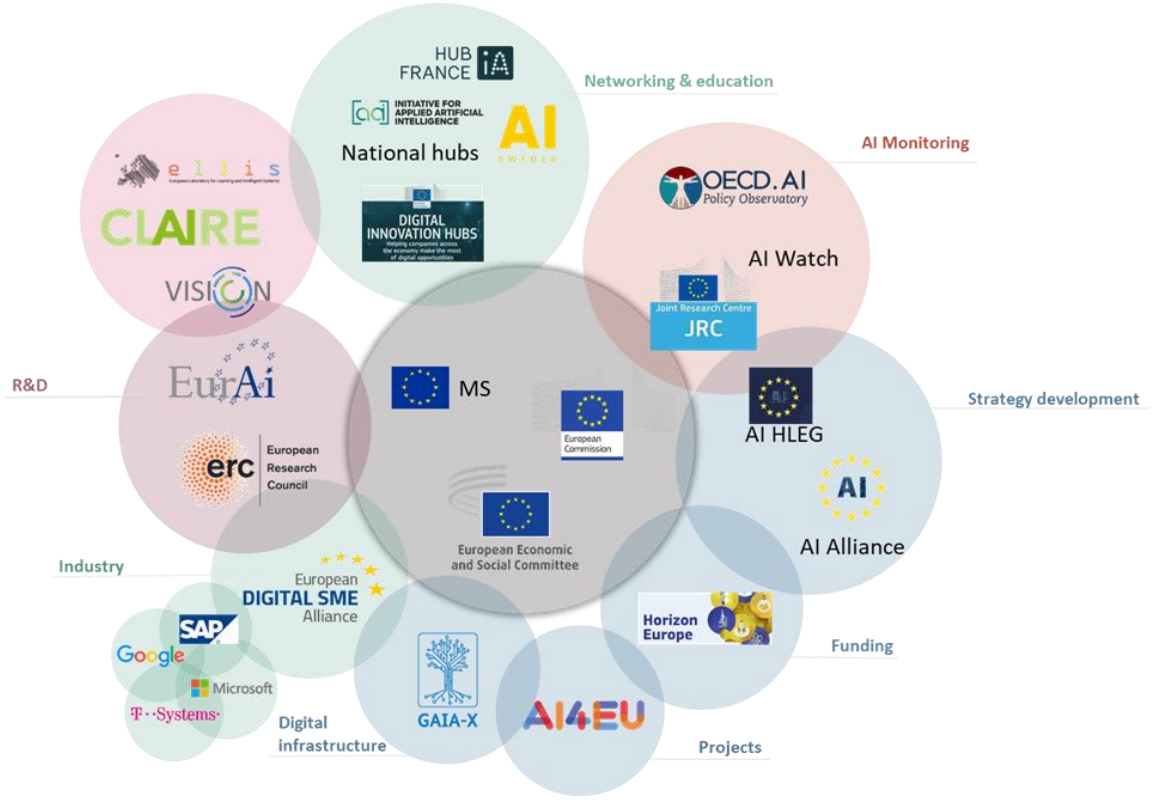
3.3 Policy landscape of AI in Europe

3.3.1 Introduction

AI has become an area of strategic importance with the potential to be a key driver of economic development. AI also has a wide range of potential social implications. As part of its Digital Single Market Strategy, the European Commission put forward in April 2018 a European strategy on AI in its Communication "Artificial Intelligence for Europe" COM(2018)237.

The European AI ecosystem is characterised by its **complex, interlaced and highly cooperative** environment, with especially the latter setting it apart from other global AI ecosystems. Research & development activities are benefitting from the close cooperation between industry, academia and cross-sectoral national hub networks that allow for ideal knowledge and technology transfer if desired. Networking & education activities are coordinated on the EU level as well as with national hubs to foster the digital skills of Europe. Based on **constant AI monitoring activities**, the Member States, alongside the European Commission and the European Economic and Social Committee, are invested in all major parts of the European AI ecosystem by integrating respective policies, strategies and initiatives and form respective funding mechanisms that give Europe a competitive edge over less cooperative global systems.

Exhibit 47: High-level mapping of the AI ecosystem (illustrative)



The following chapter details EU-level initiatives, but also analysis and compares the AI strategies of five member states to **assess strategies and find best practices**.

3.3.1.1 EESC opinions and approaches

The view of the EESC on MSMEs

In its publications, the EESC has repeatedly seconded the view that MSMEs are the backbone of many economies, pointing out their significant contributions to employment, job growth and national and pan-European GDP.[135] However, the EESC has stressed the fact that **MSMEs are a highly heterogeneous group** with also varying targets, challenges and – policymaking would have to take this seriously into account, to create effective policies.

MSMEs in a changing business environment

The EESC has identified numerous **challenges that MSMEs face** today:[136]

- Lack or limited access to required resources. These include financial resources, information and data, human capital (shortage of skilled and qualified manpower), as well as market expansion potential.
- Facing organisational issues like lack of time, missing medium management to bring in new impulses, missing forward-looking management, (family) traditional bound development.
- Lacking skill in anticipating and adapting to changing trends, especially in digitalisation.
- Little ability to shape the external environment + missing bargaining power to enforce their needs.
- "Communication gap" between MSMEs and existing supporting tools and networks for their needs.
- Intensifying competition and globalising markets.
- New (challenging) business models like digitalisation and industry 4.0.

The EESC, therefore, follows the overall view of literature concerning the challenges MSMEs face in the modern economy. However, the EESC also outlines specific sub-groups of MSMEs and their hardships.

In 2016 and 2017 for instance, the EESC drew special attention towards "Family businesses" or "Small Family and Traditional Businesses" (SFTBs) which make up to 60% of European companies and employ between 40 and 50 % of all employees.[137] Because of their **rigid character**, SFTBs, according to the EESC, have been negatively affected by the recent economic and industrial trends and developments and would need special attention to overcome SFTB-specific challenges.[138] **Family businesses**, as a special form of MSMEs for example, would therefore share similarities with other MSMEs, with the additional characteristic that they **desire passing the business onto the next generation inside the respective family**.[139] The EESC, therefore, recommends Family Businesses change development strategies and take on new employees also in management positions.[140]

The view of the EESC on AI

According to the EESC, there is still no universally accepted definition of AI.[141] The EESC considers the European Commission's working definition in its 2020 White Paper on Artificial Intelligence [142] as too broad as it could be applied to "any piece of software ever written, not just AI."[143]

The EESC emphasizes the fact that the **impact of AI is cross-border in nature and calls for supranational policy frameworks**.[144] All in all, the EESC shares the "virtually undisputed" view that AI can have significant advantages for society, giving some examples such as "sustainable agriculture, safer transport, safer financial system, more environmentally friendly production processes, better medicine, safer work, more personalised education, better jurisprudence and a safer society."[145] However, the EESC also sees **risks and societal challenges**, which AI and its applications will bring mainly to the area of ethics, safety, privacy, transparency and accountability, work, education and skills, (in)equality and inclusiveness, law and regulations, governance and democracy, warfare, and superintelligence.[146] A broad AI adoption in the EU should therefore hold various safety standards, such as a "human-in-command" approach to AI, where "machines remain machines" controlled by people at all times and a ban of autonomous weapon systems. To be compatible with European ethical standards, the EESC also calls for a "code of ethics" which ensures AI's compatibility with the principles of human dignity, integrity, freedom, privacy, cultural and gender diversity, and fundamental human rights.[147]

Challenges in AI uptake for MSMEs

In its 2019 release, the EESC emphasized the fact that AI and its benefits should be accessible to as many entities as possible, including MSMEs.[148] However, the EESC has identified several challenges MSMEs currently face for effective AI uptake, including challenges that MSMEs face in the adoption of digital and new technologies (including AI). These could be divided into internal and external factors:

Internal factors

Organisational problems hold a major challenge for AI uptake in MSMEs: These would often **lack dynamic middle management**, bringing in new impulses that would also be much needed for AI introduction.[149] In combination with a traditional bound top management that stands sceptical towards the adoption of new digital services and trends, this holds especially problems for SFTBs. Together with a **general scepticism towards AI technology** also shared by the majority of MSME employees, this could hinder AI adoption from within.[150] The EESC, therefore, highlights the fact that digitalisation and the latest tech developments prompt MSMEs to **change and adapt their culture, activities and business models**, e.g. to the introduction of a more **sophisticated middle management**.[151]

Another problem the EESC sees in AI adoption for MSMEs are **missing financial resources** to a) introduce and implement AI services and technology, and b) employing needed personnel to use and exploit these services and technologies.[152]

The latter aspect goes hand in hand with another internal challenge MSMEs are facing in AI adoption: **acquiring and employing qualified staff** to make use of AI technology (e.g. software engineers, data scientists and analysts).[153] The required professional fields tend to demand (very) high salaries, which MSMEs may not be capable of paying – in combination with other factors such as urbanisation, demographic change and the attractiveness of smaller versus bigger workplaces, this causes a **shortage of skilled and qualified (wo)manpower** needed to make use of or adapt AI technology.[154]

External factors

To support MSMEs in adopting new digital technology (including AI), effective policy making is key. The EESC however sees the risk that EU legislators and the Commission might not consider the **high heterogeneity and diversity throughout European MSMEs** and their various subgroups, which is needed to enable effective policy-making for AI adoption.[155]

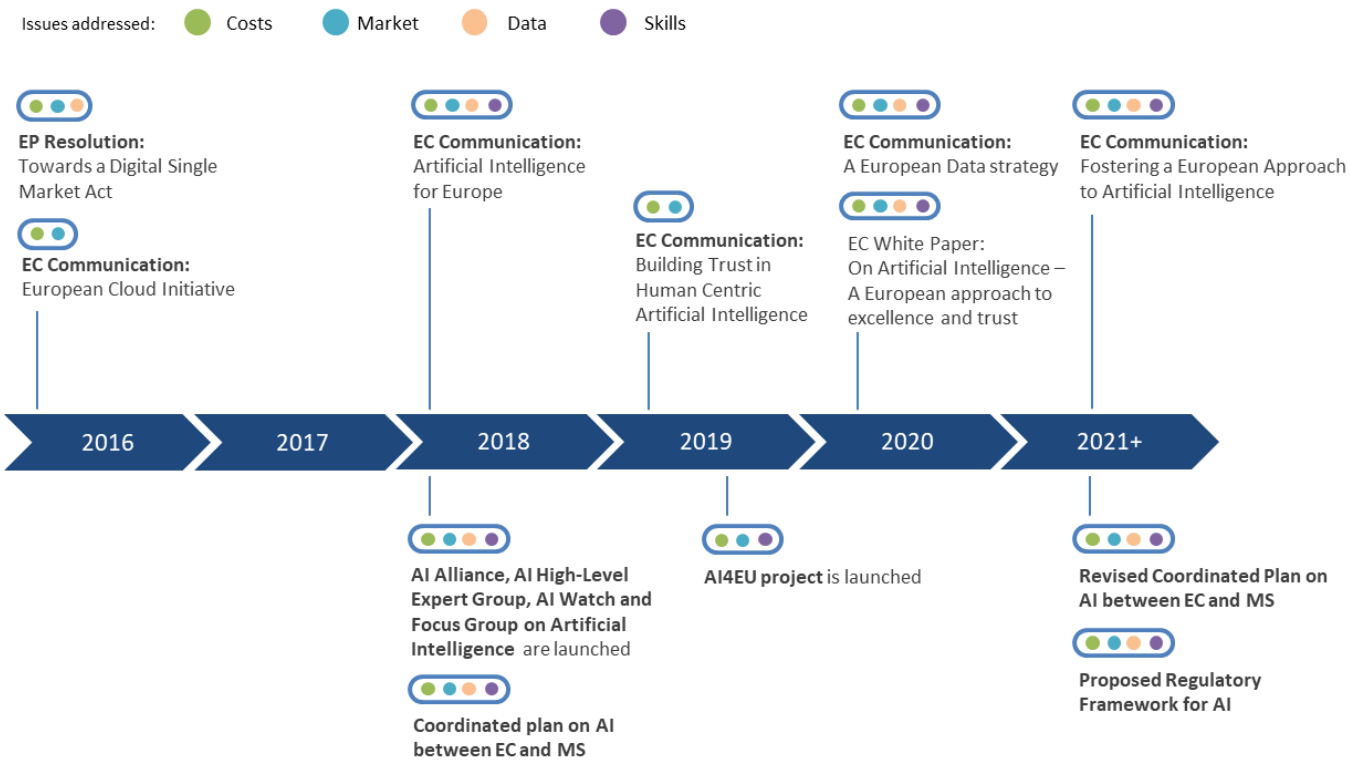
The abovementioned financial challenges can also be adapted to external factors. The EESC has drawn attention to the problem of MSMEs and start-ups having problems in **accessing appropriate financing** since 2006.[156] Special attention is paid to the fact that MSMEs mainly rely on banks for financing, however, **banks are "not well tailored for MSME and SFTB needs**". The financial crisis has put smaller and local banks under more challenge and tension, making the financing of/for MSMEs an even bigger challenge.[157]

Additionally, the EESC stressed the fact that both, **accessing information and new markets** are a "serious difficulty" that MSMEs would experience. MSMEs need access to information to make the best use of or introduce AI in their enterprise – missing market expansion potential could exclude MSMEs from accessing the valuable AI market.[158]

3.3.1.2 EU-level initiatives

The following exhibit details the most significant communication papers by the European Union and policies along a timeline:

Exhibit 48: Timeline of EU-level initiatives



The stakeholders view on the European AI market and policy making:

> - ***Create a vision for the use of AI:*** *AI is a developing technology that quickly develops. A opportunity based instead of risk-based approach should be followed to not overregulate the market.*
> - ***Europe is an engineers country:*** *Our know-how and expertise in engineering is the perfect basis for the use of AI. The strong market with industrial players is well positioned to succeed in AI.*
> - ***Excellent education & research:*** *The strong talent pool in Europe is the main strength of Europe.*
> - ***Strong data protection:*** *While GDPR & Co makes less flexible, it creates more trust in costumers.*
> - ***27 countries:*** *Due to the need to find compromises between 27 countries the policy making is slower.*
> - ***Reduced opportunities:*** *The level of investment and funding opportunities are reduced compared to the US and China. European companies and consumers also have less appetite for new technologies and are reluctant to adopt them.*

European Parliament 2016 Resolution: Towards a Digital Single Market

Summary

- European Parliament points out the need for a Digital Single Market and EU-wide digital standardisation
- Need for an EU data economy and a European Open Science Cloud to tackle fragmentation
- Calls upon better digital skills and expertise amongst European citizens
- No direct refers to AI, however first important policy recommendations and directions that tackle AI

In 2016 the European Parliament set a first important impulse towards a European approach regarding artificial intelligence with the Resolution '*Towards a Digital Single Market Act'*.[159] Whilst not referring directly to AI, the EP resolution supports endeavours by the Commission to create a unified EU approach to digitalisation. It proposes to actively strengthen trust in digital networks as well as the handling of personal data[160], first mentions of an EU data economy[161] and digital standardisation[162], and points out an increased need in fostering digital skills and expertise[163] and the need for a European Open Science Cloud as well as a European data economy to tackle fragmentation[164], the EP resolution already holds first important policy recommendations and directions for the future direction of the EU AI approach.

The European Commission 2016 Communication (European Cloud Initiative)

Summary

- Outline for a standardised pan-European data economy
- Focus on data availability and interoperability, data fragmentation, the need for High-Performance Computing infrastructure and high-speed internet, as well as a clear legal framework
- Open Science Cloud should give EU-researchers and scientists a free, cross-border and easy to use infrastructure for data analysis, storage and management

In response to the EP resolution, the Commission launched a Communication on the European Cloud Initiative, later in 2016.[165] It highlights five main areas to tackle, to fully foster data uptake and the emergence of a data economy within the EU:

- insufficient availability of open data
- a lack of interoperability of available data
- fragmentation of data
- the need for High-Performance Computing infrastructure for data processing
- the proper (re-)usability of data in a clear legal framework.[166]

To tackle these problems, the Commission introduced the European Open Science Cloud which is giving EU-located researchers and scientists a "virtual environment with free at the point of use, open and seamless service for storage, management, analysis and re-use of research data, across borders and scientific disciplines."[167] The European Open Science Cloud should be complemented by the *'European Data Infrastructure',* offering an "integrated world-class High-Performance Computing capability, high-speed connectivity and leading/edge data and software services for its scientists and other lead users from industry **(including MSMEs)** and the public sector"[168].

Whilst neither the Communication nor the initiatives directly address artificial intelligence, the initiatives already hold important markings for future AI endeavours, namely the availability of (open) data, (cross-border) interconnectivity and standardisation, as well as the provision of required infrastructure such as high-speed internet and high-performance computing power.

The European Commission 2018 Communication (Artificial Intelligence for Europe)

Summary

- First European Commission document with dedicated AI-reference
- Foresees (re)training schemes for AI affected professions as well as new student curricula, as well as networking and R&D initiatives to strengthen the European AI development and uptake with a focus on MSMEs
- Commission introduces the Coordinated Action Plan on AI and the European AI Alliance.
- Investments of around EUR 1.5bn between 2018 and 2020 in AI development and uptake activities

The first COM document directly addressing AI was published in 2018 with the Communication *'Artificial Intelligence for Europe'.*[169] It points out the added value of AI to tackle current and future challenges, namely: "(…) from treating chronic diseases or reducing fatality rates in traffic accidents to fighting climate change or anticipating cybersecurity threats"[170] and recognises structural shortcomings like the lack of private investments and infrastructure. The Commission advertises a coordinated approach to best foster AI uptake amongst the EU and its Member States.

Concretely, the Commission announced investments of around EUR 1.5 bn from 2018-2020 in research and innovation of AI technologies, the strengthening of AI research excellence centres and to foster the uptake of AI across Europe "(…) via a toolbox for potential users, with a **focus on small and medium-sized enterprises** (…) including an AI-on-demand platform (…) a network of AI-focused Digital Innovation Hubs (…) and the set-up of industrial data platforms".[171] Under the *'European Fund for Strategic Investments'*, the Commission aimed at stimulating private investments in AI with at least EUR 500 million for the 2018-20 period.[172]

Following the 'European Cloud Initiative' from 2016, and to foster data for AI-uptake, the Commission put forward a set of initiatives for the growth of the European data space in parallel to the Communication. These included updating the Directive on public sector information, guidance on sharing private sector data in the economy, and an updated Recommendation on access to and preservation of scientific information.[173]

To tackle labour shortcomings, the Commission additionally set up a dedicated (re)training scheme for AI affected professions, new Traineeships in advanced digital skills for students and graduates, and the support of establishing AI-related courses in curricula across European universities. These actions should be financially integrated into the frame of the "Blueprint on sectoral cooperation on skills", the European Structural and Investment Funds[174], and the "New Skills Agenda for Europe" launched in 2016.[175] Finally, the Commission addressed the drafting of AI ethics guidelines to be developed by the end of 2018, as well as future work on a more comprehensive legal framework including data protection.[176]

To concretely implement the above-mentioned plans and endeavours, the Commission put forward the creation of two important cooperation plans: A **Coordinated Action Plan** between the Member States and the Commission would maximise the investments into AI and be released by the end of 2018.[177] More importantly, however, the Communication foresees the creation of the **European AI Alliance** to be set up by July 2018.

Launch of the AI Alliance, the AI High-Level Expert Group, AI Watch and the MSME Focus Group on Artificial Intelligence in 2018

Summary

- General objective of supporting the implementation of the European AI strategy
- 52 experts of the AI HLEG elaborate recommendations on future-related policy development and ethical, legal and societal issues related to AI
- AI Alliance serves as an open multi-stakeholder forum for all AI-related aspects, their development and impact. Over 4000 members, open to any stakeholder invested in AI
- AI Watch initiative of the European Commission and the JRC monitors Member States AI initiatives and policies and releases regular landscape mappings, investment reports and policy papers
- Focus Group on Artificial Intelligence by the JRC and the DIGITAL MSME Alliance evaluates and monitors the impact of AI technologies on European MSMEs and offers MSMEs guidance on AI uptake and implementation

As put forward by the Commission's previous Communication, the **European AI Alliance** was officially put in place in July 2018 alongside the **High-Level Expert Group on Artificial Intelligence (AI HLEG).**

The **AI HLEG** has the general objective to support the implementation of the European AI strategy by elaborating recommendations on future-related policy development and ethical, legal and societal issues related to AI, including socio-economic challenges. The 52 experts of the AI HLEG released e.g., the *Ethics Guidelines on Artificial Intelligence* which put forward a human-centric approach on trustworthy AI[178], as well as Policy and Investment Recommendations which include 33 recommendations to build a trustworthy AI towards sustainability, growth, competitiveness and inclusion.[179] The AI HLEG is active to this day.

The AI Alliance, in parallel, acts as an open multi-stakeholder forum for all AI-related aspects, its development and impact. Initially, the AI Alliance had the task to give collected stakeholder feedback to guidelines and recommendations put in place by the AI HLEG. With rising awareness of the importance of the AI topic, however, the AI Alliance over time has become a full point of reference in stakeholder-driven discussions and is now directly contributing to the European debate on AI policy. Essentially everyone from the EU public can apply to the AI Alliance forum to ask questions, give recommendations or share their views on AI-related topics – all forum entries are reviewed and taken into account by experts like the AI HLEG. Today the AI Alliance counts over 4000 members and serves as a platform for daily exchange of discussions, documentation, as well as for the organization of AI-related events. Inputs by members of the AI Alliance are today taken into direct account by the European Commission's policy making.[180]

Additionally, in 2018 the European Commission together with the JRC implemented the **AI Watch** initiative, a "Commission Knowledge Service to Monitor the Development, Uptake and Impact of Artificial Intelligence for Europe".[181] In detail, AI Watch is monitoring the industrial, technological and research capacity, the Member States' related policy initiatives, (supra-) national AI uptake and developments, as well as AI's impact on the economy, society and public services. AI Watch regularly releases landscape mappings, investment reports and respective policy papers.

Finally, in 2018, the **Focus Group on Artificial Intelligence** was launched jointly by the JRC and the European DIGITAL MSME Alliance. The Focus Group aims to support the DIGITAL MSME Alliance and the JRC in its work to "understand the adoption, use, and the current state of adoption and use of AI (…), and the social and economic impacts of these changes".[182] There Focus Group is open to be joined

by any European MSMEs "who focus on providing AI solutions or who are intensive AI users from across Europe can join this group"[183], the Group is therefore interested in creating a network of MSMEs who go in closer cooperation with the JRC. The Focus Group is planned for 3-5 years and meets usually two times per year.

The Coordinated Plan on Artificial Intelligence (2018)

Summary

- Coordinated Action Plan between the European Commission and the EU Member States
- Member States are to create a national AI strategy by mid-2019. Some Member States have to release a strategy to this day
- Strategies should include investment plans, endeavours for the fostering of digital skills and cross-border cooperation in e.g., research networks
- Proposed annual investments of the European Union of at least EUR 1bn per year during the 2021-2027 period with an increase in public-private-partnerships

Building on their 2018 strategy on AI, the Commission released later in 2018 their Coordinated Plan on Artificial Intelligence, developed in cooperation with the EU Member States and with the goal of fostering the development and use of AI in Europe.[184] Pointing out that "(…) coordination at European level is essential"[185] to embrace the full potential of AI amongst all Member States, the plan encourages the Member States "to develop their national AI strategy by mid-2019, building on the work done at the European level. These are expected to outline investment levels and implementation measures."[186] To date most, however not all, Member States have a national AI strategy adopted.[187]

On a European level, the Commission proposes Union investments of at least EUR 1 bn per year in AI during the 2021-2027 period, an increase in public-private-partnerships (PPPs) and continuous endeavours to create a digital single market for cross-border scale-ups and trades. Special financial attention should be drawn towards start-ups and "innovative small and medium-sized enterprises".[188] Cross-border cooperation and the development of innovative AI products should be further fostered through "tighter networks of European AI research excellence centres"[189], the creation of new digital innovation hubs, as well as data spaces essential for AI in Europe, including for the public sector.[190] To tackle skill-related shortcomings, the Commission announces support of Member State's Masters and PhD programmes in the field of AI with the creation of mentioned excellence centres as well as the EU's joint research and innovation programmes.

Finally, the Commission addresses the further need for ethics guidelines as well as the assurance of creating an innovation-friendly legal framework. As mentioned above, the ethics guidelines were published by the AI HLEG in April 2019.

AI4EU project launch in 2019

Summary

- AI4EU consortium is to build the first European AI-on-demand platform (currently in beta phase)
- The platform will act as a one-stop-shop providing e.g., software, algorithms, development tools, knowledge hubs and data for AI developers
- The consortium will additionally work on a comprehensive Strategic Research Innovation Agenda, a European Ethical Observatory and related AI activities in scientific areas
- Cascade funding plan of EUR 3 million for MSMEs and start-ups in AI-development

The creation and availability of cross-border infrastructure, financing and data availability have been prominently featured in the above-mentioned Communications of the European Commission. To get concrete, the AI4EU consortium was established in January 2019 with the financial aid of the European Commission, respectively the H2020 budget.[191] Under the coordination of Thales[192], the AI4EU consortium will build the first **European AI-on-demand platform** to "lower barriers to innovation, to boost technology transfer and catalyse the growth of start-ups and MSME**s in all sectors** through open calls and other actions. The platform will act as a broker, developer and one-stop-shop providing and showcasing services, expertise, algorithms, software frameworks, development tools, components, modules, data computing, resources, prototyping functions and access to funding."[193] The works of the AI4EU consortium will include the creation of the on-demand platform, research activities in AI scientific areas, implementation of industry-led pilot projects, the creation of a European Ethical Observatory[194], the production of a comprehensive Strategic Research Innovation Agenda for Europe, and the funding of MSMEs and start-ups solving AI challenges with a cascade funding plan of EUR 3 million.[195]

The AI4EU project is foreseen to run until January 2022. The consortium is however working on the establishment of an AI4EU Foundation that will in the future moderate the platform.

Exhibit 49: Use case: GAIA-X

Use case

Building together, for a value-driven European Data and Cloud infrastructure

Enhanced data privacy, transparency, security and respect for data rights. Based on these strong digital values of the European Union, GAIA-X aims at providing the future of a European digital infrastructure for both data and open-source software.

The main partners of the project are 22 French and German companies and institutions with further European partners and companies on the horizon. National hubs located throughout the European partner states will serve as first points of contact, support centres and as the voice of the numerous future partner institutions to enable future value-driven data infrastructure.

GAIA-X

The European Commission 2020 Communication on 'A European Data Strategy' and White Paper on 'Artificial Intelligence'

Summary

Data strategy

- Data strategy foresees a Single European Data Space with easy to access free data flow within all EU Member States and across all sectors
- Data regulation follows European rules and values, especially in regards to personal data protection and consumer protection

White Paper

- White Paper highlights the creation of an AI ecosystem of excellence and trust and calls for a new legal framework
- Commission foresees close cooperation with the Member States, major digital skill-building, focus on MSMEs and private partnerships, secure access to digital and data infrastructure, and the promotion of AI uptake in the public sector to enable uptake in the private sector

Following the first concrete actions, the Commission released in 2020 a Communication on 'A European Data Strategy' as well as a White Paper on artificial intelligence to indicate how the Commission will further support and promote the development and uptake of AI across the EU and its Member States. Both documents were released on the same date and synergise.

In their European Data Strategy, the Commission outlines their strategy on the development of the data economy until 2025. The set goal is to create a single European data space, "a genuine single market for data, open to data from across the world – where personal as well as non-personal data, including sensitive business data, are secure and business also have easy access to an almost infinite amount of high/quality industrial data, boosting growth and creating value (…)"[196]. Overarching targets are to ensure that:

- Data can flow within the EU and across sectors;
- European rules and values, in particular personal data protection, consumer protection legislation and competition law, are fully respected;
- The rules for access to and use of data are fair, practical and clear, and there are clear and trustworthy data governance mechanisms in place.[197]

The Commission stresses the fact that a Single European Data Space would be important to ensure the future development of artificial intelligence products, as the current data availability is insufficient – either because of fragmentation or unavailability.[198] The Commission recognizes sufficient data access especially crucial for the development and uptake of AI technology in start-ups and MSMEs.[199]

More important the Commission released, in parallel to the European Data Strategy, their White Paper on Artificial Intelligence. At the centre of the White Paper is the creation of an "(...) ecosystem of excellence that can support the development and uptake of AI across the EU economy and public administration (…)"[200]. Therefore, the Commission identifies eight main levels of action:[201]

A. **Working with the Member States**. Including the public consultation of the presented White Paper, as well as a Member State revision of the Coordinated Plan to be fully adopted by 2020.

B. **Focusing the efforts of the research and innovation community**. Which will have the Commission to facilitate the creation of excellence and testing centres that will combine European national and private investments and introduce new legal instruments (if necessary). Financial aid will be provided under the MFF2021-2027 and the Digital Europe Programme.

C. **Skills**. Has the Commission establish and support through the advanced skills pillar of the Digital Europe Programme networks of leading universities and higher education institutes to attract the best professors and scientists and offer world-leading masters programmes in AI.

D. **Focus on (M)SMEs**. The Commission will work with the Member States to ensure that at least one digital innovation hub per Member State has a high degree of specialization in AI. Digital Innovation Hubs can be supported under the Digital Europe Programme. Future financial aids are subjected to scale up "significantly".

E. **Partnership with the private sector**. The Commission will, under Horizon Europe, set up new PPPs in AI, data and robotics to combine efforts, ensure coordination of research and innovation in AI.

F. **Promoting the adoption of AI by the public sector**. With priority to healthcare, rural administrations and public service operators.

G. **Securing access to data and computing infrastructures**. In reference to the European Data Strategy, published in parallel (see above).

H. **International aspects**. The Commission highlights the fact that it will continue cooperation with "like-minded" countries and will continue to exercise global leadership in regards to ethics in AI.

In addition to creating an 'ecosystem of excellence', the Commission emphasizes creating an 'ecosystem of trust'. To establish this system, the Commission calls for the need of a clear European regulatory framework, which would require adjustments to existing EU legislation to fully cover all questions of e.g., liability, data protection and compliance. First practical endeavours were already taken by the AI HLEG with their non-binding guidelines:[202]

- Human agency and oversight;
- Technical robustness and safety;
- Privacy and data governance;
- Transparency;
- Diversity, non-discrimination and fairness;
- Societal and environmental wellbeing;
- Accountability.

For a safe and secure AI uptake in an ecosystem of trust, the Commission however stresses the fact for a revision of the existing legal framework. The open consultation process followed the publishing of the White Paper – its outcomes are yet to be presented.

The European Commission 2021 communication: Fostering a European approach to artificial intelligence

Summary

Proposal for a regulatory framework for AI

- A new regulatory framework for AI should enable AI research and uptake whilst ensuring high protection of fundamental rights, as well as privacy rights
- Based on a light governance structure that mainly focuses on high-impact AI use cases to avoid regulatory overreach
- Highlights the need for a technology-neutral definition of AI to be future-orientated
- Bans for specific AI technologies that oppose fundamental rights and EU values

Revision of the 2018 coordinated plan on AI

- Highlights the need for better-enabling conditions for AI with a special focus on MSMEs, including a shared data and computing infrastructure and better conditions for AI investments
- "From lab to market" approach to AI-development and research
- Introduction of a European Partnership on AI, Data and Robotics
- Call for EU-leadership in AI development with a focus on high ethical standards, sustainability & the environment, and safety & security

In April 2021, the Commission released a communication as a direct response to the 2018 Coordinated Plan on Artificial Intelligence as well as to the 2020 White Paper on Artificial Intelligence (see above respectively).[203] The Commission again highlights the many benefits as well as potential risks that AI applications bring, with special attention towards **the role of AI during the fight against the COVID-19-pandemic**. With AI-powered map-modelling to depict the virus spread, AI-supported diagnoses and AI-supported developments of vaccines and drugs against the virus, AI would have demonstrated its high potential for future use cases. The communication again highlights the EU's endeavours of making the EU a world-class AI hub whilst ensuring human-centric and trustworthy developments, and presents two policy packages in reaching this goal:

1. A proposal for a regulatory framework on AI;
2. A revised coordinated plan on AI.

The communication and its two policy packages were crafted based on extensive input the Commission received by relevant public and private stakeholders after a call for public consultation. The communication and both packages were received generally positive for providing concrete and distinct measures for the future of AI development within the European Union.

Proposal for a regulatory framework for AI

In the 2020 White Paper on AI, the Commission already set out the may specific risks that AI might bring and for which the existing legislation is insufficient, which was largely confirmed by the following public consultation. Whilst highlighting strong legislation in terms of protection of fundamental rights, safety and consumer rights already in place (e.g. with reference to the General Data Protection Regulation (GDPR), the Commission, therefore, calls for **"harmonised rules applicable to the design, development and use of certain high-risk AI systems, as well as restrictions on certain uses of remote biometric identification systems"**.[204] The Commission highlights the gained trust in AI by offering risk-based legislation which should foster the uptake of AI across Europe and boot its competitiveness in the long run. To be future-proof and innovation-friendly, the Commission proposes a legal framework that is designed to intervene only where it is strictly needed and with a **light governance structure that minimises the burden for economic operators**.

The overarching objectives of the regulatory framework are to **enhance the transparency** of new AI technology whilst **minimising the risks to safety and fundamental rights**. To ensure a proportionate and risk-based European regulatory approach, the framework firstly offers a **technology-neutral definition of AI** systems, which allows it also to be extended to cover techniques and approaches which are not yet known or developed. Secondly, the framework focuses on so-called **high-risk AI use cases** (where risks that the AI systems pose are particularly high) **to avoid regulatory overreach**. The classification as "high-risk" is dependent on the intended purpose of systems, as well as on the severity of possible harm and the probability of its occurrence. Examples are automated recruitment processes, evaluation of creditworthiness, or judicial decision making. For these high-risk AI systems, a set of specifically designed requirements should be put in place, which include the use of high-quality datasets, the establishment of appropriate documentation to enhance traceability, the sharing of adequate information with the user, the design and implementation of appropriate human oversight measures, and the achievement of the highest standards in terms of robustness, safety, cybersecurity and accuracy. Accordingly, "high-risk AI systems must be assessed for conformity with these requirements before being placed on the market or put into service".

In extreme cases, the proposed draft regulation also foresees **bans on a limited set of uses of AI that contravene European Union values or violate fundamental rights**. These include for example: "AI systems that distort a person's behaviour through subliminal techniques or by exploiting specific vulnerabilities in ways that cause or are likely to cause physical or psychological harm. It also covers general-purpose social scoring of AI systems by public authorities."

For **remote biometric identification systems** (e.g. facial recognition tools to check passers-by in public spaces, the Commission's proposed regulation foresees to establish a stricter approach. This real-time technique respectively would only be applicable in spaces exceptionally authorised by law as it would clash with GDPR in open public spaces. If these systems come into place (e.g. in public buildings with high-security standards like parliaments or police stations), the systems would be subject to stricter logging and human oversight requirements, including ex-ante conformity assessment procedures by a notified external body.

Other uses of AI systems, however (like e.g. chatbots, emotion recognition systems or deep fakes(would only be subject to **minimal transparency requirements**. To test AI compliance with the new regulatory framework, the Commission calls for the creation and use of **regulatory sandboxes** to test innovative technologies for a limited time. This way, the Commission strives for a proposed regulation that combines "greater safety and fundamental rights protection while supporting innovation, enabling trust without preventing innovation".

Revision of the 2018 coordinated plan on AI

In 2018, the Commission introduced its coordinated plan on AI acknowledging the fact that "(…) coordination at European level is essential"[205] to embrace the full potential of AI amongst all Member States. The plan encouraged the Member States "to develop their national AI strategy by mid-2019, building on the work done at the European level. These are expected to outline investment levels and implementation measures."[206] In their 2021 review and revision, the Commission again stresses the coordination of AI policy and investments at the European level as absolutely crucial.

Since the adoption of the action plan in 2018 however, **the technological, economic and policy context on AI has considerably evolved**. Therefore, the Commission sees the need to revise the 2018 plan. The Commission puts forth four key sets of suggestions to enhance the existing action plan to further accelerate the opportunities of AI.

1. **Integrating a set of enabling conditions for AI**: By focusing on a pan-European cooperation framework, as well as on a shared data and computing infrastructure, the enabling conditions to invest in and uptake AI should be enhanced. The Commission draws **special attention to the needs of MSMEs**: Only by providing a true cooperation framework as well as a shared data and computing infrastructure, many MSMEs could find the enabling conditions to invest in and uptake AI. Member States as well as the EU should therefore **invest more in enabling infrastructure, especially data spaces and computing resources**.
2. **Making the EU the place where AI excellence thrives from the lab to the market:** The Commission will in the future focus on funding networks of **AI excellence centres** and set up a **European Partnership on AI, Data and Robotics** under Horizon Europe to facilitate excellence in research and rapid uptake. Member States and the Commission are e.g. to set up AI testing and experimentation facilities as well as a network of European Digital Innovation Hubs "that will help MSMEs and public administrations to take up AI".
3. **AI that works for people and is a force for good in society:** The commission will continue its endeavours to ensure an AI future that is human-centric, secure, inclusive, accessible and trustworthy. The Commission refers accordingly to the **2021 regulatory framework** mentioned above and calls on the Member States to nurture talent and improve the supply of skills to enable the development of trustworthy AI.
4. **Building strategic leadership in high-impact sectors**: The EU should be a future-orientated AI leader in high-impact areas and sectors, including climate change and the environment, health, the public sector, robotics, mobility, security and home affairs, as well as agriculture.

In a closing remark, the Commission highlights the possibility to propose to establish the EU standards for trustworthy AI globally, to ensure an AI development that is based on high personal protection and human rights standards for all individuals and our environment.

3.3.2 France

Economic Context

With a total population of approximately 68 million people, France was the **second-largest contributor** to the EU's total GDP in 2019, adding up a total national GDP of approximately EUR 2,400 bn and approximately EUR 42k GDP per capita.[207] France remains the **EU's largest producer of agricultural products**, other key industries include (nuclear) energy production, tourism, manufacturing (particularly automobile, aerospace and arms) and technology (particularly telecommunications and electronics).[208] In 2020, the French unemployment rate added up to 6.9 %, ranking #15 in EU comparison and lying under the EU27 median of 7.2%.[209]

In 2018, approximately **3.06 million MSMEs** were counted in France of which most were classified as micro-enterprises (95.5 %).[210] French MSMEs in 2018 employed 64.1% of all national workforce and added up a value of EUR 556.4bn, which was 55.8% of the total national value added in 2018. Most of France's MSMEs are located in media, communication or information, retail or wholesale (including online shops), professional services, and healthcare.[211]

The French society at large has a less positive view of robots and artificial intelligence than the general European public (see Exhibit 50). France ranks among the moderately digitised countries in the EU. Digital adoption rates in France are below the EU average for all sectors.[212]

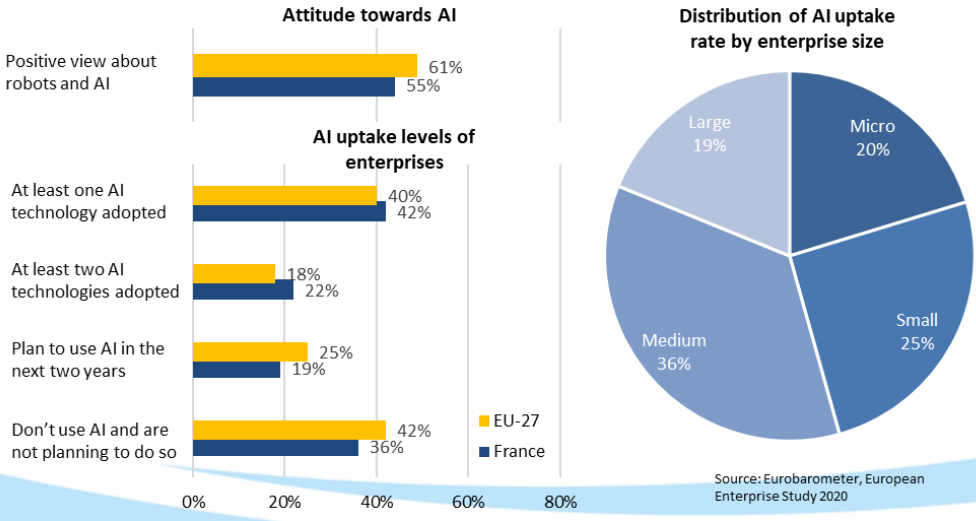
AI potential

Being the EU's largest producer of agricultural products, AI holds major potential in France's agricultural sector, mainly in the areas of automation, (market) forecasting and monitoring.[213] AI uptake in French agricultural MSMEs and large enterprises should therefore be a high priority to fully take on added AI potential in the sector.[214] Further emphasis should lie on AI uptake in the key technology industries manufacturing and technology as these sectors also hold major change and potential with future AI applications.

AI Uptake Levels

On average, French AI uptake lies below the EU27 median[215], with medium-sized enterprises account for the highest AI adoption rate amongst all enterprises.

Exhibit 50: France, attitude towards AI and AI uptake levels



AI Uptake Challenges

Following a 2020 survey by the European Commission, the main AI uptake challenges in France are due to unclear liability rules, lack of funding & high adaption costs, as well as a general lack of trust amongst citizens & lack of skills amongst existing staff.[216] Additionally, the French digital infrastructure is currently underdeveloped, compared to other EU member states, with overall lacking broadband penetration and insufficient connection speeds.[217]

Exhibit 51: AI Uptake challenges in France

AI Uptake challenges	
Data	▪ Lack of publicly available and private data.
Skills	▪ Lack of skills amongst employees. ▪ Low number of students in AI-related fields.
Costs	▪ Lack of public/external funding, missing financial incentives for AI investments. ▪ High AI adoption costs.
Market	▪ Underdeveloped digital infrastructure, lacking broadband penetration and sufficient connection speeds. ▪ Missing trust in AI amongst citizens. ▪ Unclear legal status, e.g., regarding liability for damage caused by AI.
Company	▪ High technology adoption costs. ▪ Missing financial incentives for AI investments. ▪ Insufficient or incompatible IT infrastructure. ▪ Lack of internal usable data. ▪ Lack of skills among existing staff.

National AI strategy & policies

The French Government presented its national AI strategy "*AI for* humanity" in March 2018, which foresees dedicated investments of EUR 1.5 bn until the end of 2022.[218] Coordinated by the French National Institute for Research in Digital Science and Technology *Inria*, the strategy foresees supporting policymaking to be sector-specific: health, transport, environment, and defence & security.

The main goals of the strategy target:

- **Skills:** The improvement of **AI education and training ecosystems**, including life-long learning and vocational training. Special focus is drawn towards higher education levels to double the number of students in AI by the end of 2022. The strategy further aims at insuring a successful professional transition of the workforce, through improved **labour market intelligence and forward-looking skill predictions**. The French Employment Orientation Council foresees up to half of the French occupations to be automated in the future, a better understanding of future labour demands and skills is, therefore, necessary to tackle AI-induced job losses.

- **Data:** The establishment of an **open data policy** for the implementation of AI applications and pooling of assets. The strategy plans to encourage the creation and sharing of data in the private sector, as well as a better sharing and publication of open data. As a first concrete policy measure, the French government implemented the **National Plan for Open Science**, which makes open access compulsory for all publicly funded data sets and publications.[219]
- **Market:** The strategy foresees the development of an **ethical framework** for transparent and fair use of AI applications as well as stronger and clearer **regulations regarding data security and cyber security**. As a concrete measure, the French **Digital Republic Act** offers first directives for the opening of public data, whilst strengthening and extending data privacy and users' rights. Regarding cyber security, the AI strategy underlines the French Act No. 2018-133 which was adopted in February 2018 and makes the adoption of high qualitative cyber security measures mandatory for selected industries.[220] To tackle the problem of infrastructure, the AI strategy foresees the improvement of the **French digital infrastructure** to better facilitate AI development. As an example, the French government has made investments in a supercomputer with the processing power of over 16 Petaflops, which was inaugurated in January 2020 at the Institute for Development and Resources in Scientific Computing (IDRIS) of the Université Paris-Saclay.[221] Other concrete initiatives or policies tackling the currently insufficient digital infrastructure are not part of the AI strategy.

France's International Digital Strategy (Stratégie internationale de la France pour le numérique), released in 2017, additionally considers the need for a better French digital infrastructure. It however does not provide any concrete policy measures or numbers on how to better facilitate the French digital infrastructure.[222]

Exhibit 52: Use case: interdisciplinary AI research

Use case

Interdisciplinary AI Institutes: Fostering nation-wide AI research

To better foster and centrally coordinate the national-wide interdisciplinary AI research, Inria created the 3IA network in frame of the French AI strategy. Part of this network are relevant institutes from the universities of Paris, Toulouse, Grenoble and Nice. Each of the universities are carrying out a specific research project to foster AI research between regional academic and industry ecosystems. The Nice-based Université Côte d'Azur, brings together researchers from the fields of IT, healthcare and regional development to develop e.g., AI applications for integrative computational medicine or smart and AI-secured territories.

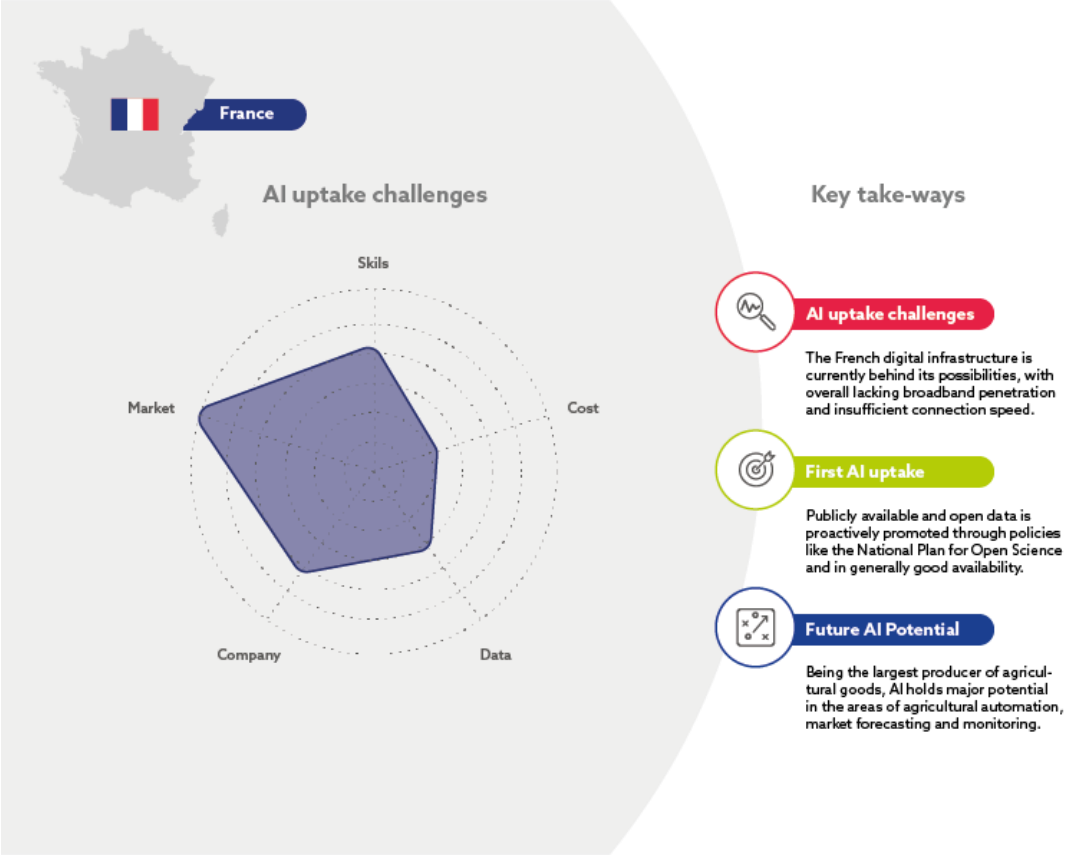
Conclusions

Being the second-largest contributor to the EU GDP, as well as the largest agricultural power in the EU, France is one of the most important economies in the EU. In terms of digitalisation, however, France remains improvable. Digital adoption rates lie under the EU-27 median in all sectors, making the country rank only amongst the **"moderately digitalised" members of the EU**. Especially an insufficient digital infrastructure with lacking broadband penetration and insufficient connection speeds are a break to French digitalisation. More public investments into public digital infrastructure are therefore crucial.

Necessary data for AI development however is better handled in France. The government actively promotes and fosters publicly available and open data as well as the sharing of private data, for example through policies like the *National Plan for Open Science* which requires all state-aided or funded university and research projects to make all generated data open access. This is a great starting point for AI development and should be further fostered.

The agricultural sector with its many MSMEs remains a key industry for France. The potential and added value of AI applications for the agricultural sector are proven and could help to further accelerate **France's pole position of being the EU's largest and one of the worlds largest agricultural manufacturers**. However, just like digitalisation in general, AI uptake levels in France are lower than the EU-27 median.

Exhibit 53: AI adoption challenges in France



In addition to the problem of missing digital infrastructure, one answer could lie in a generally sceptical stance of the French society towards AI and related fields, making them more sceptical than the EU average. Further, many MSME managements stand sceptical to AI adoption due to unclear legal situations. In addition to education campaigns to help positively change the attitude towards AI and raise awareness of its many benefits for industry and society, the legal framework of AI applications, including liability and privacy rights, needs to be enhanced.

3.3.3 Ireland

Economic context

With a population of approximately 4.9 million, Ireland shares the **second-highest GDP per capita** within the EU-27 of approximately EUR 75,000 in 2019.[223] The overall GDP in 2019 added up to a total of approximately 320 bn[224], growing by 6 per cent and making Ireland **the fastest-growing economy within the EU**.[225]

In 2020 Ireland remains the **biggest recipient of foreign direct investments (FDIs) in the world**.[226] It hosts the EU branches of many large tech companies such as Apple, Google or Microsoft due to a relatively low corporate taxation of only 12.5 % (in comparison to mostly over 20 % in other EU countries).[227] This has caused some critique by the other EU Member States and the European Commission, however, according to the latest statements by the Irish Government, there are no plans to change this low taxation rate at the moment. Accordingly, **FDIs are of immense importance for the Irish economy**, attracting investments in the areas of e.g., ICT, life sciences, financial services, engineering and business services.[228] It is estimated that up to 20% of all private-sector employment is directly or indirectly attributable to FDI – more than 1,200 overseas companies employ over 200,000 people and attract foreign workforce to the country.[229]

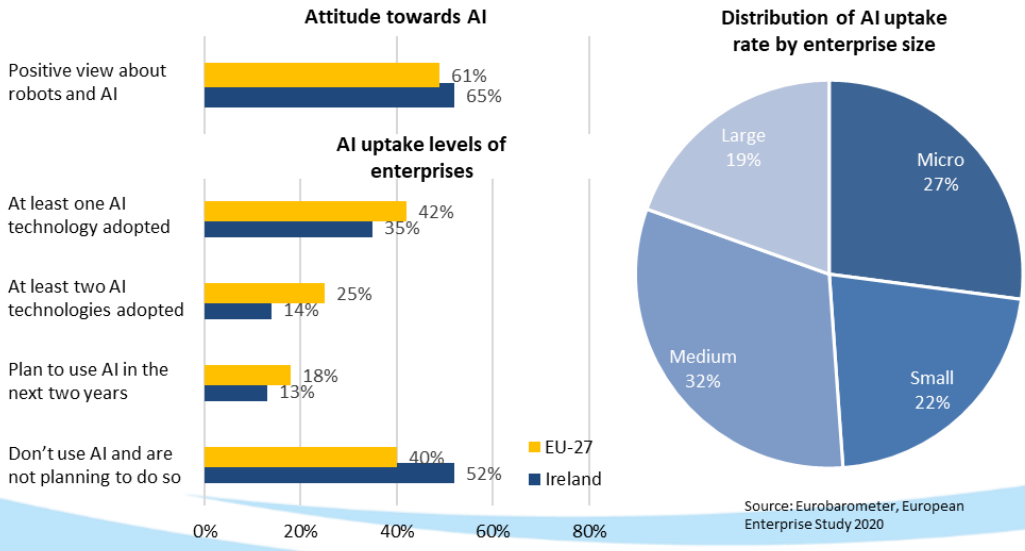
In 2018, Ireland counted **263,338 MSMEs**, with the largest number being micro-enterprises (91.9 %).[230] MSMEs play an important role in the Irish labour market, employing up to 70 % of all labourers in Ireland. MSMEs, however, contributed only 41.5 % to the total value added in 2018 staying under the EU average of 56.5 %.[231]

Irish society at large has a more positive view of robots and artificial intelligence than the general European public (see Exhibit 54). Ireland ranks among the modest digitised countries in the EU. Ireland's construction sector's adoption rate of single technologies is the only one to exceed those of the EU.[232]

AI uptake levels

In EU-comparison, AI uptake levels in Irish enterprises are currently lacking, being under the EU-27 median,[233] with medium-sized enterprises making up for the highest level of AI uptake.

Exhibit 54: Ireland, attitude towards AI and AI uptake levels



AI potential

The world-leading number of **FDI holds major potential in terms of AI research and development** for the country. 9 out of the 10 top global companies in the areas of software, pharma and ICT sectors have established operations in Ireland and undertake R&D as well as advanced manufacturing activities, including those of artificial intelligence.[234] These include global AI tech leaders such as Amazon, Apple, Cisco, Intel, IBM J&J, LinkedIn and Microsoft who foster linkages also between the Irish and US-American AI-R&D network.[235]

First estimations predict a potential added value to the Irish GDP of around 11.6%, respectively EUR 48 bn if AI is implemented effectively until 2030.[236]

AI uptake challenges

A recent study shows that only an insufficient number of Irish organisations and enterprises proactively aim at implementing AI in their operations.[237] Whilst company leaders and C-level management do realise the significant changes that AI will bring to the industry, many lack a clear understanding of where to implement AI and how it can benefit operations. Right now, there is more demand than supply for data scientists in Ireland, who are key professionals in AI development.[238]

Exhibit 55: AI Uptake challenges in Ireland

AI uptake challenges	
Data	▪ Lack of publicly available and private data.
Skills	▪ Insufficient number of data science scholars (limited by university capacities). ▪ Lack of skills amongst existing workforce
Costs	▪ Lack of public/external funding, missing financial incentives for AI investments. ▪ High AI adoption costs.
Market	▪ Unclear legal status, e.g., regarding liability for damage caused by AI.
Company	▪ High technology adoption costs. ▪ Missing financial incentives for AI investments. ▪ Insufficient or incompatible IT infrastructure. ▪ Lack of internal usable data. ▪ Lack of skills among existing staff.

High-level policy initiatives

An Irish national AI strategy *"**AI – Here for Good**"* is currently in development by the Department of Business, Enterprise and Innovation (DBEI).[239] DBEI initially announced the publication of the strategy for the first quarter of 2020, however, is yet to release it.

The strategy has been announced as an integrated, cross-government framework and will touch upon the issue areas of social opportunities and challenges: enterprise development and deployment of AI; research, development & investment: human capital considerations; data; digital and connective infrastructure; public sector use of AI; as well as frameworks for ethics, governance, standards and other regulations.[240]

As part of the development of the national AI strategy, an expert team on AI standardisation has been established under the lead of the National Standards Authority of Ireland (NSAI). The expert group has released a first guideline article *ISO/IEC TR 24028:2020* for enterprises to give an "overview of trustworthiness in artificial intelligence".[241] Whilst the main AI strategy is yet to be released, the **Industry 4.0 Strategy** released by the Irish government in December 2019 holds implications on digitalisation and AI development.[242] The strategy aims at:

- Skill-building and workforce training for relevant work fields of industry 4.0,
- Stimulating firms to adopt and build capability in Industry 4.0 technologies,
- Stimulating firms to harness opportunities enabled by Industry 4.0 technologies,
- To become the global leader in R&D and innovation,
- The formulation of a clear regulatory, legal and standardisation framework to establish foster an Industry 4.0-ready business environment.

The Industry 4.0 Strategy emphasises artificial intelligence as a key digital technology that will impact the future professional landscape of Ireland.[243]

Exhibit 56: CRT AI

Use case

A centre of excellence: for AI-related doctorate skills

The Science Foundation Ireland (SFI) established its Centre for Research Training in Artificial Intelligence in 2019 as a response to required AI skills building and education. Together with the University College Cork serving as the host institution and several other education and industry partners, the initiative aims mainly at postgraduate students and offers up to 120 PhD positions in six AI-related thematic areas.

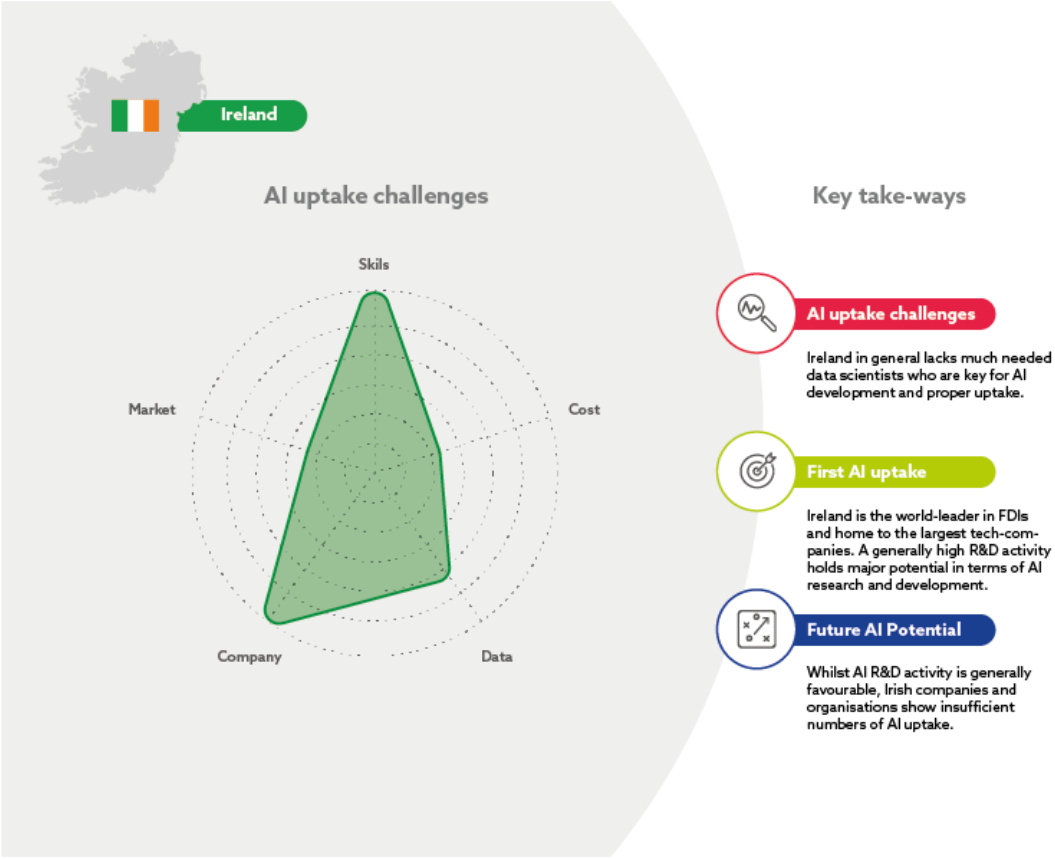
Conclusions

Ireland holds a promising starting position for AI uptake. The country currently ranks number one in FDIs and **hosts the headquarters of the world's biggest tech companies** in their respective European branches. As these tech companies like Google, Facebook, Apple and Samsung are crucial drivers for AI development and innovation, Ireland has great potential to be a European and perhaps global leader in AI research and development.

However, whilst performing well in R&D numbers, the AI uptake of Irish enterprises, mainly MSMEs, could be largely improved. AI adoption levels in Irish MSMEs remain under the EU-27 median, even though the overall digitalisation levels of Ireland are amongst the best in Europe. In general, Irish MSMEs are performing under their desired possibilities. Whilst playing an important role in the Irish labour market, MSMEs contributed only 41.5 % to the total value added in 2018 staying under the EU average of 56.5 %.

AI could hold the potential to increase the overall performance of Irish MSMEs, increasing their total value-added. A positive example is the Irish construction sector, which outperforms the EU-median in terms of adoption rates of single technologies. National C-level management in general does realise the added value of AI applications but lacks a clear vision on where to implement them.

Exhibit 57: AI adoption challenges in Ireland



Despite further fostering of AI R&D, the Irish strategy should therefore aim at **strengthening the general AI uptake** especially amongst Irish MSMEs, also **promoting the benefits** of and where to use AI.

Another problem that needs to be addressed to fully take on AI potential is skilled labour. Whilst the Irish education system, in general, does well, there are currently not enough higher-education courses for AI-related fields, leaving the industry in need of much-needed data and computer scientists. A clear priority should be therefore to create more AI-related curricula and courses. With its *Centre for Research Training in Artificial Intelligence*, the Science Foundation Ireland already aims at increasing the number of doctorate positions in the field. This is a great start; however, more courses are required also on the bachelor and master level.

3.3.4 Romania

Context

In 2020, Romania generated a total GDP of around EUR 207 bn, respectively EUR 10,750 GDP per capita.[244] Being no OECD member at the time, Romania first declared interest in joining the OECD in 2004–further internal transitions and growth are necessary to qualify for membership.[245] Romania was heavily affected by the 2008 global economic crisis, receiving two-digit bn funds, before slowly starting to recover from 2011 onwards.[246]

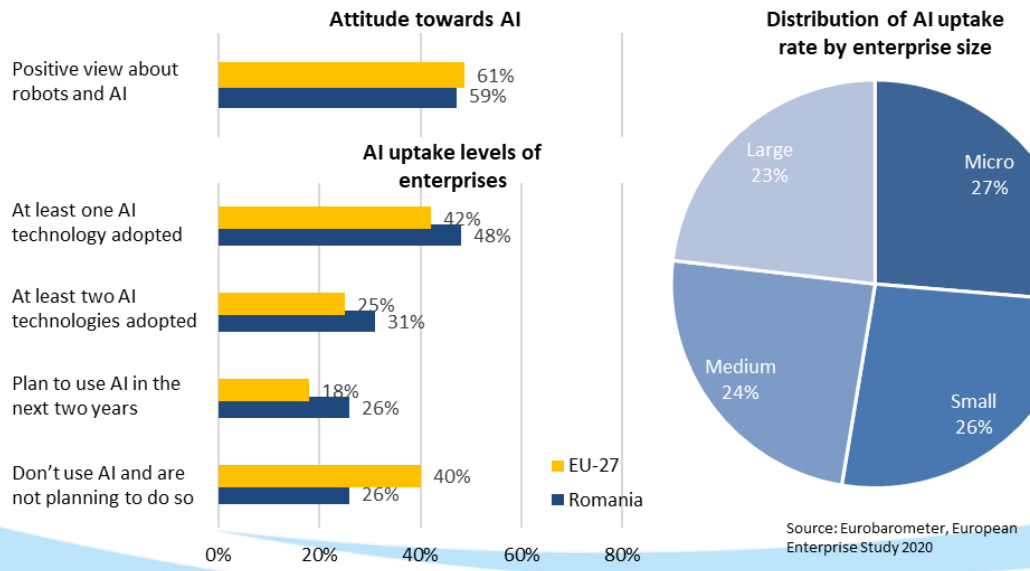
Romania is the largest country of Southeastern Europe (SSE) states by size, with a total population of 19.3m.[247] Romania's economy is largely characterised by the services sector, which employs approximately 48% of the country's workforce and contributes up to 56.2% to the Romanian GDP.[248] The industrial sector is the second-largest contributor to the country's GDP and benefits from its cheap labour, making it diversified and competitive. The technology and especially the ICT sector of Romania has been steadily rising, also benefiting from cheaper labour in European comparison. The agricultural sector, whilst employing 22% of the Romanian workforce, stays behind its capabilities mainly due to insufficient use of arable areas. Whilst the economy mostly recovered from the 2008 global economic crisis, its economy still faces major challenges, including demographic change, massive emigration of skilled labour to Western Europe, significant tax evasion, an insufficient health care system and the loosening of fiscal packages.[249]

In 2018, **485,757 MSMEs** operated in Romania, with the biggest part of 88.4% being micro-enterprises.[250] Adding 52.7% of the national total value-added and employing approximately 65.8% in 2018, MSMEs play an important role in the Romanian economic system.

AI uptake levels

The AI uptake levels of Romanian enterprises exceed the median of the EU-27.[251] The national attitude towards AI lies a bit under the EU-27 median, however, comes close with 59% of the consulted Romanian public being positive about the changes that AI might bring.

Exhibit 58: Romania, attitude towards AI and AI uptake levels



AI potential

Regarding investments, Romanian AI-related start-ups have seen a successful first quarter in 2020.[252] With a better suited and more supportive political framework, investments in Romanian AI start-ups are estimated up to EUR 50 m by 2025.[253]

A first draft of the Romanian AI strategy **highlights the Romanian agricultural sector** as a main sector of activity, as well as its currently underexploited potential.[254] The strategy sees the main problems for the agricultural sector in obsolete technology, fragmentation and erosion of soil, desertification, and difficulty in accessing funds–AI systems, however, holds significant potential to tackle these issues and increase productivity. Beneficial examples of AI in Agriculture are e.g., autonomous machines, prediction of impacts of environmental events, precision agriculture and weather forecasts.

The first draft of the strategy further highlights the benefits for the currently insufficient healthcare system in Romania. Through AI-supported prevention programmes, improved management of public healthcare systems or automated monitoring of chronic diseases, AI applications **could help to tackle the problem of an ageing population** and a decreasing density of medical doctors per capita available.

AI uptake challenges

As the Romanian economy is heavily labour and services intense, AI, robotics and automatization could replace between 40 to 50 per cent of existing jobs, mainly in the areas of accounting and marketing.[255] Corresponding education programmes are therefore important to re-educate the existing workforce and tackle potential unemployment. As Romania does not yet have an AI strategy, there are open questions regarding liability and regulation of AI systems, future skill & education systems, funding and infrastructural support.[256]

Exhibit 59: AI uptake challenges in Romania

AI uptake challenges	
Data	▪ Lack of publicly available and private data.
Skills	▪ High emigration rate for well-educated and skilled labour. ▪ Despite high numbers of STEM graduates, only a small number of ICT specialists amongst the Romanian labour force (1.9 per cent).[257] ▪ Lack of skills amongst existing workforces. ▪ High potential number of human workforce to be replaced by AI (between 40-50 per cent). ▪ Lack of AI-related education courses.
Costs	▪ Lack of public/external funding, missing financial incentives for AI investments. ▪ High AI adoption costs.
Market	▪ Unclear legal status, e.g., regarding liability for damage caused by AI. ▪ Need for more sufficient physical digital infrastructure (broadband, 4/5G coverage)
Company	▪ Insufficient adoption of digital technologies amongst Romanian enterprises. ▪ Missing financial incentives for AI investments. ▪ Lack of skills among existing staff.

AI High-Level policy initiatives

The Romanian government initially announced a national AI strategy to be released at the end of 2019, however has not released it to date. According to a statement by the at-the-time Romanian Minister for Communications and Information Society Alexandru Petrescu, the national AI strategy of Romania is drafted based on the OECD Recommendations on Artificial Intelligence, in order "to ensure the adoption of safe AI application in every day's life, and to promote fundamental research leading to genuine AI applications and developments, while preserving human rights and social values".[258]

A first draft of the planned AI national strategy ("Artificial Intelligence: A strategy for the development and adoption of AI technology at a country level") was released in May 2019 which outlines the direction of the strategy to come:[259]

- **Costs:** The draft foresees the creation and support of accelerators and incubators to financially aid start-ups in the AI field. Further, AI projects should get "prioritised" funding, the draft however does not name any numbers or other specific policies regarding costs of AI adoption.
- **Data:** As part of the national AI strategy, the Romanian government plans to facilitate the development of infrastructure for data collection and sharing. A clearer framework for data protection should further ease the use of data.
- **Skills**: The first draft of the AI national strategy foresees to prioritise funding for AI projects (including fundamental research and start-ups) to attract foreign and retain domestic experts with AI skills. Educational programmes are planned to further create domestic AI experts, networking events and initiatives should facilitate local AI communities and foster the collaboration between academia and industry.
- **Market**: To better foster the market for AI development and uptake, the draft foresees establishing clear regulations and legal frameworks regarding the adoption and procurement of AI. These will include issues of liability, data and privacy regulations as well as cyber security regulations. The creation and support of incubators and accelerators should further support the AI ecosystem, with a special focus on start-ups.

Exhibit 60: Use case: AI4RO

Use case

An expert group on advanced AI research

In late December 2020, the Romanian Secretary of State for Communications announced the set-up of a dedicated expert group on advanced AI research and coordination AI4RO. The four members of the expert group target a better promotion and coordination of the use of AI in Romania following the principles of e.g., a responsible AI, open data, and a balanced labour market.

Conclusions

Romania holds great economic potential if the education system is improved and the emigration of skilled workforce is tackled. A large benefit Romanian MSMEs hold against global competitors is the **price advantage through lower national wages than the EU average**. Respectively not only the industry sector benefits from this, but the ICT and general technology sectors have also been growing steadily in the past years.

Exhibit 61: AI uptake challenges in Romania

However, Romania faces the big challenge of the **emigration of its skilled workforce**. Highly skilled young experts are leaving the country for western industries in search of higher wages, leaving the Romanian national market scarce of much needed AI and digital experts. A side effect of this emigration movement is a large demographic change, leading Romania to an "ageing" of society. This has severe effects on the public and private health care sector, where under numbered medical staff faces an ever-increasing number of ageing patients.

AI holds the potential to relieve the Romanian healthcare and medical sector, by taking over mundane and basic tasks like AI-driven med bots for first medical patient briefings, automated health monitoring or remote medical practices. AI in healthcare should therefore play a vital role in future AI endeavours of the Romanian government.

Whilst Romania counts a respectable number of students in STEM fields, Romania only counts a vanishingly small number of ICT experts. To tackle the root of the problem, a clear priority should remain to lower the number of emigration of skilled ICT and AI professionals. Supportive policies for entrepreneurship, support for digital MSMEs, a better digital infrastructure, as well as more attractive wages can help to keep Romanian experts and overcome the problem of emigration.

3.3.5 Italy

Economic context

With a total population of approximately 60.4 million in 2020, Italy generated a total GDP of around EUR 2 tn, respectively an approximate GDP per capita of EUR 37.5 k.[260]

Despite some positive developments in recent years, Italy continues to struggle economically with large regional differences in GDP per capita (the GDP per capita remains the same as twenty years ago, despite a rise in the total GDP), a high unemployment rate amongst the youth, high absolute poverty rates, and structural weaknesses in public administration especially.[261] Supportive global economic conditions, the EU expansionary monetary policy as well as internal structural reforms and prudent fiscal policies, however, can benefit Italy in a slow and steady recovery from the ongoing economic challenges.[262]

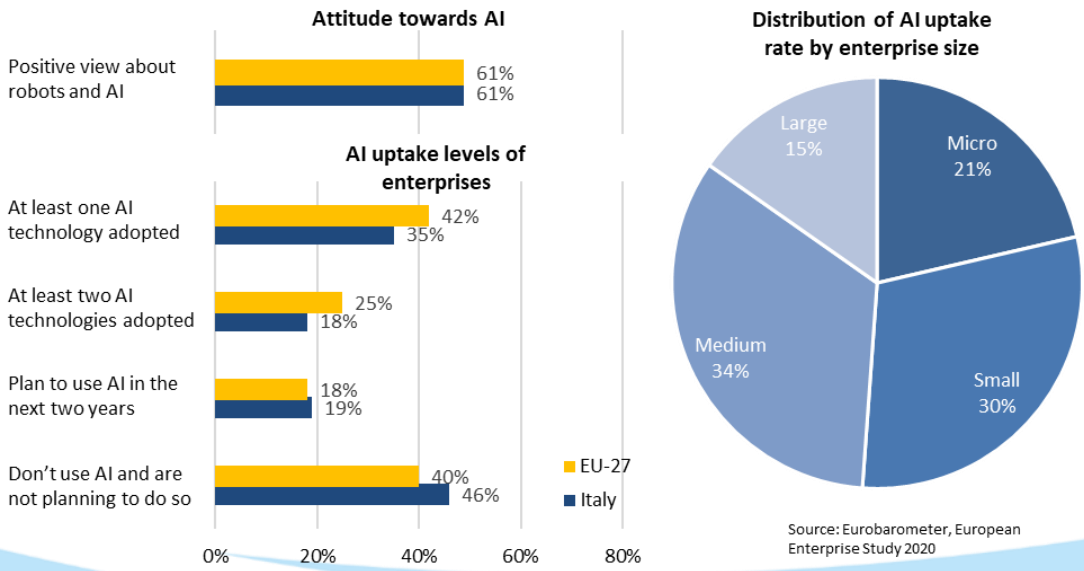
Italy is the largest global exporter of luxury goods such as cars and clothing, and the second-largest manufacturer of the EU mainly including industries such as precision machinery, vehicle production, chemicals and pharma, electrical items, fashion and clothing.[263] The service sector constitutes two-thirds of the Italian GDP (up to 66.3 %), with tourism being the fastest growing sub-sector of services. Whilst being one of the main agricultural players in the EU, the agricultural sector represents only 1.9 % of the national GDP and is highly reliant on the import of raw materials necessary for agricultural production.

In 2018, **3,791,245 MSMEs** operated in Italy making up 99.9 % of all enterprises.[264] MSMEs are the primary employers in Italy, employing up to 78.1 % of all Italian workforce. Micro-enterprises make up the largest share of Italian MSMEs with 3,559,695 businesses (a share of 94.9 %). With employment rates of 44.9 %, micro-enterprises are also the prime employers of Italy. MSMEs generated 66.9 % of the overall value-added, exceeding the EU average of 66.6 %.

AI uptake levels

Small and medium-sized enterprises make up for the biggest part of AI uptake levels in Italy. In EU comparison, Italy lies below the EU-27 median in terms of adoption of at least one or two technologies.

Exhibit 62: Attitude towards AI and AI uptake level in Italy



AI potential

Digitalisation, in general, holds great value to support Italy overcome structural economic weaknesses, especially in public administration, education, tackling tax evasion, and attraction of FDI.[265]

Being the **second-largest manufacturer of the EU** well known for automation, AI holds the valuable potential to further increase Italy's top position. Italy has shown a strong specialisation in the combination of AI with physical systems in manufacturing and automation – these embedded AI systems hold great potential to make Italy a prime researcher in the field.[266]

The overall attitude of the Italian employees towards AI is generally positive. Only 8.36 % worry that AI or automation could endanger their working place, whilst a large majority of 68.7 % welcomes AI or automation and their support to undergo mundane tasks more efficiently.[267]

AI uptake challenges

Whilst Italian employers stand generally positive towards AI, only 1.79 % of the existing Italian workforce has received AI training from employers. [268] Together with improvable infrastructure, more sufficient AI education is therefore key for successful AI uptake.

Exhibit 63: AI uptake challenges in Italy

AI uptake challenges	
Data	▪ Lack of publicly available and private data. ▪ Need for better data exchange between the private and public sector
Skills	▪ Despite a positive attitude towards AI, generally low education in AI-related themes amongst employees.
Costs	▪ Expandable funding schemes for AI adoption and digitalisation. ▪ High AI adoption costs.
Market	▪ Unclear legal status, e.g., regarding liability for damage caused by AI. ▪ Need for more sufficient physical digital infrastructure (broadband, 4/5G coverage). ▪ National economical problems in Italy remain high.
Company	▪ Missing financial incentives for AI investments. ▪ Lack of skills among existing staff.

High-level policy initiatives

The Italian Ministry of Economic Development released a first draft version of their national AI strategy together with a background paper called "Proposals for an Italian strategy for AI" in August 2019 for public consultation.[269] Based on these two documents, the Ministry proposes a first long-term strategy for the future Italian development and uptake of AI. The first proposal foresees public investments of up to EUR 1 bn by 2025, first estimations expect the public investments to create leverage effects on private investments of an additional EUR 1bn. In detail, the first draft of the Italian national AI strategy highlights the following main points: [270]

- **Data**: To improve and foster the development of AI applications, the first draft foresees the creation of data infrastructure. Public (administration) data should in future be more accessible and interoperable through **API interfaces**. To foster data exchanges between private and public data creators, the government will promote the development of **Data Sharing Agreements**, with a special focus on strategic sectors of "high potential and collective interest". Further, as part of the AI strategy, the Italian government will support the creation of a **Common European Data Space**.
- **Skills**: In terms of skills and education, the first draft aims to strengthen the provision of AI competencies "at all education levels". The development of a national plan for the **Digital School** should educate students in AI-related courses at primary and secondary education levels. At higher education levels, the draft strategy foresees the stronger promotion and integration of AI-related themes and courses in bachelors, masters and doctoral programmes. Lifelong learning activities, as well as upskilling and reskilling training programmes in AI, should benefit the existing workforce. To attract more foreign experts in the field of AI, the draft strategy foresees to strengthen existing policy instruments for easier expert work immigration, e.g., using the **EU Blue card** or the **Italian Startup Visa**.
- **Costs**: The draft foresees the Italian government to increase available funding (without naming any specific numbers), as well as to foster and encourage public-private venture capital support. As a first concrete measure regarding the latter, the government launched the **Smart&Start Italia** funding scheme to support new businesses and start-ups in the digital economy, including AI applications, with financing between EUR 100 k and EUR 1.5 m. Regarding the help of MSMEs in the digital transition, the draft strategy foresees not only financial instruments, but also the creation of advisory services – in terms of additional financing, the draft refers also to the Italian **National Innovation Fund** of 2019, with an initial budget of EUR 1 bn to be also used for the digital transition.
- **Market**: To foster the digital and telecommunication infrastructure, the draft aims to further expand the ultra-broadband fibre network as well as 5G coverage. The government plans further to participate in the Joint Undertaking to develop a competitive European computing ecosystem (**EuroHPC**), **Leonardo**. Regarding regulations, the draft foresees the establishment of a regulatory and ethical framework for AI – the current legislation shall therefore be analysed and annexed if needed to remove barriers to a smooth AI transition and development.

Exhibit 64: Use case: supercomputer for Italy

Use case

LEONARDO: a new EuroHPC world-class pre-exascale supercomputer in Italy

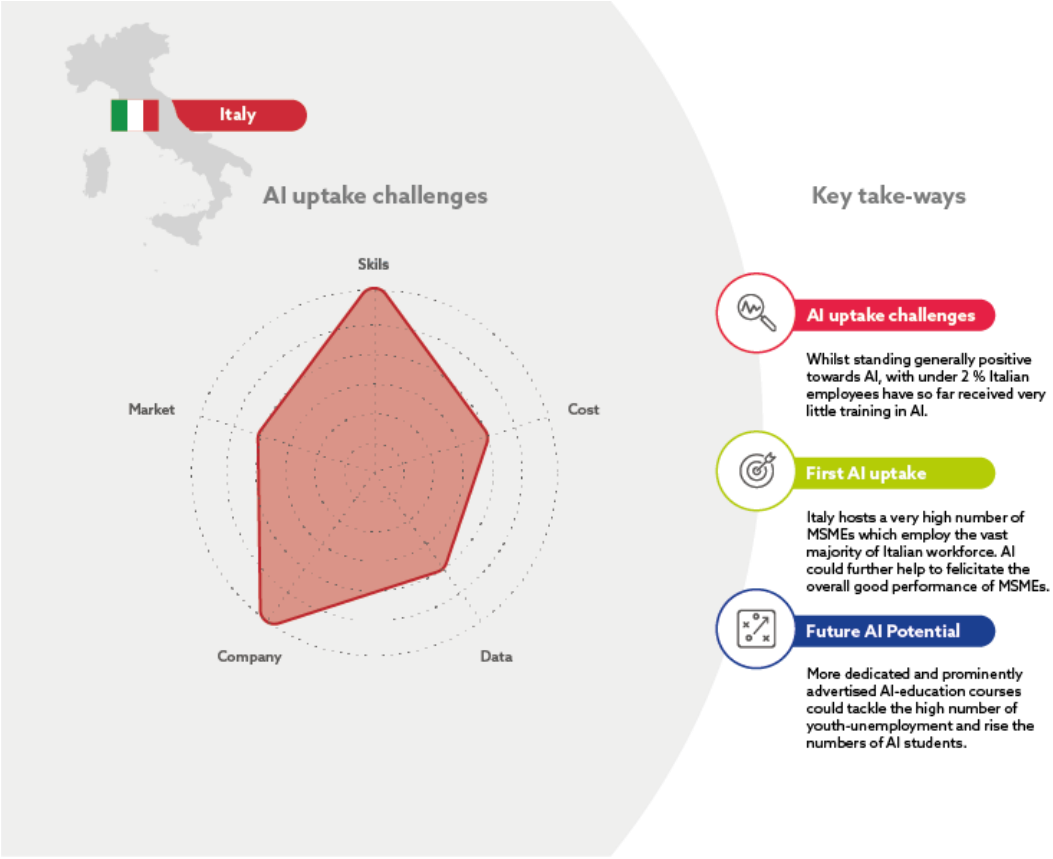
LEONARDO will be a top-of-the-range supercomputer, capable of executing more than 248 petaFLOPS (more than 248 quadrillion calculations) per second. With such massive computing power, this new supercomputer will rank amongst the world's top supercomputers and will pave the way towards exascale capabilities, the next supercomputing frontier, which allows for more than one trillion operations per second.

This new leadership-class HPC system will be located in Italy, on the premises of the new data centre of CINECA, currently built in the Bologna Technopole. CINECA is a non-profit consortium, made up of 69 Italian universities, 21 national institutions and the Italian Ministries of Universities and Research, and Education.

Conclusions

Italy shares an impressive number of MSMEs, making them by far the **biggest source of employment** in the country. However, Italy keeps struggling with high rates of (youth) unemployment, high absolute poverty rates and structural weaknesses in public administration and infrastructure, which differ largely depending on geographical locations.

Exhibit 65: AI uptake challenges in Italy



As the demand for AI specialists keeps rising globally, large investments in AI education could hold major potential in tackling the problem of youth unemployment rates. Whilst the number of students in AI-related courses, as well as the general AI training of the Italian workforce is lacking, the Italian society stands generally in favour of AI and its related fields. More active education, both in higher-education schemes as well as in life-long learning schemes is a key for success.

As Italy is Europe's second-largest manufacturer and is well-known for its automation techniques, AI holds the major potential to further accelerate this position. Italian companies already started using applied AI in manufacturing - more dedicated R&D as well as applied AI programmes could prove to be of major value for the Italian value chain. To enable AI uptake or make it more attractive, the **Italian digital infrastructure needs to be improved**. Especially outside of major cities like Rome and Naples, better coverage of high-speed broadband connections and 4/5G coverage are necessary.

3.3.6 Sweden

Economic context

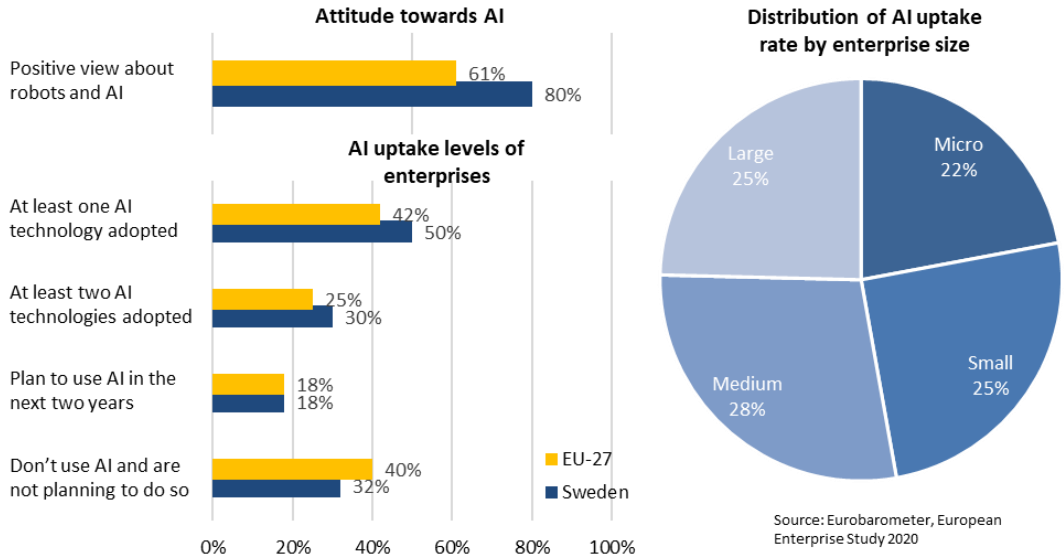
With a population of approximately 10.2 million, Sweden generated a total national GDP of EUR 440 bn, respectively a GDP per capita of approximately EUR 47 k in 2019.[271] Important economic sectors of Sweden include public administration, defence, education, human health, social work activities, telecommunications, automotive and pharma.[272] Whilst hosting a highly liberalised and competitive open market economy, Sweden is known for its high taxation rates, thus resulting in high social security and welfare standards.[273]

In 2018, Sweden counted a total of **738,624 MSMEs**, making up 99.9% of all enterprises in the country.[274] Similar to the other member states included in this study, micro-enterprises made up for the biggest part of MSMEs at 94.6%. MSMEs employed 65.2 % of all workforce in Sweden and added up a value of EUR 142 bn, respectively 61.2% of the total value added in 2018.

AI uptake levels

Medium-sized enterprises have the highest AI uptake levels in Sweden. In EU comparison, Sweden has higher levels of AI uptake of enterprises.

Exhibit 66: Sweden, attitude towards AI and AI uptake levels



AI potential

Before releasing the Swedish AI strategy, an extensive policy report outlining the opportunities and challenges of AI in Sweden was published. The Swedish society overall is, **technology-friendly and has a high level of technological skills**, with excellent IT infrastructure and a high level of digitised processes and automation. Compared to the EU the attitude towards AI is very positive in general.

While all sectors will experience some level of AI uptake, the sectors of transport, sustainability, health, and finances are expected to become more prominent in the usage of artificial intelligence in Sweden.[275] Swedish companies operate often in the higher part of value chains, including a strong telecommunications sector – the telecommunications sector plays a dominant role in national AI development and operates as a key enabler for AI uptake in other industries. Swedish telecom companies often operate with open-source software, free access to data as well as open application interfaces.

AI uptake challenges

While the general digital education and IT infrastructure are at a very mature level, significant challenges remain in the fields of AI and digitalisation. The government highlights improvements necessary in the regulatory framework including privacy and intellectual property rights, the need for better cybersecurity and AI standards, as well as the need for AI-oriented higher education.

Exhibit 67: AI uptake challenges in Sweden

AI uptake challenges	
Data	▪ Lack of publicly available and private data.
Skills	▪ Lack of AI skills amongst employees and existing workforce. ▪ Low number of students in AI-related fields.
Costs	▪ Lack of public/external funding, missing financial incentives for AI investments. ▪ Higher support in R&D required. ▪ High AI adoption costs.
Market	▪ Improvable digital infrastructure for AI applications. ▪ Unclear legal status, e.g., regarding liability for damage caused by AI. ▪ A clearer legal framework for privacy and intellectual property rights is needed.
Company	▪ High technology adoption costs. ▪ Missing financial incentives for AI investments. ▪ Insufficient or incompatible IT infrastructure. ▪ Lack of internal usable data. ▪ Lack of skills among existing staff.

High-level policy initiatives

In May 2018, the Swedish Government released its AI strategy "National Approach for Artificial Intelligence". Whilst not outlining any concrete policies or initiatives, the document serves more as a reference to help the government to outline forthcoming policy initiatives aiming at strengthening Sweden's welfare and competitiveness by fully exploiting the benefits of AI. [276] The strategy proposes the priority areas of education & training, research, innovation & use, and framework & infrastructure. The Flagship AI initiative is the "AI Sweden" Initiative" implemented by the Swedish Innovation Agency Vinnova, to accelerate the use of applied AI.[277]

- **Data:** The Swedish Government's Public Sector Information (PSI) Directive 2019 has made information that is **complete, current and machine-readable, accessible freely in open format**. Specific datasets such as geospatial data/geodata, address data, geological data and public sector data are made available with minimal restrictions.
- **Skills:** To enable AI uptake the need for formal education and training, as well as lifelong learning in AI, was determined. To provide a sufficient number of people with AI education and training with AI skills Swedish universities have started to offer bachelor's and master's programs in AI fields. Pilot projects were started to evaluate and prepare for **changes in skill needs in the labour market** due to AI technology developments.

- **Cost:** The Swedish AI strategy does not disclose financial provisions or estimations for its implementation. AI-related innovation projects are financed through Vinnova, Sweden's innovation agency. Vinnova also provides **funding support to MSMEs and public organisations** to start their first innovation project in AI. The Swedish AI strategy foresees access to a costly **Data Factory infrastructure**: storage, computational power and access management tools are made available to the research partners of AI Innovation of Sweden to analyse large and complex databases.
- **Market:** Building networks and partnerships is essential to harness the benefits of new AI opportunities, in particular for a small country such as Sweden with a relatively limited domestic market. Hence a **network of prominent players** within the country as well as across borders with the other Member States or beyond the EU is part of a set of policies. To foster the market, several policy initiatives have been established: AI Innovation of Sweden is an ambitious **research and innovation programme** with a holistic approach to foster the development of AI applications in Sweden.

Exhibit 68: Use case: AI Sweden

Use case

Accelerating the use of applied AI

Implemented by the Swedish Innovation Agency Vinnova, AI Sweden is the Swedish National Centre for applied AI. Its goal is to accelerate the use of AI for the benefit of the Swedish society and Sweden's global competitiveness. AI Sweden is actively promoting the use of AI mainly in the areas of information-driven healthcare, AI-powered linguistics, data-driven journalism, and AI-driven environmental solutions to tackle climate change.

AI SWEDEN

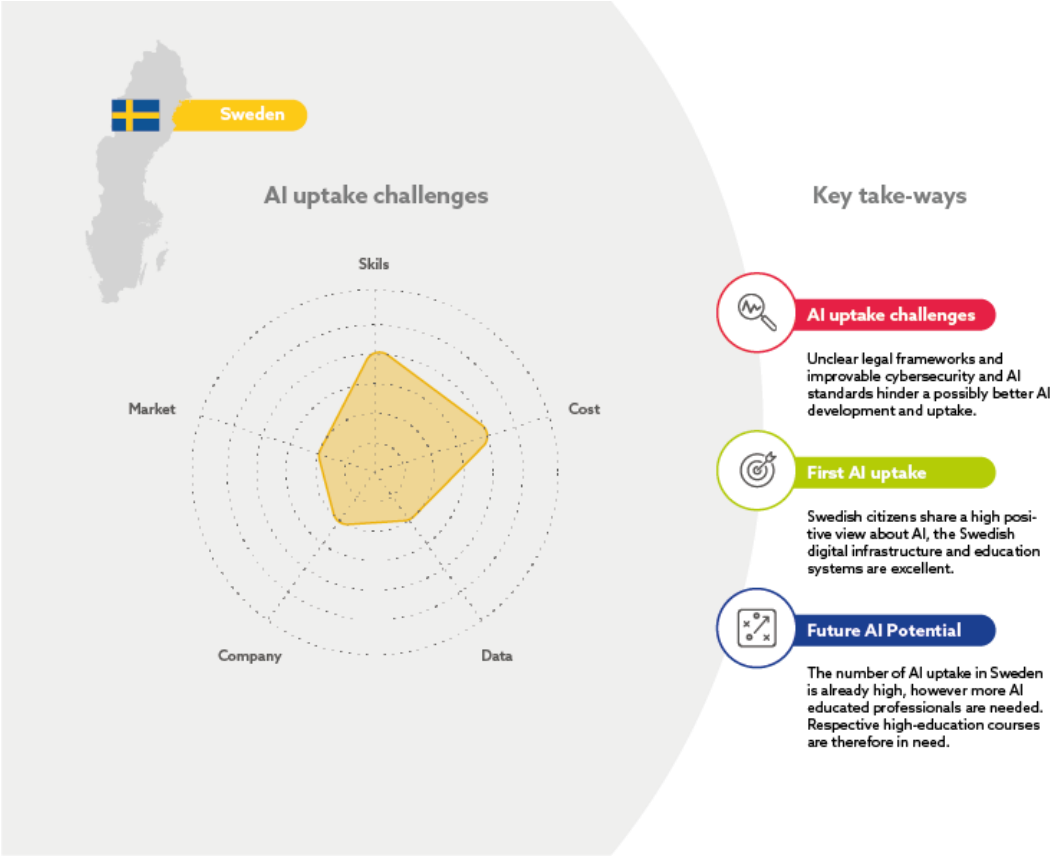
Sharing the power to unlock AI-potential

Besides information and education campaigns, AI Sweden has established a Data Factory to enable project partners to make available and access data, computing power and storage capacity for AI projects.

Conclusions

Sweden holds great potential for an AI-driven future. In EU-comparison, the Swedish society stands amongst most positive in regards to AI and adjacent areas like robotics. Sweden hosts an already **great digital infrastructure with good broadband penetration** and a generally favourable 4G coverage. The Swedish education system is internationally recognised for its high level of quality, generating a very well skilled labour force for the higher parts of value chains.

Exhibit 69: AI uptake challenges in Sweden



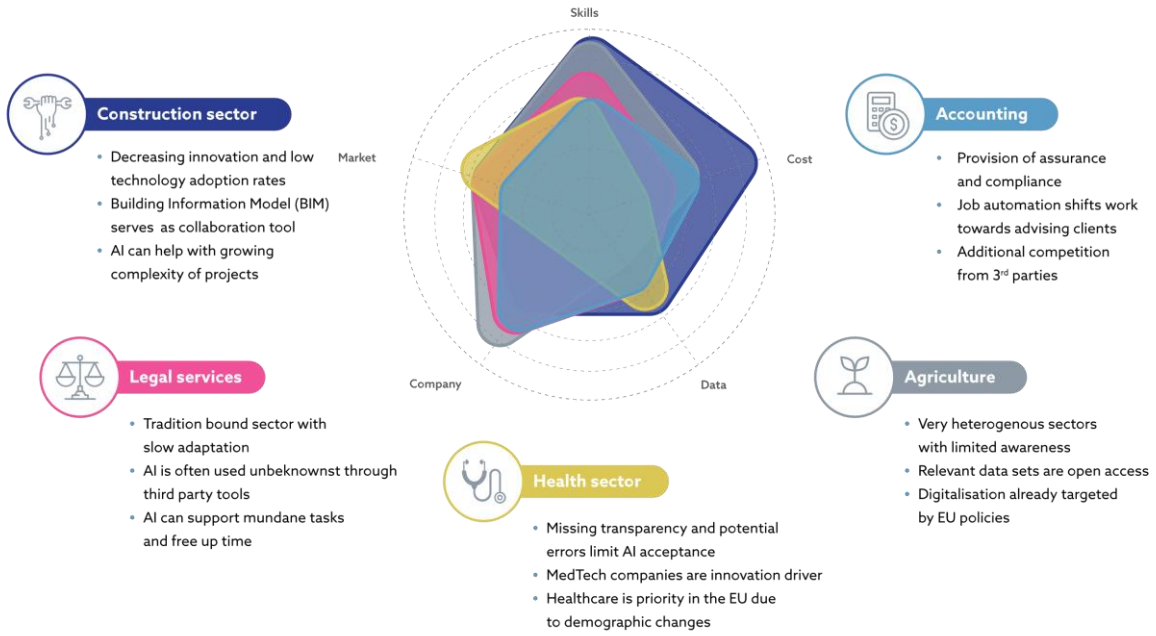
However, whilst Swedish citizens stand positive towards AI, the number of AI skilled workforce is largely improvable. This the result of e.g., a lack of higher education courses and a low number of students in fields related to AI, as well as improvable education systems for the already employed workforce ("life-long learning", further education schemes). Sweden should draw on its strong established education system and actively promote both, the creation of new higher-education courses related to AI, as well as promote these courses amongst young students.

AI adoption rates in Swedish MSMEs are above the EU-27 median, remain however still improvable. A clearer legal framework, especially in regards to liability and data protection rights, is required to make MSMEs without large legal departments more comfortable with adopting new AI solutions. The "AI Sweden" initiative is a great way to promote and accelerate the use of applied AI – the Swedish government should therefore strengthen the programme further to draw more attention to the various uses of AI applications. Especially MSMEs can greatly benefit from programmes like AI Sweden, more special focus should be drawn towards them respectively.

3.4 Key challenges to address for MSMEs

Overarching challenges for MSMEs can be identified despite the inherent differences in the studied sectors. The main challenges are **missing awareness of AI benefits** by company management and **lack of skill amongst existing (technical) staff,** in addition to **missing or inaccessible data**. Also, external market conditions, such as too restrictive or too broad legal frameworks, hamper the successful adoption of AI technologies by MSMEs.

Exhibit 70: Cross-sectoral benchmarking



3.4.1 Skills

The term "artificial intelligence" is rather well known through media and movies and has become a "buzzword" in the last years. However, the actual possibilities and limits of AI are commonly not general knowledge and making a general education of the society on the functioning and safe use of AI necessary. An increased **MSME management awareness** to understand the opportunity of AI within the company and define a business case is the main uptake challenge. While the logic of the AI model is an important aspect of efficiently and correctly implementing AI-enabled products and services within the regular business practice, understanding the complex AI algorithm is generally not seen as necessary.

> - *MSMEs are aware of AI, but they have no clear picture of what AI can do for them. It is not an awareness problem, but a problem of **knowledge maturity**.*
> - *AI is seen as a powerful technology that is going to be a **competitive advantage** in the future, but SMEs do not know if they should already start with AI uptake.*

The lack of internal and external AI talent is a prime obstacle to AI adoption in Europe. Highly talented professionals necessary for a broad AI uptake such as **data scientists, AI engineers and consultants** are drawn to well-known high-technology corporations offering a high paycheck. This often limits the workforce available for local, less-known companies and AI start-ups. A standard course on digital and AI skills independent of the chosen school and study program within the education system would ensure a basic understanding by graduates and facilitate communication with AI developers. Training to existing MSME staff and employees to **use AI applications** and to familiarise themselves with use cases in daily operations including risks and the necessity to have up-to-date cybersecurity will be necessary to complement the AI solutions offered by different suppliers. Especially in the context that internal data is used as in most cases, internal know-how and skills how to feed the necessary data to the AI solution and maintain it is a necessity.

Competing with large enterprises is difficult, if not impossible as they have more resources such as skilled personnel, time and money available and often develop solutions in-house. Access to **external expertise** through B2B **partnerships**, **accessible AI and AI-as-a-Service** will be critical to ensure a widespread AI uptake in MSMEs. Depending on the sector it is easy to access potential AI solutions cross-border as is the case in agriculture and accounting or rather limited as in the **legal regulation in the high-risk sector** healthcare. In the legal sector, the different legal systems make it necessary to adapt potential applications to each MS limiting the interest of AI start-ups to develop solutions of interest to legal MSMEs.

The **creation of an ecosystem** where AI-creators match with AI-consumers is beneficial. Initiatives by business associations have shown first successes and highlight the support necessary from defining an AI business case to finding the best collaborator to develop the solution. Within the construction sector research initiatives are driving the definition of potential AI use cases applicable for many MSMEs. Also, first attempts to introduce low cost and easy AI approaches in MSMEs have been identified in recent months.[278]

3.4.2 Data

While in all sectors in general a large amount of **data is available**, the ease of accessing and/or collecting data is, depending on the sector, rather difficult. The main obstacle within the company is that **no qualitative data is available** as well as problems due to different software platforms, lacking interoperability and data governance. For sectors with personal data, sensitivity and ethical aspects, as well as GDPR limitations, reduce data access.

In general, MSMEs possess less internal data than large enterprises. To resort to external data, **high-quality public and private data sets need to be accessible**. Data standardisation is seen as a responsibility of the industry, but policy measures to standardise and create user-friendly access to public data will be essential. A revision of the IPR-framework is ongoing in this regard.

When **sharing data with a provider of AI products or services**, **data ownership** is of great concern. Policy measures to address data governance will be necessary to ensure a fair balance of interests.

3.4.3 Cost

Depending on the AI solution type, the **cost factor to implement AI solutions** is another pressing obstacle to AI adoption. **AI-as-a-Service** is usually rather affordable but not often available. The actual cost of developing a tailored AI solution is not commonly known. Between 60-80% of costs, are associated with the aggregating and labelling of qualitative data and the necessary changes to internal processes, are "hidden".

As the benefit of AI technologies, return on investment (ROI) and applicable business cases are often not clear to MSME management, the investment is often not further considered. Similarly, the lack of existing or available solutions, potential collaborators to develop a solution and high cost to develop solutions in-house mean, that the AI uptake fails. **"Affordable AI**" is besides Access to Finance a solution to address this problem.

Many different policies address digitalisation and potential funding, often specific to a sector. **Harmonisation and simplification** are necessary to enable simpler access to information and potential subsidies and/or loans.

3.4.4 Market

The European market is fragmented at the levels of AI **technology provision, data access and standardisation and access to finance**. Further integration of the internal market would also facilitate AI adoption and AI access by MSMEs. Clear **laws and regulations** tailored towards MSMEs would push the AI development as well as adoption by MSMEs. Examples include **liability rules** for damage caused by AI, but also the needed **IP framework** update to enhance data access.

The **dominance of the platforms from Google, Microsoft and Amazon** in the field and our dependency on them, while no uptake challenges for MSMEs, are an aspect that is seen as a vulnerability cross-sector. A push for European infrastructure and technology leaders would ensure independence and ensure European values especially in regards to data privacy and security.

The language barrier is especially limiting for MSMEs. Potential applications often only exist in English, or one other European language, limiting uptake within a wider geographical area. Different legal regulation as in the health sector or jurisdiction systems reduce additionally the interest of start-ups to develop AI-enabled applications that are of interest to MSMEs. A **better integrated EU market** is indispensable to improve efficiencies and economies of scale.

The lack of **citizens' trust** (and potential reputational skills to the use of AI) are also flagged as an AI adoption obstacle. An appropriate regulatory framework, ensuring levels of **transparency, accountability, inclusiveness and a human-driven approach to AI** (currently under development) should contribute to an ecosystem of trust, and hence stimulate AI adoption through increased customer and societal confidence in the technology.

3.4.5 Companies

Micro-enterprises are **disproportionally affected by the lack of compatible IT infrastructure**. A modernisation of legacy systems and the collection and integration of large data sets is a major investment. MSMEs-specific support measures and instruments to **modernise and digitalise** could address this concern.

A level of AI leadership and vision, an agile and change-oriented company culture and sophisticated middle management contribute to AI uptake. MSMEs with a small or rigid managerial structure face an additional impediment in this regard and would benefit from dedicated training in **management and entrepreneurship**.

As for size and maturity matter, MSMEs have **natural disadvantages vis-à-vis large corporates** to enable AI uptake in their daily operations. They do not benefit from economies of scale, have less investment budget, do not possess middle management to drive complex processes, possess smaller data sets and rarely have the time or capacity to investigate complicated regulatory regimes. On top of this, MSMEs already face existing market failures and pressures, e.g., additional competition from globalised markets, administrative burdens, growing skillset demands and so forth. AI could accelerate these challenges if it creates unfair competition and inequality versus large enterprises. MSMEs should therefore benefit from exclusive and targeted support measures, focusing on enterprises in economic turmoil rather than pure staff count.

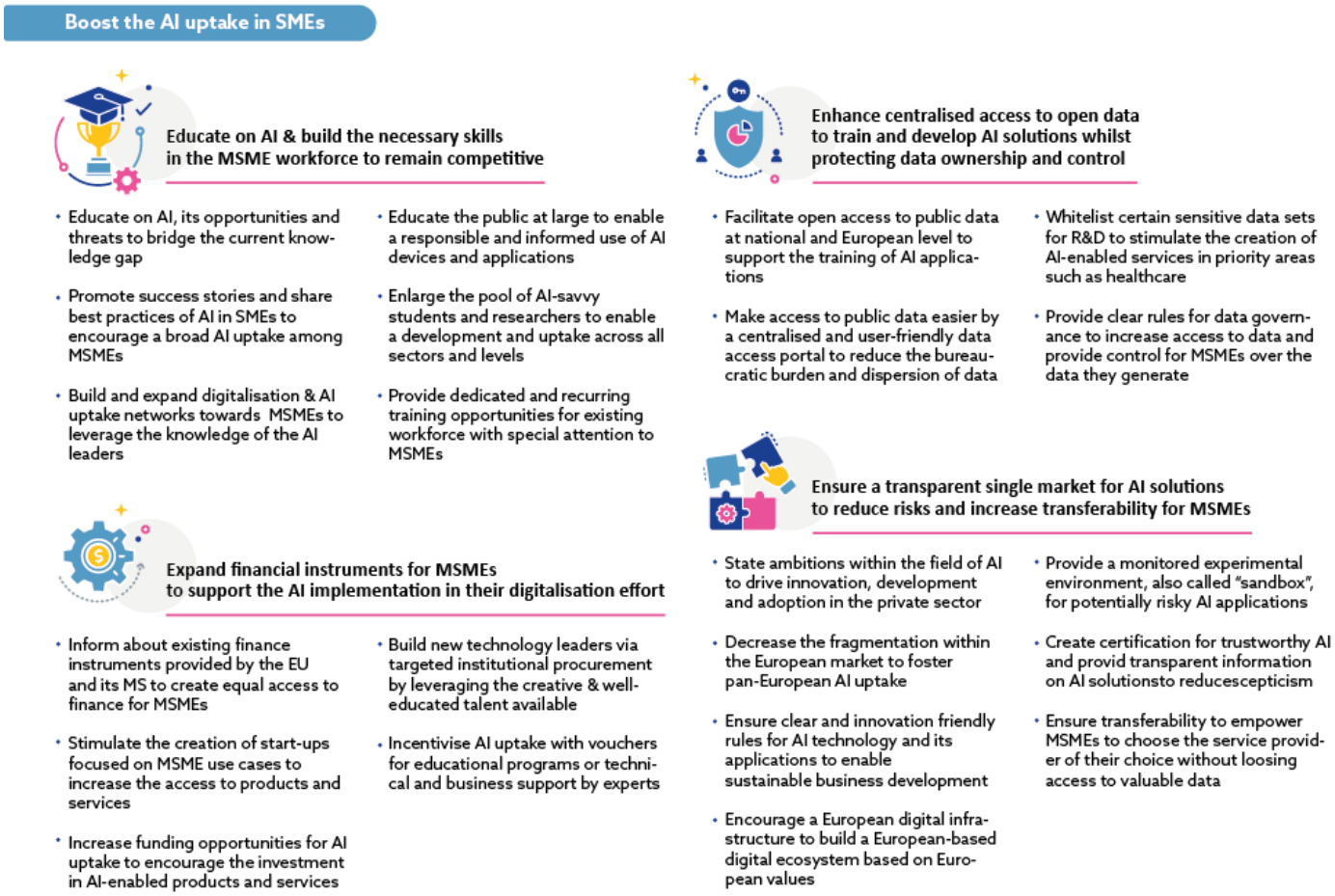
4. AI toolbox for policy makers and MSMEs

Many different use cases for the deployment of AI across different industries in Europe are available. Whilst some industries and large firms have already embraced AI and invested significantly, many firms have yet to do so, especially MSMEs. Based on the findings of the desk research and the interviews with relevant stakeholders along the up and downstream AI value chain as well as institutional actors in the field, the following recommendations are brought forward.

4.1 Policy makers toolbox

Europe has understood the challenges and opportunities offered by AI both for its economic and geopolitical role as well as the technology's potential impact on society. The mapping and assessment exercised within the context of this report have produced detailed insights into the specific challenges of MSMEs. Policy measures are proposed targeting either **support to the overall AI development**, which indirectly benefits also MSMEs through better access to AI solutions, as well as measures that **support the AI uptake within MSMEs directly**.

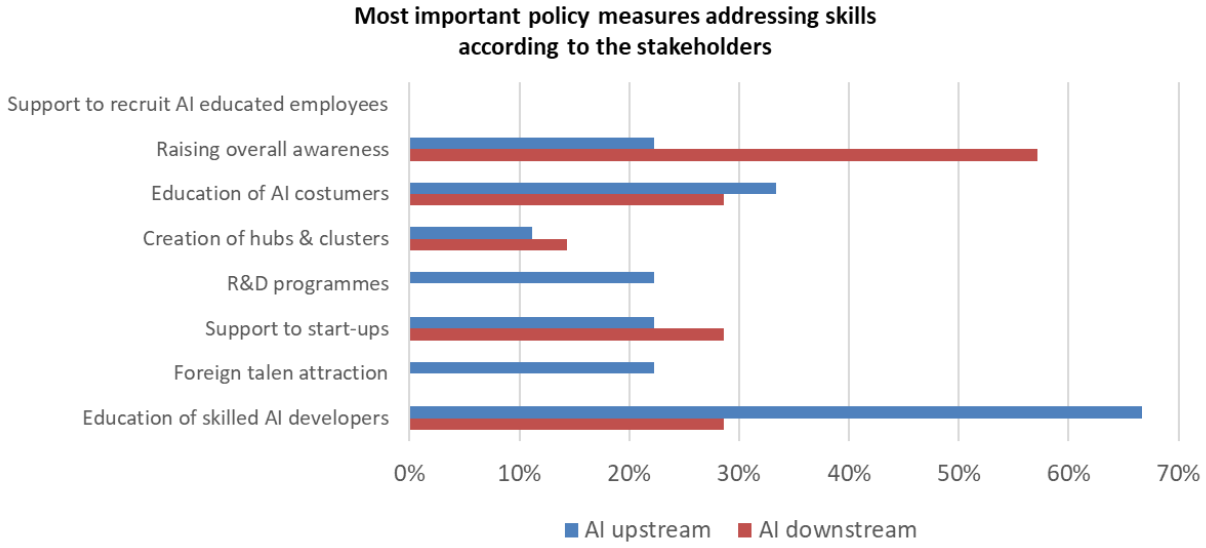
Exhibit 71: Policy toolbox overview



4.1.1 Educate on AI & build the necessary skills in the MSME workforce to remain competitive

While Europe has excellent AI research, it struggles to translate its excellent academic research into business models and **commercialise its talent and skills**. More knowledge and understanding of AI of the broader public to demystify AI as well as education across all skill levels to ensure the job market demand at R&D as well as AI uptake level.

Exhibit 72: Most important policy measures addressing AI awareness and necessary skills



Recommendation 1: Educate on AI, its opportunities and threats to bridge the current knowledge gap. Knowledge of AI and trust in AI are critical for future AI uptake. The overall awareness about AI and its benefits have been steadily increasing amongst European citizens in the past years. However, a majority of citizens still does not know what benefit potential AI-powered solutions have and The limits of AI technology at the moment – AI for many remains "science fiction". More information and education campaigns are necessary to educate citizens, employees and employers on the various benefits but also possible threats that might arise from AI development and uptake, as well as the current state of technology. The German government is currently developing a whole toolbox for the AI uptake based on the "AI Journey" presented in the MSME Toolbox (see Subsection Exhibit 80).

Recommendation 2: Promote success stories and share best practices of AI in MSMEs to encourage a broad AI uptake among MSMEs. Many MSMEs struggles with understanding how AI can benefit them in everyday business. Showcases of best practices and success stories could help MSMEs to understand how to implement AI successfully. At the same time, best practices can help MSMEs to carefully select the AI technology as well as to select the right AI supplier for their needs. Further, best practices and success stories help MSMEs to better understand what AI can currently deliver and where limitations are – helping them to avoid possible frustration and maintain realistic expectation management.

Recommendation 3: Build and expand digitalisation & AI uptake networks towards MSMEs to leverage the knowledge of the AI leaders. Leveraging networks, industry associations and clusters with interests relevant to digitalisation and AI extends the reach and multiplies efforts in raising awareness about the potential of AI uptake. Buy-ins with networks not currently active with MSMEs, especially in domains or sectors which are currently underserved or hard to reach would enable further knowledge transfer in the domain.

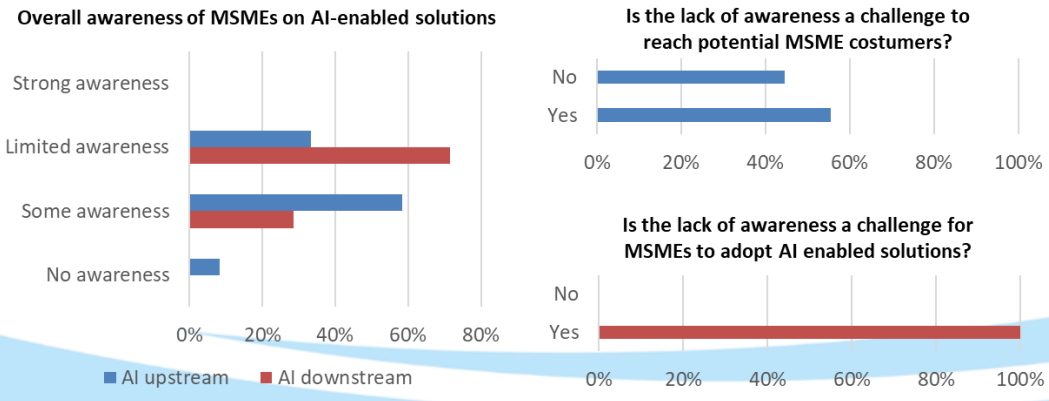
Recommendation 4: Educate the public at large to enable a responsible and informed use of AI devices and applications. From rideshare apps and social media feeds to video games anticipating next moves and online chatbots answering homework questions, both adults and children use AI technology every day. With growing use cases and applied AI devices in everyday life, proper education of a responsible and informed use of AI devices and applications is crucial. Education should already start in school as part of the general education as students need to understand the potential impact of AI now and in the future as they will enter a workforce increasingly powered by AI. As part of the "digital education" of citizens, AI education empowers the general society to make the most out of existing and upcoming AI technology without the threat of falling victim to misuse or abuse of said technology. MOOC initiatives like the Finnish "Elements of AI" programme are a promising and far-reaching opportunity to teach people of all disciplines about the creation and use of AI.

> "
> - *AI will affect everyone, so everyone should get basic education on AI to be able to shape AI.*
> - *To have a broad uptake, we have to think about AI in a more practical level: AI Bachelor degrees for more basic operations, but also specialised MSc and PhD programs for R&D.*
>
> "

Recommendation 5: Enlarge the pool of AI-savvy students and researchers to enable AI development and uptake across all sectors and levels. In terms of AI education, two major steps need to be taken. First, the number of students in AI fields should be increased. For this, more dedicated university courses from bachelor to master to PhD positions need to be created. Second, considering that AI has numerous applications across various sectors, it is crucial to create awareness of AI within other courses at universities and business schools. AI uptake has relevance in many application domains that have dedicated university curricula where AI is not sufficiently addressed at the moment. In addition to more dedicated AI curricula and courses, AI education should therefore also be extended to courses and curricula of other disciplines.

Recommendation 6: Provide dedicated and recurring training opportunities for the existing workforce with special attention to MSMEs. AI will affect the already existing workforce in their everyday work. From simple support to full automation of tasks, AI will enhance or might even replace some parts of jobs and projects. For a sustainable and socially inclusive AI uptake, dedicated education schemes are necessary both to keep nobody behind as well as make the most out of AI applications. Therefore, life-long learning opportunities are necessary to keep the workforce educated in regards to new AI opportunities and applications. Special focus needs to be drawn towards specialised MSMEs: Hands-on training given by experts who are thematically close to the participants' daily work are the most effective tools to educate the MSME workforce.

Exhibit 73: Awareness of MSMEs on AI-enabled solutions and awareness as an obstacle towards AI uptake



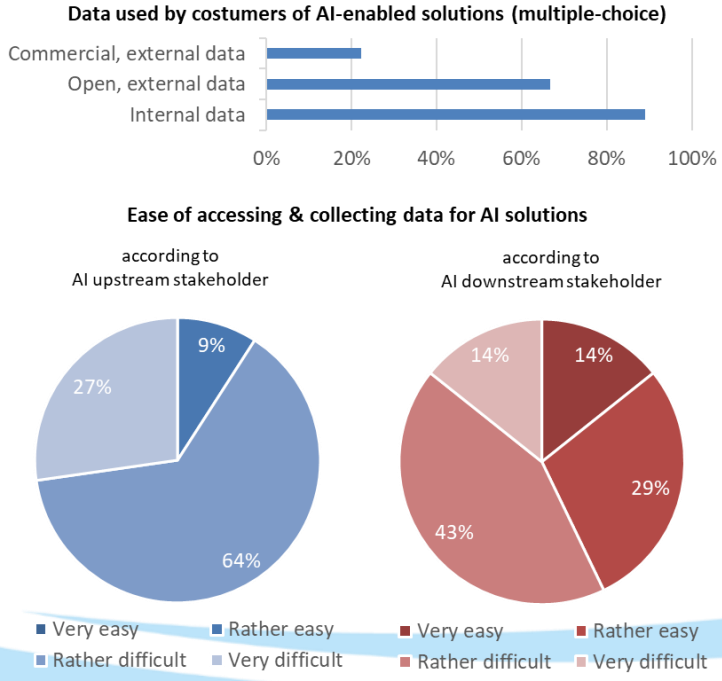
4.1.2 Enhance centralized access to open data to train and develop AI solutions whilst protecting data ownership and control

Data is the key component for training algorithms and developing/improving AI-based tools and business models. Accordingly, companies and countries with vast access to data have a massive competitive advantage when it comes to the development and commercialisation of AI-based applications. The key to adopting AI in MSMEs will lie in the capacity to develop the European data ecosystem and enable access to (open) data while ensuring data governance.

Recommendation 7: Facilitate open access to public data at the national and European level to support the training of AI applications. Limited availability of and access to data are major roadblocks in the development and training of new AI applications. The European Union as well as its Member States have brought forth some first important initiatives to open and centrally publish public data, which is needed to enhance the development and training of AI solutions. With the EU Open Data Portal, now data.europe.eu, European Open Science Cloud or the French Digital Republic Act, developers have access to much-needed data for the training and development of AI systems. However, the number of publicly available data remains (too) limited to fully take on AI training, research and development. The EU and its MSs should further enhance strengthen its current endeavours in opening and centralising cross-border public data and implement measures for centralised open data to foster national and cross-national AI development and training.

Recommendation 8: Make access to public data easier by a centralised and user-friendly data access portal to reduce the bureaucratic burden and dispersion of data. If available, public data is often scattered across numerous national portals making it hard to find and access it. Often, these data portals require user accounts and/or require lengthy sign-up processes, making acquiring data even more burdensome. Centralised easy to access data portals both on national as well as on European levels can immensely reduce the amount of time and effort needed to find and access publicly available data necessary to train AI solutions and especially in the case of MSMEs necessary to supplement internal data.

Exhibit 74: Data used by AI and ease of access to data

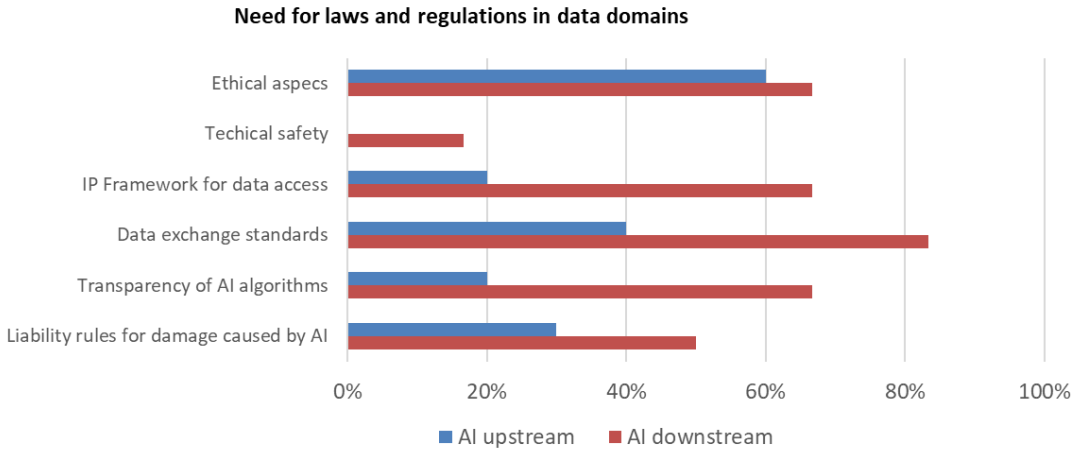


> - *80% of setting up an AI-enabled solution is getting qualitative and relevant data in the necessary amount.*
> - *Open public data sets are important as training data to significantly decrease the time to a marketable product.*

Recommendation 9: Whitelist certain sensitive data sets for R&D to stimulate the creation of AI-enabled services in priority areas such as healthcare. With an anonymisation standard such as 95%, large amounts of data could be made available for research to experiment and enable the creation of innovative solutions especially for high priority areas where oftentimes special data regulations are enforced due to the sensitivity of the data. A document similar to an organ donation card could be visualised allowing everyone the decides what personal data for what purposes to make available for the society at large.

Recommendation 10: Provide clear rules for data governance to increase access to data and provide control for MSMEs over the data they generate. Private data generated for example by MSMEs and other private businesses are an important part of the data pool needed to develop and train AI applications. Current data regulation laws and governance systems however are often unclear or underdeveloped, putting off MSMEs to potentially share generated data. Clearer governance systems that allow MSMEs to maintain control over their data in a clear matter could help to boost the willingness of private entities to generate and share data.

Exhibit 75: Need for laws and regulations



4.1.3 Expand financial instruments for MSMEs to support the AI implementation in their digitalisation effort

Although some MSMEs are among Europe's frontrunners in AI development, small businesses generally have fewer resources than larger players to invest in innovation. Public and private EU **funding at different stages** is a key element of achieving a high level of AI development as well as uptake.

Recommendation 11: Inform about existing financial instruments provided by the EU and its MS to create equal access to finance for MSMEs. Numerous financial instruments already exist at the national and EU level to support MSMEs in digitalisation. Often these instruments remain underused because they are either hard to find or eligibility criteria are unclear – putting off potential users. Through better information campaigns, MSMEs can gain a clearer picture of existing financial instruments that benefit digitalisation, including AI development and uptake. Additionally, it should be made more clear that financial instruments to promote digitalisation include AI development and uptake.

Recommendation 12: Stimulate the creation of AI start-ups focused on MSME use cases to increase access to products and services. MSME lack the large platform to promote their potential AI use cases and attract start-ups to build tailored AI solutions with a large MSME customer base. Europe has already several AI-related start-up initiatives such as **Hub France IA, the German Accelerator or Ignite Sweden** amongst others, which can be used as starting point for a tailored "MSME AI use case" stimulation programme. As a successful start-up ecosystem requires a significant deal flow, seen as the relatively low success rate of start-ups, the volume of start-up initiatives should be increased to subsequently increase the number of successful start-ups created. The existing initiatives showed can be expanded and new ones created.

Recommendation 13: Increase funding opportunities for AI uptake to encourage investments in AI-enabled products and services. High adoption costs remain one of the biggest hurdles to AI adoption of MSMEs across all sectors and Member States. Specific AI-related stimulus packages, subsidies, cash grants, easier loans or tax reliefs could greatly help to boost AI uptake amongst European MSMEs Additionally, more public state investments into private AI research for example through public-private partnerships could greatly benefit AI R&D.

Recommendation 14: Build new technology leaders via targeted institutional procurement by leveraging the creative & well-educated talent available. Public procurement often includes high barriers towards start-ups with little revenue and to prove their financial stability. AI procurement that does not automatically exclude innovative and young start-ups or interpretation of rules in favour of start-ups is necessary to foster new European technology leaders.

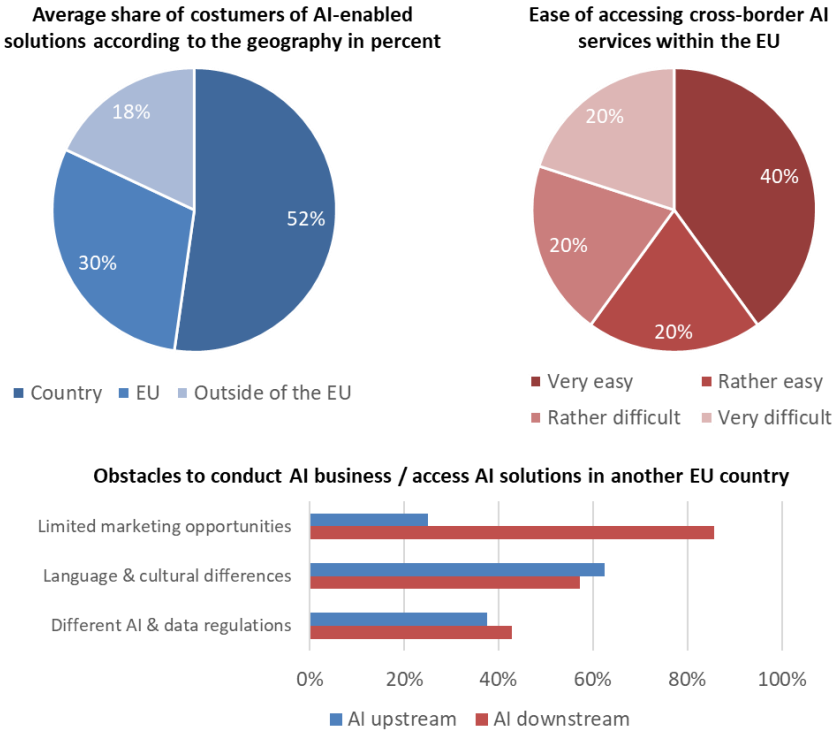
Recommendation 15: Incentivise AI uptake with vouchers for educational programmes or technical and business support by experts. Educational programmes are often crucial for MSMEs to build the missing skills, understand and fully embrace new AI technologies, and learn how to implement and operate them. Costly educational programmes however can be off-putting for MSMEs who are yet unsure whether or not to take on AI applications. Vouchers for professional education programmes or subsidised/free business and technical support could create a system that helps MSMEs help themselves.

4.1.4 Ensure a transparent single market for AI solutions to reduce risks and increase transferability for MSMEs

AI is not just yet disrupting EU labour markets or posing a threat to the welfare system. A top priority for the EU should be a **clear and Union-wide regulatory framework** that gives legal certainty, embodies the Union's fundamental values and sets the playing field on which AI can thrive. It must make sure that AI will benefit all citizens and enable a digital transformation in a human-centric and value-based way.

Recommendation 16: State ambitions within the field of AI to drive innovation, development and adoption in the private sector. While the private sector is the driving power of innovation, the EU can state ambitions and use all available tools to incentive this ambition. An example is the European Green deal with the stated ambition to reduce greenhouse gases by 55% by 2030, where all financial fundings and research projects are aligned and therefore drive innovation in the private sector. While the goal is very ambitious, its setting gives the market a signal especially in combination with easier access to financial instruments such as loans and subsidies.

Exhibit 76: Share of customers according to geography and ease to access to AI services cross border within the EU



Recommendation 17: Decrease the fragmentation within the European market to foster pan-European AI uptake. Market fragmentation remains a general obstacle to develop the economic potential within the European Union. This accounts also for the development and the uptake of AI. The European Union and its Member States have already made important steps to generate the full capability of a true European Single Market. In terms of digitalisation, the situation remains improvable. An open Digital Single Market to ensure the free flow of data and software is crucial for pan-European AI development and uptake and holds the potential to set Europe as a future leader in AI development. With its "European Digital Strategy" and the associated regulatory framework, the European Commission has already set forth the first important measures for the future creation of a Digital Single Market – it is now important that both the EU institutions, as well as the Member States, lie clear focus on an open Digital Single Market that emphasis pan-European AI development and uptake.

Recommendation 18: Ensure innovation-friendly, clear rules for AI technology and its applications to enable sustainable business development. The current legal frameworks and governance systems in place leave room for (mis)interpretation and open questions for the future of specific AI technologies. Clear and future-orientated rules and governance systems are necessary to enable MSMEs to develop and uptake AI technology in a sustainable and long-term way, avoiding any unforeseen changes in future legislation. However, AI regulation must be adjusted and updated over time, either to react to further technological changes, to close regulatory loopholes, or to drive back regulation where one might find it too restrictive.

Recommendation 19: Encourage a European digital infrastructure to build a European-based digital ecosystem based on European values. Access to digital infrastructure is crucial for AI development and uptake. A centralised European approach helps to bridge possible regional shortcomings and lack of available infrastructure including 5G connection and high-speed LAN connectivity. The EU has already put forth various instruments to create a future European Digital Single Market including the creation of digital infrastructure. The existing endeavours should be extended to support the creation of a pan-European digital ecosystem that is based on Europe's strong personal and privacy rights and supports data sovereignty of participating MSMEs.

Exhibit 77: Infrastructure as the backbone for AI

Infrastructure for AI

Digital infrastructure is a prerequisite for enabling more and more businesses processes as industries undergo digital transformation. Without high-speed networks and highly secure, available, and reliable data centres, there can be no digitalisation – for companies of any size. Europe's current level of digitalisation varies widely. While many urban areas already benefit from next-generation fibre and 5G networks, some of Europe's rural and remote areas still suffer from patchy coverage and lower network speeds.

As the EU emerges from the COVID-19 crisis, a once-in-a-generation opportunity to rebuild and reshape the economy has materialised. The €750 billion temporary recovery instrument called NextGenerationEU targets 20% directed at fostering digital transition. Strengthening digital infrastructure offers Europe a chance to strengthen the digital economy. The benefits of further digitalising MSMEs will be significant in ensuring economic sustainability and resilience, particularly in communities outside of urban centres.

Recommendation 20: Provide a monitored experimental environment, also called "sandbox", for potentially risky AI applications. AI applications often break into new grounds with previously unforeseen or unexpected outcomes. Applications can tackle or breach critical parts of legal compliance, infringe ethical principles, values or data security, or represent a possible (cyber) security threat. Sandboxes are safe artificial environments in which new technologies can be tested inside a closed system without the risk of data, ethical, legal or security infringement. So far AI developers have to mainly rely on costly private sandbox systems. In compliance with its call for a value-driven and legally compliant AI development, the European Commission in its recent communication, introduced its plans to build and supply to MSMEs a non-private alternative to test their new applications within a safe environment. The creation of these sandboxes are an important step into an ethical and legally compliant AI development and should be fostered with high priority.

Recommendation 21: Create certification for trustworthy AI and provide transparent information on AI solutions to reduce scepticism. European Union quality schemes like labels, registers or certifications are an internationally renowned process of standardising minimum requirements of quality, from agriculture and food to manufacturing or construction. Quality labels protect and promote the origins, traditions and unique characteristics of the EU's Member States as well as the EU's high-level data, privacy and human rights. The newly released AI regulatory framework by the Commission already proposes a system of specifically designed requirements, AI needs to fulfil in order to be classified as a low-risk AI system that is in line with EU ethical, regulatory and legal standards. A dedicated certification scheme for trustworthy AI would be a great way of for respective developing companies, including MSMEs, to showcasing this high minimum level of quality and high level of product standard.

Recommendation 22: Ensure transferability to empower MSMEs to choose the service provider of their choice without losing access to valuable data. MSMEs are often dependant on specialised external service providers as they cannot take on all parts of research, development and uptake themselves. Changing a service provider, however, for example, due to better suitability, better pricing, or other factors is challenging and underregulated. MSMEs should have the possibility to freely choose their service providers cross-border and without geographical discrimination. In addition, MSMEs should be empowered to hold their access and ownership of data and software currently stored within one service provider.

Exhibit 78: COVID-19 & AI

COVID-19 & AI

While digitalisation has been on the policy-making agenda for quite a while, including the focus on AI by the Von der Leyen Commission, the COVID-19 pandemic and its restrictions resulted in a massive surge of digitalization activities in the areas of education, business, public administration, research, and for everyone in private. A survey has shown that in eight weeks, digital adoption has made a leap of five years.[279]

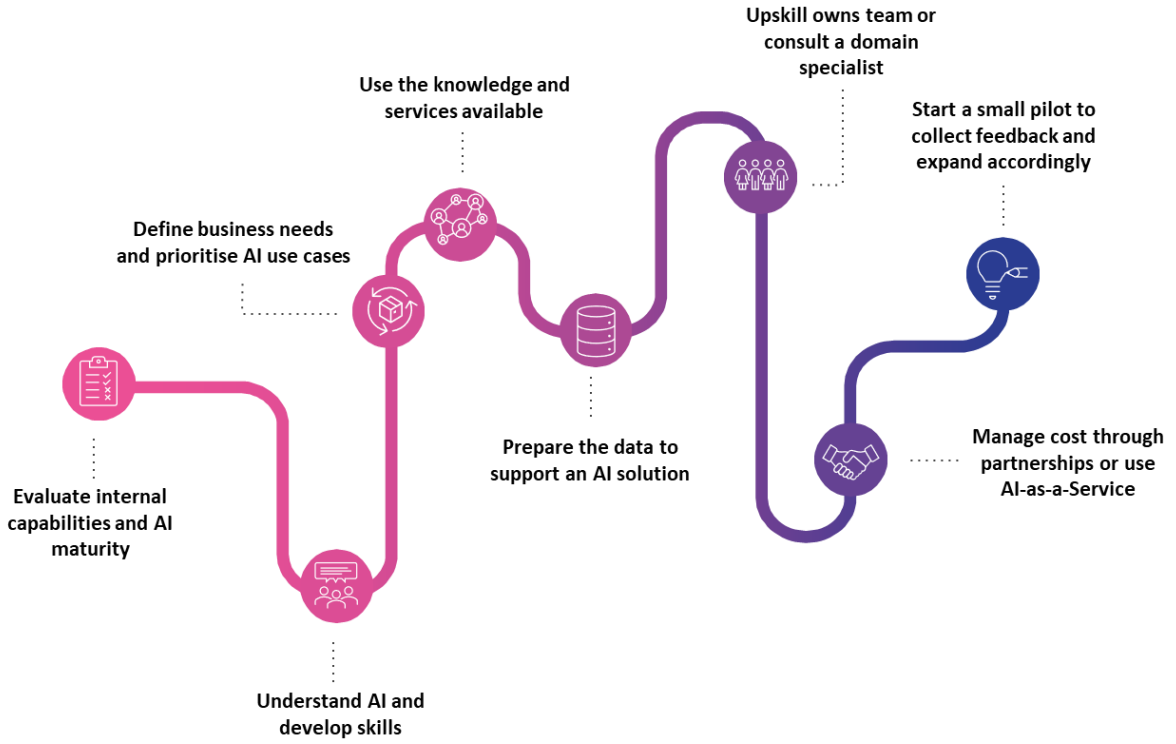
Several countries with its tech companies, medical and scientific institutions worldwide have put artificial intelligence (AI) at the forefront to reduce the spread of COVID-19. For example, AI-powered algorithms were used to process enormous amounts of unstructured data from 100.000 news articles in 65 languages on a daily basis to predict the spread pattern. AI was utilised to find a vaccine, support triage and impact modelling, optimise demand forecasting, supply-chain management, and post-vaccination surveillance. Moreover, AI played an important part in empowering robots to reduce human interaction. Predominantly, China has used AI at scale to support their Covid response and its companies used it as large-scale stress test

A report by the JRC concluded that COVID-19 might act as a boost to the adoption of AI[280]. However, recent Eurobarometer surveys have also shed some light on the Europeans trust in technology and the use of data within it. While the level of trust varies enormously across countries, the overall level of trust is still relatively low. The low level of trust makes Europe slower to adopt frontier technologies, meaning society misses out on the benefits, while the European businesses miss the first-mover advantage.

4.2 MSME toolbox

For businesses, practical AI applications can manifest in all sorts of ways depending on your organizational needs and the business intelligence insights derived from the data you collect. Enterprises can employ AI for everything from mining social data to driving engagement in customer relationship management to optimising logistics and efficiency when it comes to tracking and managing assets.

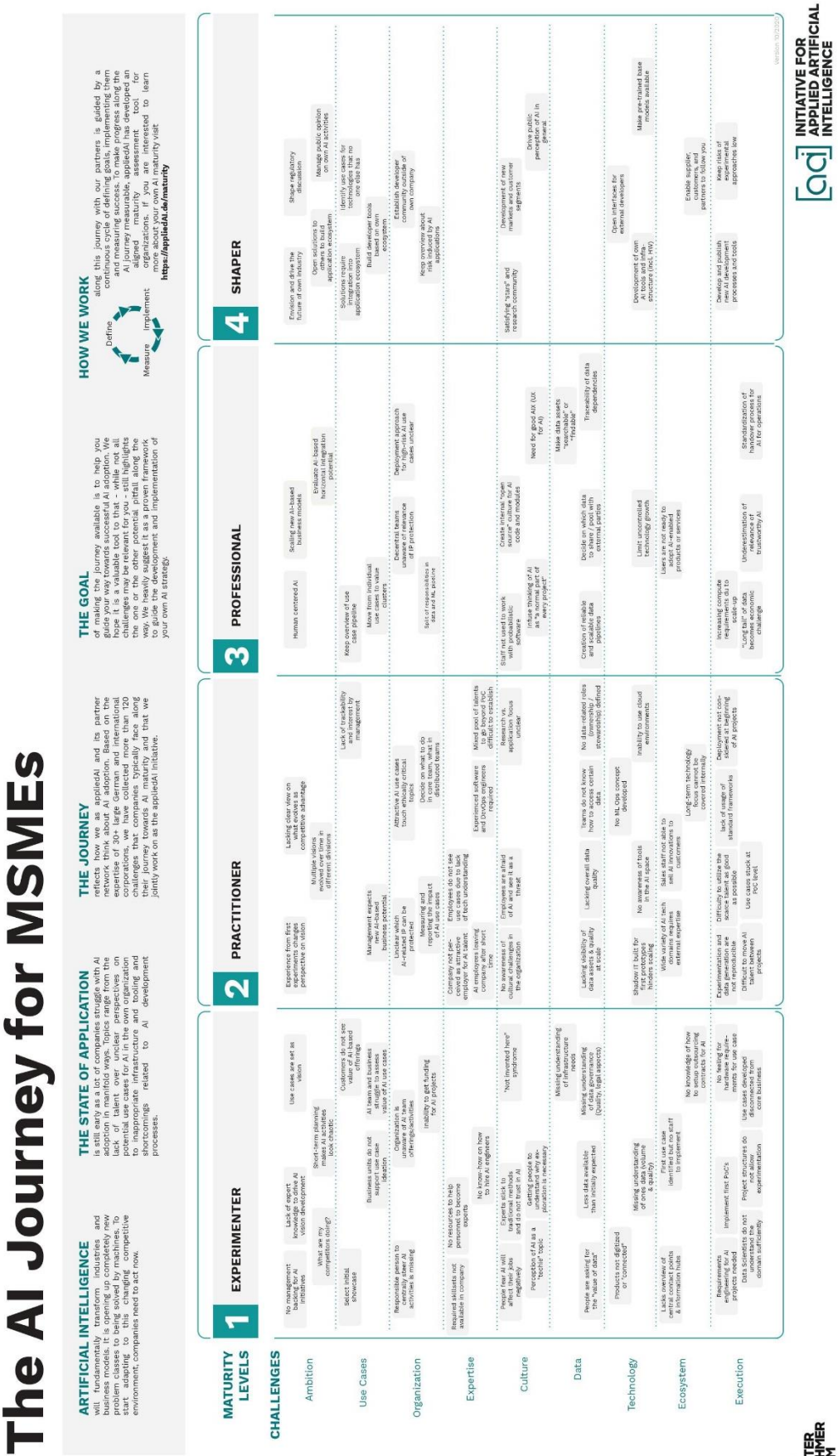
Exhibit 79: MSME toolbox as roadmap



Recommendation 1: Evaluate internal capabilities and AI maturity with the AI Journey to establish the starting point. Applying AI is a journey that must be started at some point and will mature over time. Therefore, organizations need to be clear about their current internal capabilities as well as their status quo and develop their AI activities starting from this baseline. One way to assess the current level of AI maturity in organizations is through the help of AI Maturity Assessments. This type of Assessment is being offered by some AI DIHs in Europe (https://ai-dih-network.eu/). Based on expertise from various national & international companies, typical challenges across various dimensions in each maturity level are assessed. Once the current AI maturity level for a company is determined, the journey identifies relevant dimensions to be adjusted to reach the next level. Gaining an understanding of necessary steps to develop the organization towards AI maturity by collaborating with experienced partners is helpful for MSMEs with little experience in AI. Planned for June/July 2021 many of them make the applied AI Maturity Assessment available in their national language.

Public institutions also need to consider AI as a journey for companies. Many support programs focus on individual activities like training, information, matchmaking, innovation vouchers, etc. but this only addresses one single segment of the AI journey and gives no guidance on how to advance. Therefore, policymakers should be encouraged in considering AI as a comprehensive transformation of the industry and design programs that support companies in this activity.

Exhibit 80: AI journey for MSMEs



Recommendation 2: Understand AI and develop skills starting from the top management. As for any change, AI needs a champion in the company at the top management level that pushes the uptake to transform the organization and exploit the value AI provides. Therefore, successful companies need sufficient understanding of AI on the management level to be able to understand the technology's impact on the industry and organization and take required actions. There is plenty of information as well as courses available to understand the basics of AI:

The whitepaper *Artificial Intelligence for Boards – Gearing up for the Future of Business* presents a guide on how Artificial Intelligence will affect and impact both company board and supervisory board roles and how to manage the change. Based on insights of different board members of experienced and leading organizations in Europe, relevant AI skills across board functions and top priorities to be tackled in the AI journey are described. While it was originally written for larger companies and the names of the roles might be different in MSMEs, the tasks and responsibilities are well transferable.

Exhibit 81: AI uptake starts at the leadership level (source: AI for Boards Whitepaper)

Role	Responsibility
CEO	Leadership – Strategic direction – Values / ethics
CFO	Budgeting and investments – Risk management
CIO	Cybersecurity – Applications at scale – make-or-buy
CTO	New products/services- Collaborations – R&D process
COO	Production / SCM – quality – shared services
CHRO	Talent, skills and reskilling – couture and change management – HR processes
CMO/CSO	Marketing – Customer relationship and data - Sales

Several online and offline sources offer courses on basic and more specific topics regarding AI:

- Udacity's Intro to AI course and Artificial Intelligence Nanodegree Program
- Stanford University's online lectures: Artificial Intelligence: Principles and Techniques
- MIT's online course on Artificial Intelligence: Implications for Business Strategy
- A 16-day on-campus course of the University of St. Gallen on Big Data and Artificial Intelligence for Managers
- edX's online AI course offered through Columbia University
- Microsoft's open-source Cognitive Toolkit (previously known as CNTK) to help developers master deep-learning algorithms
- Google's open-source (OS) TensorFlow software library for machine intelligence
- AI Resources, an open-source code directory from the AI Access Foundation
- The Association for the Advancement of Artificial Intelligence (AAAI)'s Resources Page
- MonkeyLearn's Gentle Guide to Machine Learning
- Stephen Hawking and Elon Musk's Future of Life Institute
- OpenAI, an open industry and academia-wide deep-learning initiative

Depending on the initial knowledge level, these courses and tools can be used to deepen managers' and other individuals' understanding of the technology and help evaluate the impact and resulting steps needed for their organization. Especially massive open online courses on AI (MOOCs), e.g. through the platform Coursera, provide a good starting point for MSMEs as they can be accessed from anywhere and are free of charge while transmitting a solid base on the workings and implications of AI.

Recommendation 3: Define business needs and prioritise AI use case by identifying the main drivers of value and efforts required for implementation. Deciding for initial use cases to be developed is not easy as it depends on various aspects individual to each organization. They should be aligned with the overall AI vision, a definition of where and what AI is used for in the organization, e.g., to improve processes, enhance existing products or build-up entirely new business models. Thereby, AI should be used to solve relevant business problems; however, use case ideas can come both from the demand (based on customer journey & process maps) and supply-side (based on data and internal AI capabilities). Each use case is then evaluated based on the value it brings, both financially and strategically, as well as its ease of implementation, which includes the categories data, algorithm, process/ systems and know-how. The AI Use Case Canvas can help inexperienced MSMEs to assess the value of use case ideas and prioritize them. Ideally, use cases in line with the AI vision that bring high value to the organisation and are easy to implement and operate are addressed first.

> - *Start with the low hanging fruits, so that you have the time to build the capabilities internally.*
> - *When work gets automated, other skills like soft skills have to be built to e.g. explain to clients the results of the work.*
> - *Find local ambassadors from early adopters to AI suppliers in the ecosystem, to highlight potential AI use cases and AI suppliers to connect supply & demand.*

Recommendation 4: Use the knowledge and services available through networks and business associations. Ultimately, AI Hubs are existing in many EU country which could be the first source of information and support to start AI activities. Typically, they provide know-how in terms of consulting services and help with technical implementations of AI projects or infrastructure. They also offer a strong network and community of AI Startups and like-minded companies in the relevant region and beyond. MSMEs can use these central institutions to collaborate with them in taking initial steps along the AI journey and gain access to a dense AI network. With this as a starting point, MSMEs bypass the hurdle to build up initially required knowledge and networks themselves. Some examples for these hubs are *AI Sweden*, *Hub France IA*, *appliedAI* (Germany), *Croa.AI* (Croatia), *AI Poland*, *FAIA* (Finland), *NLAIC* (Netherlands), *AI Austria*, and many more. Moreover, the DIH AI or the future EDIHs in the European Union are selected based on their support activities for MSMEs and therefore a good source for advice.

Recommendation 5: Prepare the data to ensure enough qualitative data is available to support an AI solution. Data is a crucial building block for the quality of AI applications, so it requires specific attention. To use AI applications successfully, datasets should fulfil some requirements:

- Clean data to avoid *garbage in, garbage out* scenarios
- Accurate data for the specific context
- Free datasets from incoherent information
- Comprising all necessary attributes required for an algorithm to perform its task

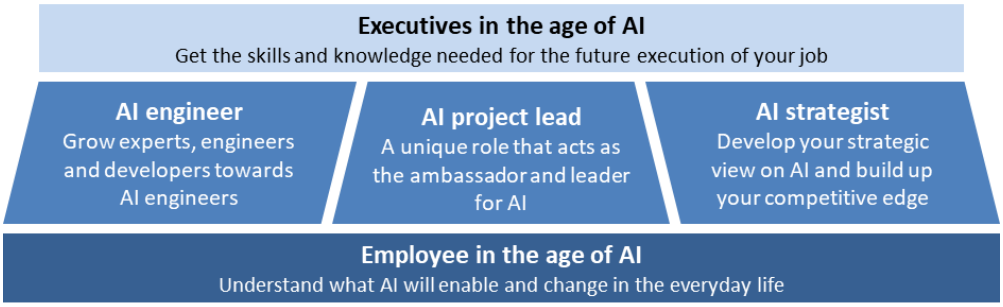
However, MSMEs taking the first steps with AI typically lack the required amounts of data. There are several measures that MSMEs can take to counteract this missing component and reach high-quality AI applications, namely pre-trained models, synthetic data and open data spaces. Pre-trained models, as the name suggests, have been trained already, so the MSMEs do not require large datasets and time for training the AI model. However, pre-trained models pose the risk of unnoticed bias that is inherent in the training data. Synthetic data is data that is artificially generated, and which can then be used for

training AI models. Several organisations focus on generating synthetic data, which MSMEs can approach if they are currently missing required data.

Moreover, organizations like AI Sweden work heavily on data sharing and data federation solutions which can especially empower MSMEs to build and use high-quality models. In addition, the European Commission has a variety of activities about European data spaces, e.g. a Data Space for Manufacturing, which aims to provide wide availability of data and tools as well as the appropriate knowledge to apply these in an industrial context. Through data spaces, shared infrastructures, systems and processes can help with the trustworthy exchange of privately held data. These three measures help MSMEs to fill the blank of missing data. Furthermore, MSMEs could also collaborate with AIaaS Providers or Startups. They typically offer their solutions with pre-trained models that require only a little own data. While data itself is an ingredient, the data pipelines need to be managed professionally to suffice (upcoming) EU regulations on data, e.g. EUGDPR.

Recommendation 6: Upskill owns team or consult a domain specialist. Once the foundations of AI and the tendency to transform the organization into an AI direction are established, people with the right skills are required. Hiring AI talent is difficult, as MSMEs compete against large organizations for rare (and expensive) AI talent. Therefore, upskilling of interested employees is essential. Related to the specific required capabilities of each role, each follows an individual learning path resulting in specific skill sets, which can be supported by many (free) courses available:

Exhibit 82: Roles within AI

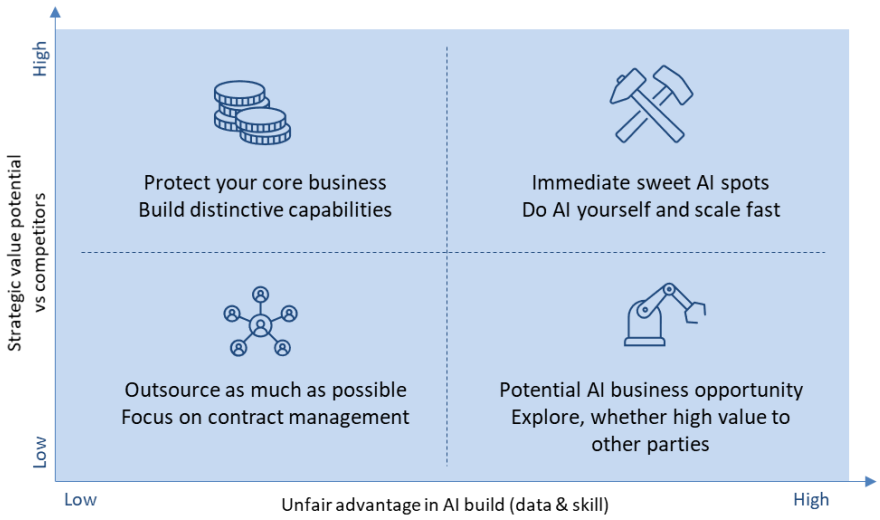


- **Employee**: Each employee needs to understand what his/her job will look like in the future and how to use AI in their daily business. Their domain knowledge is required to build successful AI applications that deliver value to the organization.
  Recommended courses: Foundations of AI[281] (free of charge, English version to be launched mid-2021) or Elements of AI (elementsofai.com)
- **AI Engineer**: AI Engineers need to be able to build AI-based solutions and to identify good collaboration partners, for which they need technical skills. Since the opportunities to upskill and train AI Engineers are versatile, this course overview presents some roadmaps to learn AI, which can be helpful for MSMEs with little experience in the AI space.
  Recommended courses: High-quality courses are offered by professional organizations like datacamp[282]
- **AI Strategist**: AI Strategists are managers or team leads. They need to understand how AI will influence their department and what they need to do to set the ground for a successful AI adoption in their area of responsibility.
  Recommended courses: Courses like those of Udacity, e.g. AI for Business Leaders[283], are designed for this target group

- **AI Project Manager**: AI projects are different from traditional software projects. Thus, project management needs to be done differently.
  Recommended courses: There is hardly any course available for project managers. The cloud providers support interested organizations with management know-how based on the tools they are providing, e.g. Oracle[284]

Recommendation 7: Manage cost through partnerships or use AI-as-a-Service. It is easy to create working AI prototypes, but it is hard to industrialize them. To manage costs especially if MSMEs want to implement AI beyond a simple prototype, they need to partner with fitting solution providers. In many cases, these are startups that created innovative solutions based on AI technologies. Finding the right startup or collaboration partner for MSMEs is not easy in an environment where lots of organizations do *something with AI*. To guide MSMEs and help them find quality AI startups they can trust and build collaborations with, the European AI Startup Landscape is developed. It currently provides an overview of AI Startups in France, Germany and Sweden, however, it is in continuous development and will be expanded to most European countries in the next months.

Exhibit 83: AI implementation types



In addition, many tools and libraries are published online. The AI4EU platform, supported by the European Commission, collects those and provides them to interested parties. Furthermore, they provide access to a European AI ecosystem to facilitate collaboration between European AI actors, such as scientists, MSMEs and entrepreneurs.

Recommendation 8: Start a small pilot to collect feedback, prove the value add for the business and expand accordingly. Although the enthusiasm for employing big AI applications right away and expecting immediate results is high, organizations should start small and collect feedback on their way forward. Especially MSMEs with limited resources should proceed step-by-step and initiate AI pilots. This gives them a feeling for the development of AI applications which they can build on and leverage in the future. Within the refinements and further developments from the pilot towards a scalable product, the necessary infrastructure needs to be established and issues in the workflow have to be resolved. When scaling the AI solution, the value-added for the organization needs to be visible to justify the developments. Simultaneously, the organization needs to be adjusted so that it can constantly maintain and further develop AI solutions through the right balance of central coordination of activities and decentralized ownership of AI products, as well as broad commitment from an AI-educated C-level.

5. Annexes

5.1 List of relevant EESC Opinions

Year	EESC Opinion	Relevance
2020	White Paper on Artificial Intelligence (ongoing)	EESC opinion on the European Commission's White Paper on Artificial Intelligence.
2019	Building Trust in Human-Centric Artificial Intelligence	Provides recommendations on how to build trust and bring in methods to promote social dialogue related to AI
2019	Guidance on the free flow of non-personal data	Recommends that the Commission merges the GDPR and the Free Flow on Non-Personal Data Regulation and that it helps Europeans to use algorithms capable of processing vast amounts of non-personal data; encourage Member States to improve lifelong education in IT and AI at all levels.
2018	Artificial Intelligence for Europe	Agrees to strengthen the EU's industrial and technological capability to spread AI across the internal market; believes that AI should be as accessible as possible for global competitiveness; suggests that the Commission and the Member States should work together to develop guidelines on AI ethics; suggests a harmonised and mandatory legal framework at European level; highlights the role of educational training programmes to protect European workers in a changing environment by the emergence of AI.
2018	Artificial Intelligence: anticipating its impact on jobs to ensure a fair transition	Flagging the potential of AI, while addressing the social transformations which go hand in hand with the rise of AI and robotics. Recommends ethical guidelines and ethics training for engineers to be established, and to consult workers when deploying new technologies such as AI and robotics.
2018	EU concepts for transition management in a digitalised world of work – a key input for an EU White Paper on the future of work	Points out that the lack of clarity surrounding how AI algorithms work and how they make the choices that are beyond human control poses massive challenges for the EU and fundamental questions about the society we want to live in. An approach focusing on human control over machines is vital.
2018	Promoting MSMEs in Europe with a special focus on a horizontal legislative MSME approach and respect of the SBA's "think small first"	Provides evidence-based, practical actions to support MSMEs, highlights the challenges they face, and provides starting points on topics such as funding and equity.
2017	Artificial Intelligence - The consequences of artificial intelligence on the (digital) single market, production, consumption, employment and society	Raises that AI carries risks and presents complex societal challenges in several areas such as labour, safety, privacy, ethics, skills and so on.
2017	Improving the effectiveness of EU policies for MSMEs	Hearing providing opinions on the challenges, opportunities, and the types of support that MSMEs need.
2017	Europe's next leaders: the Start-up and Scale-up Initiative	Provides opinions on skills, taxation, access to finance, and identifies further needs of small businesses.
2016	Family businesses in Europe as a source of renewed growth and better jobs	Provides definitions of family businesses and the challenges facing them which are generally a part of the MSME ecosystem.
2017	The potential of small family and traditional businesses to boost development and economic growth in the regions	Provides context on subgroups of MSMEs, as well as suggesting that the single-family and traditional businesses are failing due to technology.

5.2 Overview of interviewed AI Stakeholders

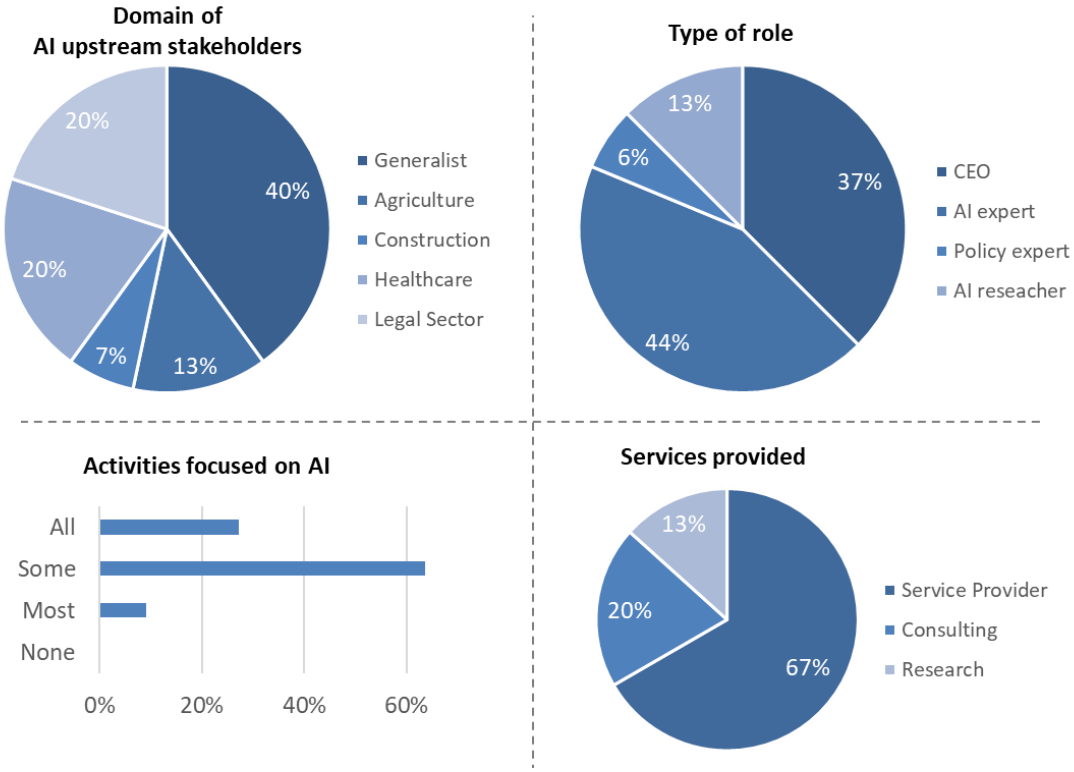
Two categories of stakeholders have been defined, as being an interesting interview partner for the study:

- **Upstream AI stakeholders**: MSMEs or companies with a track record in the development of AI applications for MSMEs in our selected downstream industries. These stakeholders will be consulted to assess and validate the potential downstream applications, as well as the added value and obstacles of AI for MSMEs.
- **Downstream AI stakeholders**: Stakeholders which are specialists in their sector, with a thorough understanding of the challenges their MSMEs face. We aim to target EU-level umbrella organisations and federations, optimise and streamline our consultation processes and gather an immediate high-level understanding of their sectors through interaction with one or multiple experts. These networks can furthermore be activated to distribute online questionnaires to the MSMEs in their industries.

Within the study 25 AI up and downstream stakeholders were interviewed to provide their view on opportunities, threats and AI uptake challenges for MSMEs.

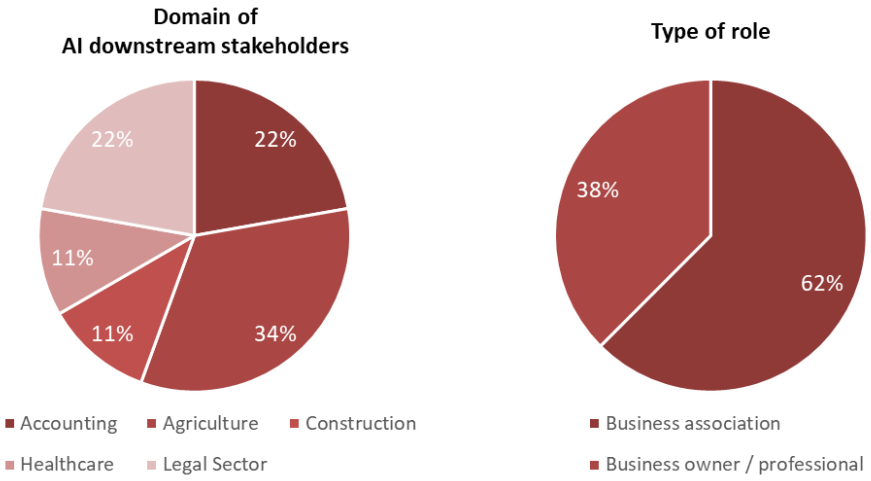
Within the AI upstream domain, a selection of different AI start-ups, service providers and also AI experts and researchers were interviewed. A specific focus was set on ensuring interview partners developing and providing general, but also sector-specific solutions.

Exhibit 84: Typology of interviewed AI upstream stakeholders



Within the AI downstream domain as the first point of contact federations and business associations were contacted. The federations have the advantage of having a **general high-level understanding of the pressing challenges their sectoral MSMEs are facing**, allowing to accelerate the understanding of each sector's specificities. Specific members of the federation were recommended by the federations enabling the interview of MSMEs in specific sectors to ensure a detailed understanding of sector-specific challenges.

Exhibit 85: Typology of interviewed AI downstream stakeholders



5.3 Potential policy measures

5.3.1.1 AI Uptake

External

Skills

- **Recruitment & (foreign) talent attraction**: Initiatives to help MSMEs attract and recruit skilled staff to develop tailored AI solutions, or to acquire/procure applicable AI technologies
- **AI training & awareness**: Initiatives to train MSME staff and executives to understand the benefits of AI, to exploit AI applications and to define their user needs
- **Hubs, clusters & ecosystems**: Creation and support of hubs, clusters & ecosystems to allow MSMEs to share best practices and to connect with AI-providers to acquire ready-to-use systems, tailored solutions or external expertise

Costs

- **Access to finance/subsidies/tax reliefs**: Access to related financial sources (grants, loans, tax reliefs) to invest in the development of company-specific AI solutions, and to invest in the optimisation of internal processes, data integration or updated IT infrastructure Data

Data

- **Access to the public & private data**: Ensured access to full, free and open public & private data to best exploit AI, via e.g., a Digital Single Market or European Data Spaces
- **Data standardisation & interoperability**: Stimulate data standardisations and ensure data interoperability (e.g., through APIs)

Company

- **Support for internal digital transformation**: Policies to support and encourage MSMEs' digital transformation and the modernisation of legacy systems, but also education in terms of data management and data integration
- **Comprehensive cybersecurity**: Ensure the availability to and educate MSMEs about cybersecurity
- **Awareness-raising & sensibility training for management**: Educate and sensible MSME top management towards existing AI applications, their benefits, uptake areas and business cases

Internal

Skills

- **EU AI market integration**: Fostering a cross-border and cross-sectoral European AI market, through the creation of e.g., a central platform like AI4EU to connect providers to consumers
- **Access to AI-as-a-Service (AIaaS)**: Funding and support to research into AI-as-a-Service solutions, to allow MSMEs to license or buy AI software tailored to its needs, extending affordability and financial feasibility to make use of AI-driven solutions
- **Hubs, clusters & ecosystems**: Creation and support of hubs, clusters & ecosystems to allow MSMEs to share best practices and to connect with AI-providers to acquire ready-to-use systems, tailored solutions or external expertise

Costs

- **Affordability of AI**: Initiatives encouraging affordable and accessible AI solutions to MSMEs, via e.g. a European AI-as-a-Service or programmes like AI4EU
- **Access to finance/subsidies/tax reliefs**: Access to related financial sources (grants, loans, tax reliefs) to invest in the acquisition of AI solutions, and to invest in the optimisation of internal processes, data integration or updated IT infrastructure Data

Data

- **Access to the public & private data**: Ensure access to public & private data to best exploit AI, via e.g. a Digital Single Market or European Data Spaces
- **Data standardisation & interoperability**: Create mandatory data standardisations and ensure data interoperability e.g., through APIs

Market

- **Digital Single Market**: Creation of a Digital Single Market to allow a level playing field amongst MSMEs in terms of IT infrastructure, as well as data and software uptake across all EU Member States
- **Provision of infrastructure**: Ensure the provision of required infrastructure, including high-speed fibre internet connections, 5G connections, external quantum computing power, as well as the required AI chipsets and access to natural resources and vertical supply chains for European (or Member State) strategic autonomy in AI
- **Comprehensive legal framework**: Creation of a comprehensive AI legal framework that clarifies AI liability, includes ethical & sustainability guidelines and updates IP regulations for public & private data access

5.3.1.2 AI Development

Skills

- **Education of AI developers**: Initiatives to stimulate school, university or adult education programmes focusing on AI development, through e.g., new Bachelor/Master courses, PhD scholarships, university Professions, and lifelong learning programmes
- **R&D**: Foster AI-related R&D through respective programmes, tools and instruments like e.g., labs, excellence centres, joint undertakings
- **Foreign talent attraction**: In addition to national education programmes, introduce easier mechanisms for the recruitment of foreign talent via e.g., simplified visa or blue card procedures, as well as location advertisement for the EU to attract foreign talent
- **Accelerators & start-up programmes**: Carry out and (financially) support start-up programmes such as incubators, accelerators or hackathons to drive the EU AI providers market
- **Hubs, clusters & ecosystems**: Creation and support of hubs, clusters & ecosystems to AI-providers to connect with their potential MSME client base for ready-to-use systems, tailored solutions or expertise provision

Costs

- **Easier access to financing**: Creation of funds, and fostering of grants, loans, equity, mixed instruments, VC or even for the easier start-up and scale-up of AI-developing MSMEs, especially start-ups
- **Dedicated funding schemes**: Funding schemes to support the creation of products related to AI, the integration with additional key enabling technologies (IoT, blockchain) or sector and domain-specific applications and market developments

Data

- **Access to the public & private data**: Ensured access to full, free and open public & private data to best exploit AI, via e.g., a Digital Single Market or European Data Spaces
- **Data standardisation & interoperability**: Create mandatory data standardisations and ensure data interoperability e.g., through APIs

Market

- **Digital Single Market**: Creation of a Digital Single Market to guarantee access to needed data and software needed for AI development, across all EU Member States
- **Provision of infrastructure**: Ensure the provision of infrastructure required to develop AI applications, including high-speed fibre internet connections, 5G connections, external quantum computing power
- **Comprehensive legal framework**: Creation of a comprehensive AI legal framework that clarifies liability, includes ethical & sustainability guidelines and updates IP regulations for public & private data access.

5.4 Relevant Literatur

AI4Belgium (2019): "AI4Belgium". Available online: https://www.ai4belgium.be/wp-content/uploads/2019/04/report_en.pdf [latest access: 16.10.2020].

Aiash, Siti / Prakoonwit, Simant / Sahandi, Reza / Wajid, Khan (2019): "Big Data and IoT Opportunities for Small and Medium Sized Enterprises (SMEs)", Faculty of Science & Technology, University of Bournemouth, United Kingdom.

Barry, Simon / BusinessLive (2020): "SMEs in the manufacturing sector see biggest fall in output for over a decade". Available online: https://www.business-live.co.uk/manufacturing/smes-manufacturing-sector-see-biggest-18197921 [latest access: 16.10.2020].

Bernard Marr (2020): "How AI And Machine Learning Are Transforming Law Firms And The Legal Sector". Available online: https://bernardmarr.com/default.asp?contentID=1464 [last access: 16.10.2020].

Berns, Michael (2020): "AI: a promising innovation for the German financial sector". Available online: https://www.pwc.de/en/future-of-finance/artificial-intelligence-in-financial-services.html [latest access: 16.10.2020].

Brooks, Chay / Gherhes, Cristian / Vorley Tim (2020): "Artificial intelligence in the legal sector: pressures and challenges of transformation".

Degen, Andrea / de Giacomoni, Anne-Cécile / Galecka, Kasia / Reschwamm, Katrin / Ripperger, Johannes / Viseur, Jacques (2011): "The voice of biomedical MSMEs. Performance factors in moving from research to market".

Euractiv (2016): "The construction sector in Europe and its MSMEs: facts and figures". Available online: https://www.euractiv.com/section/social-europe-jobs/infographic/the-construction-sector-in-europe-and-its-smes-facts-and-figures/ [last access: 16.10.2020].

European Commission: "Belgium AI Strategy Report". Available online: https://ec.europa.eu/knowledge4policy/ai-watch/belgium-ai-strategy-report_en [latest access; 16.10.2020].

European Commission: "Construction". Available online: https://ec.europa.eu/growth/sectors/construction_en [latest access: 16.10.2020].

European Commission: "Industrial applications of artificial intelligence and big data". Available online: https://ec.europa.eu/growth/industry/policy/advanced-technologies/industrial-applications-artificial-intelligence-and-big-data_en [latest access: 16.10.2020].

European Commission (2019a): "Supporting digitalisation of the construction sector and MSMEs. Including Building Information Modelling".

European Commission (2019b): "Annual Report on European MSMEs 2018/2019, Research & Development and Innovation by MSMEs".

European Commission (2020a): "White Paper on Artificial Intelligence. A European approach to excellence and trust", COM(2020) 65 final.

European Commission, DG JRC (2020b): "AI Watch – Defining Artificial Intelligence. Towards an Operational Definition and Taxonomy of Artificial Intelligence".

European Commission (2020c): “Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Commission Work Programme 2020. A Union that strives for more”.

European Commission, DG CNECT (2020d): “European Enterprise Survey on the use of Technologies based on Artificial Intelligence”.

European Commission / Joint Research Centre (2020): JRC Technical report “AI Watch. National strategies on Artificial Intelligence. A European perspective in 2019”. Available online: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC119974/national_strategies_on_artificial_intelligence_final_1.pdf [last access: 16.10.2020]

European Defence Agency (2020): “Artificial Intelligence: Joint quest for future defence applications”, online via: https://eda.europa.eu/info-hub/press-centre/latest-news/2020/08/25/artificial-intelligence-joint-quest-for-future-defence-applications [last access: 16.10.2020].

European Economic and Social Committee (2013): “Opinion of the European Economic and Social Committee on the Strategy for the sustainable competitiveness of the construction sector and its enterprises”.

European Economic and Social Committee (2014): “The State of Liberal Professions Concerning their Functions and Relevance to European Civil Society”, conducted by the European Centre for Liberal Professions.

European Economic and Social Committee (2015): “OPINION of the European Economic and Social Committee on An EU Industrial Policy for the Food and Drinks Sector”.

European Economic and Social Committee (2016): “Opinion of the European Economic and Social Committee on “Family businesses in Europe as a source of renewed growth and better jobs””.

European Economic and Social Committee (2017a): “Artificial intelligence – The consequences of artificial intelligence on the (digital) single market, production, consumption, employment and society”.

European Economic and Social Committee (2017b): “Europe’s next leaders: The Start-up and Scale-up Initiative”.

European Economic and Social Committee (2017c): “Improving the effectiveness of EU policies for MSMEs”.

European Economic and Social Committee (2017d): “The potential of small family and traditional businesses to boost development and economic growth in the regions.”

European Economic and Social Committee (2018a): “Artificial Intelligence: anticipating its impact on work to ensure a fair transition”.

European Economic and Social Committee (2018b): “Artificial Intelligence for Europe”.

European Economic and Social Committee (2018c): “EU concepts for transition management in a digitalised world of work – key input for an EU White Paper on the future of work”.

European Economic and Social Committee (2018d): “Promoting MSMEs in Europe with a special focus on a horizontal legislative MSME approach and respect of the SBA’s “think small first””.

European Economic and Social Committee (2019a): "Artificial Intelligence for Europe. Position paper January 2019".

European Economic and Social Committee (2019b): "Guidance on the Regulation on a framework for the free flow of non-personal data in the European Union".

European Economic and Social Committee (2019c): "Building trust in human-centric artificial intelligence".

European Economic and Social Committee (2020): "Opinion. White Paper on Artificial Intelligence – A European Approach to excellence and trust"

European Investment Bank (Innovation Finance Advisory) (2019): "The digitalisation of small and medium-sized enterprises in Portugal. Models for financing digital projects."

European Parliament / DG IPOL Policy Department for Structural and Cohesion Policies (2020): "Research for CULT Committee – The use of Artificial Intelligence in the Audiovisual Sector Concomitant expertise for INI report".

European Parliament (2020): "An EU Framework for Artificial Intelligence – At a Glance". Online available: https://www.europarl.europa.eu/RegData/etudes/ATAG/2020/659282/EPRS_ATA(2020)659282_EN.pdf [last access 16.10.2020].

Eurostat (2011): "Key figures on European business with a special feature on MSMEs".

Hansen, Emil Blixt / Bøgh, Hansen (2020): "Artificial Intelligence and Internet of Things in Small & Medium-Sized Enterprises: A Survey", University College of Northern Denmark, Aalborg, Denmark.

Horgan, Denis / Kranen, Henk J. van / Morré, Servaas A. (2018): „Optimising MSME Potential in Modern Healthcare Systems: Challenges, Opportunities and Policy Recommendations", Public Health Genomics 21/2018, p. 1-17.

ICAEW (2018): "Artificial intelligence and the future of accountancy".

International Telecommunication Union (2016): "Trends in tech MSMEs and startup support".

International Telecommunication Union (2016): "A review of Micro, Small and Medium Enterprises in the ICT Sector".

Luhti Toni (Platform of Trust) (30 April 2020): Contribution at the European Digital MSME Alliance Webinar: "AI in the EU. What are the Bottlenecks for MSMEs?"

Manufacturing Tomorrow (2020): "4 Benefits of Digital for Manufacturing MSMEs". Available online: https://www.manufacturingtomorrow.com/article/2020/04/4-benefits-of-digital-for-manufacturing-smes/15092 [latest access: 16.10.2020].

MarketsandMarkets (2020): "Artificial Intelligence in Agriculture Market worth $4.0 bn by 2026". Available online: https://www.marketsandmarkets.com/PressReleases/ai-in-agriculture.asp [latest access: 16.10.2020].

Martin, Segolene (Kantify) (30 April 2020): Contribution at the European Digital MSME Alliance Webinar: "AI in the EU, What are the Bottlenecks for MSMEs?"

Matt, Dominik / Rauch, Erwin (2020): “SME 4.0: The Role of Small- and Medium-Sized Enterprises in the Digital Transformation”, in Matt, Dominik / Modrák, Vladimír / Zsifkovits, Helmut [edit.]: *Industry 4.0 for MSMEs. Challenges, Opportunities and Requirements*, Palgrave Macmillan, Switzerland, p. 03-35.

MedTech Europe (2011): “European health and MSMEs – big challenges, small & medium sized solutions”. Available online: https://www.medtecheurope.org/resource-library/european-health-and-smes-big-challenges-small-medium-sized-solutions/ [latest access: 16.10.2020].

Microsoft / Ernest & Young (2018): “Artificial Intelligence in Europe, Outlook for 2019 and Beyond”.

Planradar (2020): “What is the potential for AI in construction?” Available online: https://www.planradar.com/ai-in-construction/ [latest access: 16.10.2020].

Phaneuf, Alicia / Business Insider (2020): “Artificial Intelligence in Financial Services: Applications and benefits of AI in finance”. Available online: https://www.businessinsider.com/ai-in-finance?r=US&IR=T [latest access: 16.10.2020].

Quinn, Barry / Dunn, Adele / McAdam, Rodney / McKitterick Lynsey: Call for Papers “Special issue on ‘The Competitiveness of MSMEs in the Food Sector: Exploring Possibilities for Growth”.

Rana, Renuka / Ace Cloud Hosting (2018): “How Artificial intelligence Will Impact the Accounting Industry?”. Available online: https://www.acecloudhosting.com/blog/artificial-intelligence-impact-accounting/ [latest access: 16.10.2020].

Roland Berger (2020): “Artificial intelligence in the construction industry. How to increase efficiency over the entire lifecycle chain”. Available online: https://www.rolandberger.com/en/Point-of-View/Artificial-intelligence-in-the-construction-industry.html [latest access: 16.10.2020].

Salathe, Marcel / Wiegand, Thomas / Wenzel, Markus / Kishnamurthy, Ramesh (2018): “Focus Group on Artificial Intelligence for Health”.

Selamat, Siti Aishah Mohd / Prakoonwit, Simant / Sahandi, Reza / Khan, Wajid (2019): „Big Data and IoT Opportunities for Small and Medium-Sized Enterprises (SMEs)”, University of Bournemouth, United Kingdom.

SME United (2019): “The EU Craft and MSME Barometer”. Available online: https://smeunited.eu/policies/sectors/construction [last access: 16.20.2020].

Spore (2020): “Smart farming. Transforming agriculture with artificial intelligence”, issues 195.

Su, Jeb / Forbes (2018): “Why Artificial Intelligence Is The Future of Accounting: Study”. Available online: https://www.forbes.com/sites/jeanbaptiste/2018/01/22/why-artificial-intelligence-is-the-future-of-accounting-study/#2a10d1da337b [latest access: 16.10.2020].

Terziovski, Milé (2009): “Innovation practice and its performance implications in small and medium enterprises (SMEs) in the manufacturing sector: a resource-based view”.

Toews, Rob / Forbes (2019): “AI Will Transform The Field Of Law”. Available online: https://www.forbes.com/sites/robtoews/2019/12/19/ai-will-transform-the-field-of-law/#476ce1437f01 [last access: 16.10.2020].

Vaio, Assunta Di / Boccia, Flavio / Landriani, Loris / Palladino, Rosa (2020): “Artificial Intelligence in the Agri-Food System: Rethinking Sustainable Business Models in the COVID-19 Scenario”. Cited: Vaio et al. 2020.

Vickery, Andrew R. / Rauch, Erwin / Rojas, Rafael A. / Brown, Christopher A. (2019): "Smart Data Analytics in MSME Manufacturing – an Axiomatic Design based Conceptual Framework".

World Economic Forum (2020): "Accelerating the Impact of Industrial IoT in Small and Medium-Sized Enterprises: A Protocol for Action".

5.5 Bibliography

[1] European Commission / DG JRC (2020): "AI Watch – Defining Artificial Intelligence. Towards an Operational Definition and Taxonomy of Artificial Intelligence".

[2] European Commission (2020): "White Paper. On Artificial Intelligence – A European Approach to Excellent and Trust."

[3] European Defence Agency (2020): "Artificial Intelligence: Joint quest for future defence applications". Available online: https://eda.europa.eu/info-hub/press-centre/latest-news/2020/08/25/artificial-intelligence-joint-quest-for-future-defence-applications

[4] Microsoft / Ernst & Young (2018): "Artificial Intelligence in Europe, Outlook for 2019 and Beyond".

[5] Microsoft / Ernst & Young (2018): "Artificial Intelligence in Europe, Outlook for 2019 and Beyond".

[6] European Commission (2019): "Annual Report on European MSMEs 2018/2019. Research & Development and Innovation by MSMEs".

[7] Eurostat (2011): "Key figures on European business with a special feature on MSMEs".

[8] EESC / ECLP (2014): "The State of Liberal Professions Concerning their Functions and Relevance to European Civil Society".

[9] Ibid. p. 10.

[10] Matt / Rauch (2020): "SME 4.0: The Role of Small- and Medium-Sized Enterprises in the Digital Transformation".

[11] Microsoft / Ernst & Young (2018): "Artificial Intelligence in Europe, Outlook for 2019 and Beyond".

[12] EESC (2017c): "Improving the effectiveness of EU policies for MSMEs", pp. 03 / EESC (2017d): "The potential of small family and traditional businesses to boost development and economic growth in the regions.", pp. 05 / EESC (2018d): "Promoting MSMEs in Europe with a special focus on a horizontal legislative MSME approach and respect of the SBA's "think small first"", pp. 08.

[13] EESC (2017d): "The potential of small family and traditional businesses to boost development and economic growth in the regions.", p. 03.

[14] EESC (2016): "Opinion of the European Economic and Social Committee on "Family businesses in Europe as a source of renewed growth and better jobs"", p.05.

[15] Hansen / Bøgh (2020): "Artificial Intelligence and Internet of Things in Small & Medium-Sized Enterprises: A Survey", p. 03.

[16] World Economic Forum (2020): "Accelerating the Impact of Industrial IoT in Small and Medium-Sized Enterprises: A Protocol for Action", p. 09.

[17] European Commission / DG CNECT (2020): "European Enterprise Survey on the use of Technologies based on Artificial Intelligence".

[18] World Economic Forum (2020): "Accelerating the Impact of Industrial IoT in Small and Medium-Sized Enterprises: A Protocol for Action", p. 03.

[19] Microsoft / Ernst & Young (2018): "Artificial Intelligence in Europe, Outlook for 2019 and Beyond".

[20] EIB (2019): “The digitalisation of small and medium-sized enterprises in Portugal. Models for financing digital projects.”, p. 03.

[21] EESC (2017c): “Improving the effectiveness of EU policies for MSMEs”, pp. 03 / EESC (2017d): “The potential of small family and traditional businesses to boost development and economic growth in the regions.”, pp. 05 / EESC (2018d): “Promoting MSMEs in Europe with a special focus on a horizontal legislative MSME approach and respect of the SBA’s “think small first””, pp. 08.

[22] Selamat et al. (2019): „Big Data and IoT Opportunities for Small and Medium-Sized Enterprises (SMEs)”, pp. 02 / World Economic Forum (2020): “Accelerating the Impact of Industrial IoT in Small and Medium-Sized Enterprises: A Protocol for Action”, p. 06.

[23] EIB (2019): “The digitalisation of small and medium-sized enterprises in Portugal. Models for financing digital projects.”, p. 03.

[24] Microsoft / Ernst & Young (2018): “Artificial Intelligence in Europe, Outlook for 2019 and Beyond”.

[25] European Commission / DG CNECT (2020): “European Enterprise Survey on the use of Technologies based on Artificial Intelligence”.

[26] Microsoft / Ernst & Young (2018): “Artificial Intelligence in Europe, Outlook for 2019 and Beyond”.

[27] European Commission / DG CNECT (2020): “European Enterprise Survey on the use of Technologies based on Artificial Intelligence.”

[28] EESC (2017c): “Improving the effectiveness of EU policies for MSMEs”, pp. 03 / EESC (2017d): “The potential of small family and traditional businesses to boost development and economic growth in the regions.”, p. 05 / EESC (2018d): “Promoting MSMEs in Europe with a special focus on a horizontal legislative MSME approach and respect of the SBA’s “think small first””, p. 08.

[29] European Commission / DG CNECT (2020): “European Enterprise Survey on the use of Technologies based on Artificial Intelligence”.

[30] Ibid.

[31] Selamat et al. (2019): „Big Data and IoT Opportunities for Small and Medium-Sized Enterprises (SMEs)”, p. 03.

[32] World Economic Forum (2020): “Accelerating the Impact of Industrial IoT in Small and Medium-Sized Enterprises: A Protocol for Action”, p. 03.

[33] Microsoft / Ernst & Young (2018): “Artificial Intelligence in Europe, Outlook for 2019 and Beyond”.

[34] Selamat et al. (2019): „Big Data and IoT Opportunities for Small and Medium-Sized Enterprises (SMEs)”, p. 04.

[35] EESC (2017c): “Improving the effectiveness of EU policies for MSMEs”, pp. 03 / EESC (2017d): “The potential of small family and traditional businesses to boost development and economic growth in the regions.”, pp. 05 / EESC (2018d): “Promoting MSMEs in Europe with a special focus on a horizontal legislative MSME approach and respect of the SBA’s “think small first””, p. 08.

[36] Hansen / Bøgh (2020): “Artificial Intelligence and Internet of Things in Small & Medium-Sized Enterprises: A Survey”, p. 03.

[37] Selamat et al. (2019): „Big Data and IoT Opportunities for Small and Medium-Sized Enterprises (SMEs)”, p. 04

[38] EESC (2017c): “Improving the effectiveness of EU policies for MSMEs”, p. 03 / EESC (2017d): “The potential of small family and traditional businesses to boost development and economic growth in the regions.”, p. 05 / EESC (2018d): “Promoting MSMEs in Europe with a special focus on a horizontal legislative MSME approach and respect of the SBA’s “think small first””, p. 08.

[39] Microsoft / Ernst & Young (2018): “Artificial Intelligence in Europe, Outlook for 2019 and Beyond”.

[40] Microsoft / Ernst & Young (2018): "Artificial Intelligence in Europe, Outlook for 2019 and Beyond".

[41] Martin, S. from Kantify (30 April 2020). Contribution at the European Digital MSME Alliance Webinar: AI in the EU. What are the Bottlenecks for MSMEs?

[42] European Commission (2020): "European Enterprise Survey on the use of technologies based on artificial intelligence".

[43] European Parliament / DG IPOL (2020): "Research for CULT Committee – The use of Artificial Intelligence in the Audiovisual Sector Concomitant expertise for INI report", p. 14.

[44] European Commission (2020): "European enterprise survey on the use of technologies based on artificial intelligence".

[45] Ibid.

[46] Ibid.

[47] Ibid.

[48] Ibid.

[49] European Parliament: (2020): "An EU Framework for Artificial Intelligence – At a Glance".

[50] European Parliament / DG IPOL (2020): "Research for CULT Committee – The use of Artificial Intelligence in the Audiovisual Sector Concomitant expertise for INI report", p. 14.

[51] European Commission (2020): "European enterprise survey on the use of technologies based on artificial intelligence".

[52] Eurostat / European Commission (2008): "NACE Rev. 2. Statistical classification of economic activities in the European Community", pp. 72 + pp. 209.

[53] European Commission: "Construction", available online: https://ec.europa.eu/growth/sectors/construction_en / Euractiv (2016): "The construction sector in Europe. And its MSMEs. Facts and figures", available online: https://www.euractiv.com/section/social-europe-jobs/infographic/the-construction-sector-in-europe-and-its-smes-facts-and-figures/

[54] European Commission / DG GROW (2019): "Supporting digitalisation of the construction sector and MSMEs", p. 08.

[55] European Commission / DG GROW (2019): "European Construction Sector Observatory – 2019 Infographics on Digitalisation".

[56] https://www.rolandberger.com/en/Publications/Hot-trends-in-construction-A-new-era-of-opportunities.html [last access 02.12.2020].

[57] European Commission (2019): "Supporting digitalisation of the construction sector and MSMEs. Including Building Information Modelling", p. 06.

[58] Schia et al. (2019): "The Introduction of AI in the Construction Industry and its Impact on Human Behavior".

[59] European Commission / DG GROW (2019): "European Construction Sector Observatory – 2019 Infographics on Digitalisation".

[60] Roland Berger (2020): "Artificial Intelligence in the construction industry", available online: https://www.rolandberger.com/en/Point-of-View/Artificial-intelligence-in-the-construction-industry.html

[61] Ibid.

[62] RICS (2020): "European construction sector in decline", available online: https://www.rics.org/de/news-insight/latest-news/news-opinion/european-construction-sector-in-decline/ / Roland Berger (2020): "What the

new normal could look like in construction", available online: https://www.rolandberger.com/sv/Point-of-View/The-coronavirus-crisis-will-cause-significant-delays-to-the-construction.html.

[63] Eurostat (2020): *Euro indicator 173/2020*, available online: https://ec.europa.eu/eurostat/documents/2995521/11529239/4-19112020-AP-EN.pdf/eff0563b-91b4-4b30-051c-e494cb46d7cd?t=1605720262000

[64] Lexology (2020): "AI's potential and key risks in the construction industry".

[65] Ibid.

[66] Ibid.

[67] See e.g., https://www.businesscloud.co.uk/news/from-drones-to-job-losses-the-future-of-ai-in-construction/ for the US market see also https://www.globalconstructionreview.com/innovation/robots-will-lead-millions-construction-job-losses-/

[68] Research Dive (2020): "Global AI in Construction Market Projected to Garner $2,325.9 Million by 2026 despite the Covid-19 Chaos".

[69] Based on value chain used by the Buildings Performance Institute Europe (BPIE): https://bpie.eu/wp-content/uploads/2016/01/DrivingTransformationalChangeCVC2016.pdf (p. 06+17).

[70] For all see: Roland Berger (2020): Artificial intelligence in the construction industry" available online: https://www.rolandberger.com/en/Point-of-View/Artificial-intelligence-in-the-construction-industry.html / European Commission (2019): "Supporting digitalisation of the construction sector and MSMEs", p. 12.

[71] European Commission (2020): "European enterprise survey on the use of technologies based on artificial intelligence", p. 37.

[72] European Commission (2019): "Supporting digitalisation of the construction sector and MSMEs", p. 15.

[73] Roland Berger (2018): „Artificial intelligence in the construction industry", available online: https://www.rolandberger.com/en/Point-of-View/Artificial-intelligence-in-the-construction-industry.html

[74] European Commission (2019): "Supporting digitalisation of the construction sector and MSMEs", p. 32.

[75] Ibid. p. 32.

[76] Ibid. p. 36.

[77] Ibid. p. 37.

[78] Eurostat / European Commission (2008): "NACE Rev. 2. Statistical classification of economic activities in the European Community", p. 81 + 265.

[79] Mordor Intelligence (2020): "LEGAL SERVICES MARKET - Growth, Trends, COVID-19 Impact, and Forecasts (2021 - 2026)".

[80] Beroe (2020): "Legal Services Europe Category Intelligence".

[81] Research and Markets (2019): "Legal services in Europe", available online: https://www.researchandmarkets.com/reports/1961875/legal_services_in_europe

[82] Stevenson / Doleac (2019): "Algorithmic Risk Assessment in the Hands of Humans" / *see also*: https://eu.usatoday.com/story/tech/2019/04/17/ai-too-white-male-more-women-minorities-needed-facial-recognition/3451932002/

[83] Forbes (2019): "AI will transform the field of law", available online: https://www.forbes.com/sites/robtoews/2019/12/19/ai-will-transform-the-field-of-law/#476ce1437f01 / Bernard Marr & Co. (2019): "How AI And Machine Learning Are Transforming Law Firms And The Legal Sector".

[84] Remus / Levy (2015): "Can Robots Be Lawyers? Computers, Lawyers and the Practice of Law".

[85] Brooks/Gherhes/Vorley (2020): "Artificial intelligence in the legal sector: pressures and challenges of transformation".

[86] Forbes (2019): "AI will transform the field of law", available online: https://www.forbes.com/sites/robtoews/2019/12/19/ai-will-transform-the-field-of-law/#476ce1437f01

[87] Ibid.

[88] MedTech Europe (2020): "The European Medical Technology Industry in figures 2020", p. 04.

[89] For the health sector we consider a mixture of several third-party definitions together with the NACE's definition of "Human Health and Social Work Activities", following Eurostat / European Commission (2008): "NACE Rev. 2. Statistical classification of economic activities in the European Community", pp. 86 + 294.

[90] EU Skills Panorama (2014) Skills for social care Analytical Highlight, prepared by ICF GHK and Cedefop for the European Commission.

[91] MedTech Europe (2020): "The European Medical Technology Industry in figures 2020", p. 20.

[92] MedTech Europe (2020): "The European Medical Technology Industry in figures 2020", p. 16.

[93] Ibid. p. 13.

[94] European Commission: "Technological MSMEs for the Health Industry", available online: https://ec.europa.eu/growth/tools-databases/sme-week/index.cfm?fuseaction=sme.viewPublishedEvent&event_id=7972&edition_id=9751&country_cd=IT

[95] Degen et al. (2011): "The voice of biomedical MSMEs. Performance factors in moving from research to market", p. 14.

[96] Horgan et al. (2018): „Optimising MSME Potential in Modern Healthcare Systems: Challenges, Opportunities and Policy Recommendations", p. 05.

[97] Salathe et al. (2018): "Focus Group on Artificial Intelligence for Health", p. 02.

[98] Ibid.

[99] Novartis / Microsoft (2020): "Working Group on Digital and AI in Health. Reimagining Global Health through Artificial Intelligence: The Roadmap to AI Maturity", p. 08.

[100] MIT Technology Review (2020): "Doctors are using AI to triage covid-19 patients. The tools may be here to stay", available online: https://www.technologyreview.com/2020/04/23/1000410/ai-triage-covid-19-patients-health-care/

[101] European Commission (2020): "European enterprise survey on the use of technologies based on artificial intelligence", p. 37.

[102] European Commission's Joint Report on Health Care and Long-term Care Systems and Fiscal Sustainability (2016), EXPHs report Assessing the impact of digital transformation of health services (2019)

[103] Novartis / Microsoft (2020): "Working Group on Digital and AI in Health. Reimagining Global Health through Artificial Intelligence: The Roadmap to AI Maturity", p. 78; *see additionally* Salathe et al. (2018): "Focus Group on Artificial Intelligence for Health", p. 03.

[104] Salathe et al. (2018): "Focus Group on Artificial Intelligence for Health", p. 03.

[105] Eurostat / European Commission (2008): "NACE Rev. 2. Statistical classification of economic activities in the European Community", p. 265.

[106] Data extracted from Eurostat: "Annual detailed enterprise statistics for services (NACE Rev. 2 H-N and S95)", available online: https://ec.europa.eu/eurostat/databrowser/view/SBS_NA_1A_SE_R2__custom_334833/default/table?lang=en

[107] Forbes (2018): "Why Artificial Intelligence Is The Future of Accounting. Study", available online: https://www.forbes.com/sites/jeanbaptiste/2018/01/22/why-artificial-intelligence-is-the-future-of-accounting-study/?sh=19d652b0337b#33c484a2337b

[108] Forbes (2018): "Why Artificial Intelligence Is The Future of Accounting. Study", available online: https://www.forbes.com/sites/jeanbaptiste/2018/01/22/why-artificial-intelligence-is-the-future-of-accounting-study/?sh=19d652b0337b#33c484a2337b / ACE Cloud Hosting: "How Artificial Intelligence Will Impact the Accounting Industry?", available online: https://www.acecloudhosting.com/blog/artificial-intelligence-impact-accounting/

[109] ICAEW: "What does AI have to do with finance?", available online: https://www.icaew.com/insights/features/2020/mar-2020/what-does-ai-have-to-do-with-finance

[110] Ernst & Young (2019): "Does corporate reporting need a culture shock?", available online: https://www.ey.com/en_gl/assurance/does-corporate-reporting-need-a-culture-shock

[111] AICPA: "Skills that help accounting professionals succeed alongside AI", available online: https://mycareer.aicpa-cima.com/article/accounting-skills-to-succeed-alongside-artificial-intelligence/

[112] ICAEW (2018): "Artificial intelligence and the future of accountancy", p. 07.

[113] KPMG (2017): "Digitalisation in Accounting. Study of the Status Quo in German Companies".

[114] ICAEW (2018): "Artificial intelligence and the future of accountancy", p. 09.

[115] ICAEW (2018): "Artificial intelligence and the future of accountancy", p. 10.

[116] Eurostat / European Commission (2008): "NACE Rev. 2. Statistical classification of economic activities in the European Community", p.61.

[117] Eurostat (2020): "Agriculture, forestry and fishery statistics 2018 edition", p. 12.

[118] Ibid. p. 24+68.

[119] European Parliament / Policy Department for Structural and Cohesion Policies (2019): The EU farming employment: current challenges and future prospects".

[120] Eurostat (2018): "Agriculture, forestry and fishery statistics 2018 edition", p. 12.

[121] European Commission (2017): "Annual Report on European MSMEs 2016/2017".

[122] Eurostat (2018): "Agriculture, forestry and fishery statistics 2018 edition", p. 18. The term 'family farm' refers to any farm under family management where 50 % or more of the regular agricultural labour force is provided by family members.

[123] Eurostat (2018): „Agriculture, forestry and fishery statistics 2018 edition", p. 17.

[124] European Environment Agency (2019): "Climate change adaptation in

the agriculture sector in Europe".

[125] European Commission (2017): "Modernising and simplifying the CAP - Economic challenges facing EU agriculture, p.15, Directorate-General for Agriculture and Rural Development".

[126] Vaio et al. (2020): "Artificial Intelligence in the Agri-Food System: Rethinking Sustainable Business Models in the COVID-19 Scenario", p. 01.

[127] Vaio et al. (2020): "Artificial Intelligence in the Agri-Food System: Rethinking Sustainable Business Models in the COVID-19 Scenario", p. 06.

[128] For more information on the "Farming by Satellite" initiative please refer to http://www.farmingbysatellite.eu/

[129] European Commission (2020): "European enterprise survey on the use of technologies based on artificial intelligence", p. 37. Please note that the survey combines agriculture, forestry and fishing into one category, so these are included in the uptake level.

[130] European Parliament (2017): "Precision agriculture in Europe. Legal, social and ethical considerations".

[131] European Commission / JRC (2014): "European farmers' intentions to invest in 2014-2020: survey results".

[132] Knowles / Hanson (2018): "The wisdom of older technology (non)users.",

[133] European Parliament (2017): "Precision agriculture in Europe. Legal, social and ethical considerations".

[134] Centre for European Policy Studies / Barilla Center for Food & Nutrition (2019): "Digitising Agrifood Pathways and Challenges".

[135] E.g. EESC (2016): "Opinion of the European Economic and Social Committee on "Family businesses in Europe as a source of renewed growth and better jobs"" / EESC (2017c): "Improving the effectiveness of EU policies for MSMEs" / EESC (2017d): "The potential of small family and traditional businesses to boost development and economic growth in the regions" / EESC (2018d): "Promoting MSMEs in Europe with a special focus on a horizontal legislative MSME approach and respect of the SBA's "think small first"".

[136] EESC (2017c): "Improving the effectiveness of EU policies for MSMEs", pp. 03 / EESC (2017d): "The potential of small family and traditional businesses to boost development and economic growth in the regions.", p. 05 / EESC (2018d): "Promoting MSMEs in Europe with a special focus on a horizontal legislative MSME approach and respect of the SBA's "think small first"", p. 08.

[137] EESC (2016): "Opinion of the European Economic and Social Committee on "Family businesses in Europe as a source of renewed growth and better jobs"" / EESC (2017d): "The potential of small family and traditional businesses to boost development and economic growth in the regions.".

[138] EESC (2017d): "The potential of small family and traditional businesses to boost development and economic growth in the regions.", p. 03.

[139] EESC (2016): "Opinion of the European Economic and Social Committee on "Family businesses in Europe as a source of renewed growth and better jobs"", p. 02.

[140] Ibid. p. 05.

[141] EESC (2020): "Opinion. White Paper on Artificial Intelligence – A European Approach to excellence and trust", p. 05.

[142] "a collection of technologies that combine data, algorithms and computing power".

[143] Ibid. p. 05.

[144] EESC (2017a): "Artificial intelligence – The consequences of artificial intelligence on the (digital) single market, production, consumption, employment and society", p. 03.

[145] Ibid. p. 05.

[146] Ibid. p. 03.

[147] Ibid. p. 03.

[148] EESC 2019a, p. 02.

[149] EESC (2016): "Opinion of the European Economic and Social Committee on "Family businesses in Europe as a source of renewed growth and better jobs"", pp. 03+05.

[150] Additional reading on scepticism towards AI adoption see Vickery et al. 2019, pp. 02.

[151] EESC (2018d): "Promoting MSMEs in Europe with a special focus on a horizontal legislative MSME approach and respect of the SBA's "think small first"", p. 04. Regarding general scepticism towards AI technology see Selamat et al. 2019, p. 02 or WEF 2020, p. 06.

[152] EESC (2017d): "The potential of small family and traditional businesses to boost development and economic growth in the regions.", p. 09

[153] EESC (2017c): "Improving the effectiveness of EU policies for MSMEs", p. 07.

[154] EESC (2017d): "The potential of small family and traditional businesses to boost development and economic growth in the regions.", p. 09..Regarding high salary demands see e.g. https://www.planradar.com/ai-in-construction/

[155] Ibid. p. 04.

[156] Ibid.

[157] Ibid.

[158] EESC (2017d): "The potential of small family and traditional businesses to boost development and economic growth in the regions.", p. 09.

[159] European Parliament resolution of 19 January 2016 on Towards a Digital Single Market Act (2015/2147(INI))

[160] Ibid. p. 21.

[161] Ibid. pp. 22.

[162] Ibid. pp. 24.

[163] Ibid. pp. 25.

[164] Ibid. pp. 22+27.

[165] COM (2016) 178 final.

[166] Ibid. pp. 03.

[167] Ibid. p 06.

[168] Ibid. p. 08.

[169] Also referred to simply as the "EU strategy on artificial intelligence"

[170] COM (2018) 237 final: 02.

[171] Ibid. pp. 09.

[172] Ibid. p. 10.

[173] Ibid. p. 11.

[174] The European Structural and Investment Fund consists of the European regional development fund, European social fund, Cohesion fund, European agricultural fund for rural development, European maritime and fisheries fund.

[175] COM (2018) 237 final: 14.

[176] Ibid.

[177] Ibid. p. 19. The 'Coordinated Action Plan' got implemented in 2019

[178] The Ethics Guidelines are available online via: https://ec.europa.eu/futurium/en/ai-alliance-consultation/guidelines#Top

[179] The Policy and Investment Recommendations are available online via: https://ec.europa.eu/digital-single-market/en/news/policy-and-investment-recommendations-trustworthy-artificial-intelligence [last access: 13.11.2020].

[180] For more information see the official webpage of the AI Alliance: https://ec.europa.eu/digital-single-market/en/european-ai-alliance [last access: 13.11.2020].

[181] European Commission: "About AI Watch", available online: https://ec.europa.eu/knowledge4policy/ai-watch/about_en

[182] Based on information from the official website, available online: https://www.digitalsme.eu/european-focus-group-on-artificial-intelligence/

[183] Ibid.

[184] In addition to the EU Member States, Norway and Switzerland were involved in the creation of the Coordinated Plan.

[185] COM (2018) 795 final, p. 01.

[186] Ibid. p. 02.

[187] Member States not having released a full national AI strategy as of yet include: Bulgaria, Croatia, Greece, Ireland, Romania. Source: COM/JRC (2020): "AI Watch. National strategies on Artificial intelligence, A European perspective in 2019".

[188] COM (2018) 795, p. 03.

[189] Ibid. p. 04.

[190] Ibid. pp. 04-06.

[191] European Commission: "A European AI On Demand Platform And Ecosystem", available online: https://cordis.europa.eu/project/id/825619/de

[192] THALES SIX GTS FRANCE SAS.

[193] European Commission: "A European AI On Demand Platform And Ecosystem", available online: https://cordis.europa.eu/project/id/825619/de

[194] The European Ethical Observatory will offer regular publications and outreach activities to pursue public AI education, as well as the monitoring of ethical, legal and socio-economical standards. More information is available online: https://www.ai4eu.eu/ai4eu-observatory

[195] For more information on the project please refer to the website, available online: https://www.ai4eu.eu/about-project

[196] COM (2020) 66 final, p. 04.

[197] Ibid. p. 05.

[198] Ibid. p. 06.

[199] Ibid. p. 02.

[200] Ibid. p. 05.

[201] Ibid. pp. 05-08.

[202] COM (2020) 65 final, p. 09.

[203] COM (2021): "Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions. Fostering a European approach to Artificial Intelligence", COM(2021) 205 final.

[204] COM(2021) 205 final: 06.

[205] COM (2018) 795 final, p. 01.

[206] Ibid. p. 02.

[207] Excluding already the United Kingdom's economic data due to the Brexit. https://data.worldbank.org/country/FR / https://ec.europa.eu/eurostat/de/web/products-eurostat-news/-/DDN-20200508-1 / https://data.oecd.org/france.htm

[208] Societe Generale Import Export Solutions: "French Market: Main Sectors", available online: https://import-export.societegenerale.fr/en/country/france/market-sectors

[209] Statista (2020): "Unemployment rate in member states of the European Union in July 2020), available online: https://www.statista.com/statistics/268830/unemployment-rate-in-eu-countries/

[210] European Commission (2019): "Annual report on European MSMEs 2019", available online: https://ec.europa.eu/growth/smes/sme-strategy/performance-review_en

[211] Statista (2018): "Main industry sectors of small and medium enterprises (SME) in France as of April 2018, available online: https://www.statista.com/statistics/701501/monthly-sme-industry-sectors-france/

[212] EIB (2019): „Who is prepared fo the new digital age? Evidence from the EIB Investment Survey".

[213] Talaviya et al. (2020): Implementation of artificial intelligence in agriculture for optimisation of irrigation and application of pesticides and herbicides".

[214] PWC (2020): "An introduction to implementing AI in manufacturing".

[215] European Commission (2020): "European enterprise survey on the use of technologies based on artificial intelligence", p. 96.

European Commission (2020): "European enterprise survey on the use of technologies based on artificial intelligence", p. 97.

[217] OECD (2019): "OECD Economic Surveys. France, April 2019", p. 15.

[218] European Commission / JRC (2019): "AI Watch. National strategies on Artificial Intelligence. A European perspective in 2019", p. 36.

[219] French Ministry of Higher Education, Research and Innovation: "Science ouverte", available online: https://www.enseignementsup-recherche.gouv.fr/cid132529/le-plan-national-pour-la-science-ouverte-les-resultats-de-la-recherche-scientifique-ouverts-a-tous-sans-entrave-sans-delai-sans-paiement.html

[220] See additionally data from Digital Europe (2018), available online https://www.digitaleurope.org/resources/nis-implementation-tracker/#France

[221] European Commission / JRC (2019): "AI Watch. National strategies on Artificial Intelligence. A European perspective in 2019", p. 38. / See additionally, https://www.universite-paris-saclay.fr/en/news/powerful-supercomputer-campus-paris-saclay

[222] Document "Stratégie internationale de la France pour le numérique" is available online https://www.diplomatie.gouv.fr/IMG/pdf/strategie_numerique_a4_02_interactif_cle445a6a.pdf

[223] https://data.oecd.org/ireland.htm / https://ec.europa.eu/eurostat/statistics-explained/index.php/GDP_per_capita,_consumption_per_capita_and_price_level_indices / https://europa.eu/european-union/about-eu/figures/living_en#quality_of_life

[224] https://data.worldbank.org/country/IE

[225] Business World (2019): "Ireland has fastest-growing economy in EU for the fifth consecutive year", available online: https://www.businessworld.ie/economy/Ireland-has-fastest-growing-economy-in-EU-for-the-fifth-consecutive-year-572117.html

[226] RTE (2020): "Ireland received more FDI than any other country in first half of 2020", available online: https://www.rte.ie/news/business/2020/1030/1174965-fdi-oecd-ireland/

[227] The Guardian (2016): "After Apple: will other tech companies face Irish tax bills of their own?", available online: https://www.theguardian.com/technology/2016/aug/31/google-microsoft-facebook-apple-europe-ireland-taxes

[228] Irish Department of Enterprise, Trade and Employment: "Foreign Direct Investments (FDI)", available online: https://enterprise.gov.ie/en/What-We-Do/Trade-Investment/Foreign-Direct-Investment-FDI-/

[229] Ibid.

[230] Statista (2018): "Number of small and medium-sized enterprises (SMEs) in Ireland in 2018, by size", available online: https://www.statista.com/statistics/879089/number-of-smes-in-ireland/

[231] European Commission (2019): MSME Performance Review 2019".

[232] EIB (2019): „Who is prepared for the new digital age? Evidence from the EIB Investment Survey".

[233] European Commission (2020): "European enterprise survey on the use of technologies based on artificial intelligence", p. 104.

[234] Irish Department of Enterprise, Trade and Employment: "Foreign Direct Investments (FDI)", available online: https://enterprise.gov.ie/en/What-We-Do/Trade-Investment/Foreign-Direct-Investment-FDI-/

[235] International Trade Administration (2020): "Ireland Artificial Intelligence", available online: https://www.trade.gov/market-intelligence/ireland-artificial-intelligence

[236] PWC (2019): "Artificial Intelligence – the six priorities for Irish organisations", available online: https://www.pwc.ie/issues/artificial-intelligence-six-priorities.html

[237] Ibid.

[238] Silicon Republic (2018): "In Ireland, we cannot produce data scientists fast enough", available online: https://www.siliconrepublic.com/innovation/andrew-parnell-maynooth-university

[239] European Commission (2019): "National strategies on Artificial Intelligence. A European perspective in 2019", available online: https://knowledge4policy.ec.europa.eu/sites/default/files/ireland-ai-strategy-report.pdf

[240] Ibid.

[241] NSAI: „Bringing Trustworthyiness to AI with Standards". Available online: https://www.nsai.ie/about/news/bringing-trustworthiness-to-ai-with-standards/

[242] Government of Ireland (2019) "Ireland's Industry 4.0 Strategy 2020-2025", p. 07.

[243] Ibid. p. 05.

[244] https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=RO / https://www.worldbank.org/en/country/romania/overview

[245] Romanian Ministry of Foreign Affairs (2020): "Romania's candidacy for OECD Membership", available online: https://www.mae.ro/en/node/18543

[246] OECD: "The OECD and South East Europe. Romania", available online: https://www.oecd.org/south-east-europe/economies/see-romania.htm

[247] https://www.worldbank.org/en/country/romania/overview

[248] Nordea Trade (2020): "The economic context of Romania", available online: https://www.nordeatrade.com/en/explore-new-market/romania/economical-context

[249] Ibid.

[250] European Commission (2019): MSME Performance Review 2019".

[251] European Commission (2020): "European enterprise survey on the use of technologies based on artificial intelligence", pp.: 120.

[252] Business Review (2020): "Why Romania must tap into artificial intelligence", available online: https://business-review.eu/tech/why-romania-must-tap-into-artificial-intelligence-209746

[253] Ibid.

[254] "Romania in the era of Artificial Intelligence", available online: https://drive.google.com/file/d/1A-RCl1djDIo8FTZmkK7Hp72QrX8G2z3T/view

[255] Business Review (2020): "Why Romania must tap into artificial intelligence", available online: https://business-review.eu/tech/why-romania-must-tap-into-artificial-intelligence-209746

[256] See also McKinsey (2018): "The rise of Digital Challengers. Perspectives on Romania"

[257] Ibid. p. 20.

[258] Romania Insider (2019): "Communications Ministry to launch Romania's AI strategy by end of the year", available online: https://www.romania-insider.com/romania-artificial-intelligence-strategy / European Commission (2019): "AI Watch. National strategies on Artificial Intelligence. A European perspective in 2019", pp. 67.

[259] Romania in the era of Artificial Intelligence", available online: https://drive.google.com/file/d/1A-RCl1djDIo8FTZmkK7Hp72QrX8G2z3T/view

[260] Statista (2020): "Italien: Bruttoinlandsprodukt (BIP) in jeweiligen Preisen von 1980 bis 2019 und Prognosen bis 2025", avilable online: https://de.statista.com/statistik/daten/studie/14402/umfrage/bruttoinlandsprodukt-in-italien/ / https://data.oecd.org/italy.htm

[261] OECD (2019): "OECD Economic Surveys. Italy 2019" pp. 03+08.

[262] Ibid. p. 20.

[263] Societe Generale / Import Export Solutions (2021): "Italian Market: Main Sectors", available online: https://import-export.societegenerale.fr/en/country/italy/market-sectors

[264] European Commission (2019) "SME Performance Review 2019", available online: https://ec.europa.eu/growth/smes/sme-strategy/performance-review_en

[265] OECD (2019): "OECD Economic Surveys. Italy 2019" pp. 32+48+57+63.

[266] Clifford Chance / Talking Tech (2020): "Artificial Intelligence: the expoert taks force releases its final proposal for the Italian strategy", available online: https://talkingtech.cliffordchance.com/en/emerging-technologies/artificial-intelligence/artificial-intelligence--the-expert-task-force-releases-its-fina.html

[267] Statista (2019): "If artificial intelligence or automation (i.e. automating functions of certain jobs or daily tasks) is introduced into your workplace, do you think it would have a positive impact on your job?", available online: https://www.statista.com/statistics/1040031/opinion-on-how-ai-will-change-jobs-in-italy/

[268] Ibid.

[269] European Commission (2019): "AI Watch. National strategies on Artificial Intelligence. A European perspective in 2019", p. 47.

[270] Ibid.

[271] Statista (2020): "Sweden: Gross domestic product (GDP) in current prices from 1985 to 2025", available online: https://www.statista.com/statistics/375279/gross-domestic-product-gdp-in-sweden/ / https://data.oecd.org/sweden.htm

[272] European Union: "Sweden. Overview", available online: https://europa.eu/european-union/about-eu/countries/member-countries/sweden_en / https://www.globaltenders.com/economy-of-sweden.php

[273] Britannica: "Sweden. Government and Society", available online: https://www.britannica.com/place/Sweden/Government-and-society

[274] European Commission (2019): "SME Performance Review 2019", available online: https://ec.europa.eu/growth/smes/sme-strategy/performance-review_en

[275] Flanders Investment & Trade (2020): "Artificial Intelligence in Sweden".

[276] European Commission (2019): "AI Watch. National strategies on Artificial Intelligence. A European Perspective in 2019", p. 75.

[277] For more info on AI Sweden please refer to the respective website: https://www.ai.se/en

[278] Matt / Rauch (2020): "SME 4.0: The Role of Small- and Medium-Sized Enterprises in the Digital Transformation".

[279] McKinsey, the COVID-19 recovery will be digital: A plan for the first 90 days, online available https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/the-covid-19-recovery-will-be-digital-a-plan-for-the-first-90-days

[280] JRC Science for policy report, Artificial Intelligence and Digital Transformation: early lessons from the COVID-19 crisis, Craglia, M. editor(s), EUR 30306 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-20802-0, doi:10.2760/166278, JRC121305.

[281] Foundations of AI, available online: https://www.foundationsofai.com

[282]Datacamp, AI Fundamentals, available online: https://www.datacamp.com/courses/ai-fundamentals

[283] Udacity, AI for Business Leaders, available online https://www.udacity.com/course/ai-for-business-leaders--nd054

[284] Oracle, Artificial Intelligence Learning Library, available online: https://www.oracle.com/artificial-intelligence/what-is-ai/#ai-journey

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