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Advanced Technologies for Industry – AT WATCH

Technology Focus on Data sharing

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1 Introduction

This Advanced Technology Watch report has been developed in the framework of the Advanced Technologies for Industry (ATI) project, initiated by the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the Executive Agency for Small and Medium-Sized Enterprises.

As a part of a series of analytical reports on trends in advanced technologies, this report is a comprehensive monitoring tool endowing policymakers, industry players, researchers and other relevant stakeholders with regularly updatable research. The AT Watch report series is meant to play a complementary role to the other analytical, policy and statistical reports of the project, by focusing on the market, business and socioeconomic trends driven by technology innovation. This Advanced Technology Watch therefore encompasses a whole set of advanced technologies that are a priority for European industrial policy. These technologies enable process, product and service innovation throughout the economy, thus fostering industrial modernisation.

The qualitative and quantitative analysis included in this Advanced Technology Watch report is specifically designed to provide novel insight and up-to-date content to technology users across all European industries, with the aim of revealing potential opportunities emerging from the most recent applications of advanced technologies.

The AT Watch report series targets:

- A primary audience of industry stakeholders, including SMEs and industry associations interested in learning about upcoming technology trends and business opportunities
- A complementary audience of national, regional and local policy makers interested in supporting industry in the exploitation of technology innovation and emerging business opportunities by removing barriers and creating favourable market conditions
- A complementary audience of research and technology stakeholders interested in the applied research challenges to be solved to capture emerging business opportunities.

Each report is thus structured using two main sections:

- A brief overview of the uptake of all advanced technologies and demand trends by industry (Section 1: Technology Landscape)
- A more in-depth analysis of one advanced technology, selected because of its relevance in terms of emerging business opportunities and disruptive potential (Section 2: Technology Focus).

This report focuses on the evolution of data sharing as the advanced technology fostering the digital transformation of Europe. Data sharing is vital for companies in general, and SMEs in particular, to reap the benefits that data offers and is a key asset for the EU's ambitions to become a role model for a data-driven society, to create a single market for data and to facilitate common European data spaces.[1]

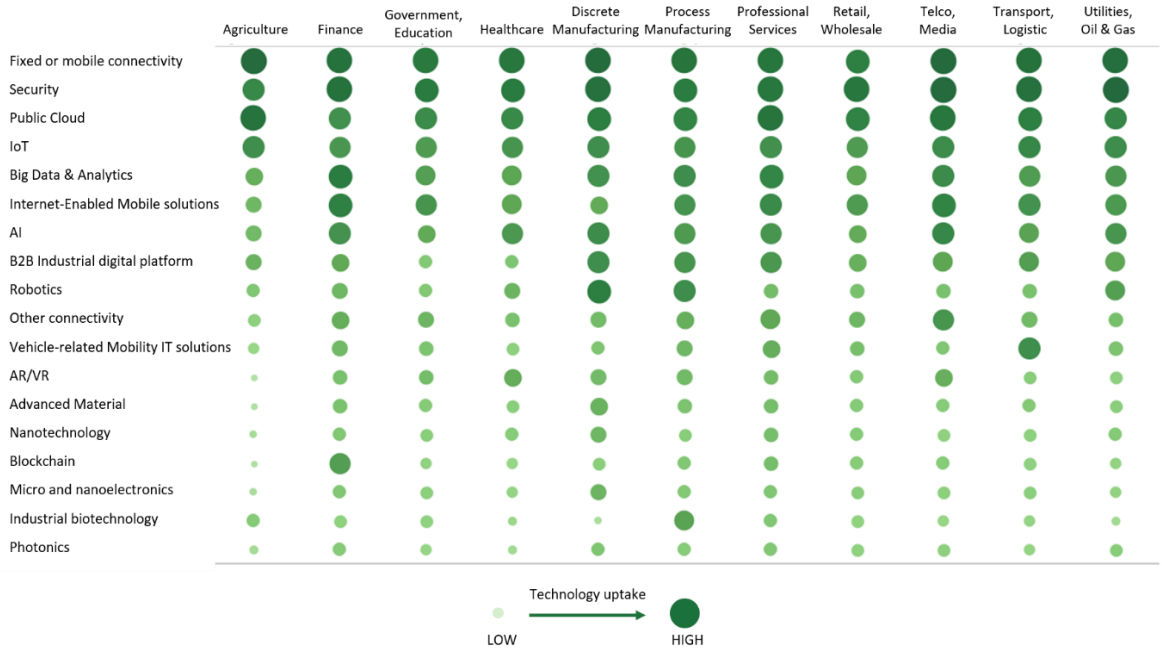
[1] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en

1.1 The Advanced Technologies for Industry Landscape

The digitisation and industry modernisation process in Europe is progressing at different speeds across all industry sectors, driven by a whole set of changing priorities, challenges and use cases. Advanced technology adoption has been impacted by the pandemic, resulting in a slowdown necessary to allow companies to focus on more business contingency related initiatives. At the same time, the COVID-19 has sped up the adoption of some specific technologies through forced digitisation of customers and supply-chains interactions and all the related internal processes. These technologies are acting as 'return-to-growth' accelerators, making businesses and organisations as a whole more resilient for the future scenario. However, throughout the path to recovery, the focus will be more on safe bets than big bets.

The different mix of advanced technologies adopted by each industry is visualised in Figure 1.The figure shows the percentage share of enterprises in each industry adopting or planning to adopt each technology (the size of bubbles corresponds to the level of uptake, with the highest value being 85%). The data is based on the Advanced Technologies for Industry Survey (November 2020)[2] and on a sample of European enterprises from 7 Member States, representing more than 60% of the EU GDP in 2020. This is an updated version of last year the ATI Survey conducted in July 2019.

Figure 1: Advanced Technologies Uptake by European Industries, 2020



Source: Advanced Technologies for Industry Survey November 2020, (N=1 547).

Note: Bubble size represents the % of enterprises in the industry adopting the technology in the same row. The maximum value is 85%.Technologies are ordered top-down based on the total sample average adoption.[3]

The visualisation highlights how a distinct group of technologies **features a marked horizontal diffusion** across all industries (general purpose technologies Connectivity, Security, Public Cloud, Mobile solutions, Big Data & Analytics, Internet of Things (IoT) and Industrial Digital Platform): they represent the technology portfolio necessary (but not sufficient) for digital transformation. **Other technologies clearly display a niche or industry-specific orientation**. However, this does not mean that they do not provide opportunities for investments outside their main industry niche. Robotics is a very interesting example: the technology was initially developed in manufacturing, where it served as a substitute to human workforce in several time-consuming tasks, helping human to save time and

[2] The survey interviewed a sample of 1 547 enterprises with more than 10 employees in DK, DE, FR, ES, IT, PL, SE.
[3] The ATI technology definitions can be found in the methodological report at https://ati.ec.europa.eu/reports/eu-reports/advanced-technologies-industry-methodological-report

speed up production. New areas of applications are now emerging, and multiple novel use cases proliferate in order to drive business value in other industries. For instance, in manufacturing, Robotics is used for a wide variety of tasks, from shop floor production automation to warehouse inventory management. Similarly, Robotics exhibits a great potential in the healthcare sector where it can be used to support the medical personnel enhancing procedures' safety, reducing operative costs, disinfecting rooms, preparing and storing medications and much more. Compared to the previous survey, industries show some similar technological patterns: connectivity, public cloud and security technologies are among the most adopted technologies, with small differences across industries, while advanced materials, nanotechnologies and industrial biotechnology represent a niche of few sectors, such as manufacturing and healthcare. Compared to 2019 results, IoT and AI show an interesting increasing pattern in Transport and Healthcare, while B2B industrial digital platform is quickly taking ground in manufacturing and agriculture. Firms in the finance sector are more and more interested in Robotics, which represent the highest increase in adoption rate across industries, proving the high potential this technology can provide to the sector. Referring to Robotics, respondents mainly referred to Robotic Process Automation (RPA), which finds very fertile ground in this sector. On the other side, some technologies are slowing down: while industrial biotechnology is increasingly adopted in manufacturing, it is decelerating in utilities. A similar trend is shown for the public cloud in healthcare and retail.

When looking at the European industries in more detail, we observe that:

- The operational excellence that the **manufacturing industry** is looking for will be achieved through the adoption of advanced technologies. This operational improvement will be of paramount importance in ensuring performance during the next normal. In fact, COVID-19 impact on trade caught many firms unprepared, with negative consequences on supply chains. This event drastically changed the focus from a low-cost country sourcing mantra to a more resilient and simpler network. Implementing new technologies is turning supply chain processes and activities towards less uncertainty and complexity. Technologies like **Robotics, AI, IoT, Blockchain and Edge** Computing are the key drivers to achieve these goals, together with efficiency benefits and zero-touch production (ZTP) processes, the latter being pushed significantly during the pandemic and becoming a strategic asset for the future of enterprises. Efficiency is also fostered by **ARVR** solutions that allow experts to provide remote support to on-field operators and guide them through step-by-step instructions. **B2B digital platform** is also a key trend in the manufacturing industry, pushing for a more collaborative relation between colleagues, peers and employees. This opportunity is deeply connected to **Big Data/analytics** technology, which allows to track and analyse processes, improve operational visibility and understand improvements and trends. **3D printing** has shown its huge potential in creating and modifying manufacturing and healthcare products during the pandemic, proving to be a key trend in the next years. Product innovation is also driving the adoption of **Advanced Materials, micro and nanoelectronics, nanotechnologies and photonics** with the aim to improve products and reduce costs.
- In **finance,** besides operational efficiency, the other main business goal driving investments in advanced technologies is the need to attract and retain customers. This is pushing the industry towards piloting new service delivery models. **AI**, **Big Data** and **Blockchain** are among the most promising technologies for the industry as they enable automation of internal operations, improve customer service and enhance protection against security threats. To counter the uncertainty of the new reality and improve loan portfolio health, **Advanced Analytics** is making it possible to analyse every payment that a corporate or small business makes and receives. Key AI trends in the industry include automation of IT operations and opening new digital channels to improve customer experience leveraging voice banking and chatbots. Blockchain main applications include for example cross-border payments and settlements. **Robotics**, mainly in the form of Robotic Process Automation (RPA), is changing how banking and finance companies carry out business through fraud detection, auditing and reducing time-consuming workloads. To keep pace with the information security risks, **Security Technology** represents a key element for the financial sector. The industry has also been central to the emergence of a new digital economy, the open banking, which is connected to the European payment services directive (**PSD2**[4]). Customers will therefore look for more suitable and personalised products and services, not being obliged to use what the traditional financial institutions provide to them, and will drive the next wave of growth of the fintech sector.
- For **telecom and media** providers, new technologies and new customer behaviours are generating several opportunities to boost current income sources and generate new revenue

[4] https://ec.europa.eu/info/law/payment-services-psd-2-directive-eu-2015-2366_en

streams. **5G technologies,** for example, are expected to provide many monetisation opportunities for telco, although the pandemic has led to a delay in the technology's rollout as a result of the post-crisis economic condition. **Robotic and Blockchain** reduce error rates, enhance data quality, improve customer service, ensure transparency and efficiency, while also significantly reducing operational costs. The provision of the necessary network infrastructure and **connectivity** for voice, data, media and other related services will become even more important in next years given that businesses have become more distributed than ever after the COVID-19 pandemic. To ensure that their infrastructure will meet the need for digital initiatives in the coming decade, enterprises and service providers are reconsidering how their networks are architected. The increasing volume of personal data gathered in this sector is pushing towards more and more sophisticated **Security** solutions, making it a real priority even among other high-risk industries. Interesting pockets of growth can be found also in investment in other advanced technologies, such as **Photonics** which are supporting the development of fibre optic network communications. As said at the beginning, media transformation process had been driven by changing customer needs and behaviours: innovation in the industry has been driven by new channels and platforms for distributing, accessing and producing content. Streaming, content-as-a service and new technologies for creating engaging entertainment experiences, such as wearables and **AR/VR** technologies, are major trends under the spotlight.

- **Utilities** and **Oil&Gas** show interesting opportunities in terms of many advanced technologies, but the pandemic outbreak inevitably cooled down European utilities' IT spending ambitions. In this context, **Artificial Intelligence** and **cybersecurity** competencies are more requested than ever as a fundamental asset to come out of the current crisis and be ready for the next normal. Hot spots in the industry are the **e-mobility revolution** and **AI-powered home energy management**. Electric vehicles are expected to be a mass-market revolution, driven by increasing sustainability concerns and blurring industry boundaries between power distribution and retail, transportation and automotive. The quest for **alternative and sustainable energy sources** is also paving the way to the use of advanced technologies such as **photonics** and **nanotechnologies** for power generation and for new and more efficient lighting solutions. **Robotics** and **IoT** are fastly spreading in these sectors, increasing productivity, lowering labour costs and, most importantly, keeping workers safe for dangerous tasks, providing a high degree of accuracy and efficiency. The second mass-market revolution is the smart home ecosystem where utilities can play a big role in providing advanced home energy management solutions and automation functionalities using devices such as smart plugs, thermostats and smart lighting for optimising energy consumption but also for getting insights into consumers' habits.
- The **healthcare industry** shows some interesting investments in **AI, Robotics, AR/VR, Nanotechnology and Advanced Materials**, compared to the other industries. Uptake of advanced technology in the industry is strictly linked to the need to innovate and improve patient care, providing integrated and personalised services. The outbreak of COVID-19 has put enormous pressure on many European healthcare systems but triggered an unprecedented demand for digital health technology solutions at the same time. **AI, Automation** and **advanced analytics** are not just solutions to put on top of a technology stack, but the intelligent core of a new enterprise platform. **Robots**, especially for surgery and logistics purposes, are becoming more affordable, and hospitals will start to invest more significantly in the upcoming years. Investments in **wearables, IoT and AI** are growing with the need to monitor patient behaviour and accidents for elderly people with medical conditions to provide prompt emergency help. **AR/VR** devices are helping doctors improve surgery and diagnosis and are also used for therapeutic purposes (e.g. rehabilitation).
- COVID-19 has disrupted the **retail** sector, with different impacts depending on several variables (brick-and-mortar versus online shops, essential versus non-essential stores, small versus large retailers). Overall, the industry impact has been significant although advanced technologies played a key role in supporting organisations in the industry along their COVID reaction initiatives. The **e-commerce** channel, where consumers can finalise their purchases using their PCs or **mobile** phones, remains a priority for retailers and a successful strategy during the COVID-19 pandemic crisis. A key focus of retailers as an immediate crisis response was accelerating the implementation of retail commerce platform capabilities, providing retailers with the foundations for the execution of new commerce everywhere business models. As more customers are switching to mobile commerce, customer assistance and support are also changing. Through **AI-enabled chatbots**, customers can contact companies on social platforms to track shipments, request product refunds or raise complaints. COVID-19 will have a long-lasting effect on customer experience, and in the years to come, it will push retailers to permanently integrate contactless solutions into their customer experience road maps. A

growing opportunity in the industry is represented by **real-time contextual personalisation** for the customer, which allows retailers to shape the customer experience in relation to multiple parameters such as demographics, location, day/time, weather and purchasing patterns. **Advanced Analytics and Big Data** are crucial to achieve this degree of personalisation. **Photonics** is also gaining ground compared to the other industries, helping for example retailers of Consumer Packaged Goods (CPG) and customers to judge the ripeness of fruit and vegetables, and so reduce the percentage of discarded food, or through more dynamic use of displays.

- The pattern of technology adoption by **Government** and **Education** is influenced by the national context and the coronavirus crisis. Public sectors of all countries tried to cope at their best with the current downturn, through massive injection of resources to support the economy and by putting in place multiple advanced technology-enabled emergency solutions. Governments are working to streamline internal bureaucratic processes through **automation** to speed up critical government work, resulting in more agile access services. **AI** solutions will support citizens with the right level of speed, quality and personalisation, while it will provide remote management of the workforce. After the emergency-driven experience of distance learning during the lockdown period, **Education institutions** in Europe are prioritising investments in **mobile solutions**, for example investing in the provision of mobile devices. Lesson are carried out via **distance learning,** with the development of online platforms and e-learning apps for students. At the same time, some changes accelerated by COVID-19 are likely to become permanent: governments are moving towards **permanent remote working**, where secure remote access to data and applications, and collaborative tools enable them to work across departmental silos. **Smart city** projects, combining **mobile, IoT and Big Data/Analytics** solutions, are expected to push investments in technology, especially for safety purposes (such as video surveillance) and for public transport optimisation. **Security** of digital services is therefore a top priority so that both citizens and civil servants can trust their reliability and the stewardship of sensitive data. Another driving trend in the industry is represented by the **open data portals**, with the aim to improve transparency, openness and interaction by sharing public data with citizens.
- Although the pandemic has significantly tested **Professional Services** firms, they reacted with agility, evolving their services and business models to cope with the changing environment. Despite considerable challenges, this sector performed quite well, mainly when they had an adequate technological infrastructure that allowed to continue their daily business processes and operations. Professional services are carrying out their activities in a more agile and flexible way, such as **working from home**, which is supporting investments in devices (laptops, smartphones, tablets), collaborative apps, video linking, cloud and content sharing. Tech providers in this industry will also be on high pressure to provide strong digital platforms and will be required to enhance their existing **cloud solutions**. As a data-intensive vertical sector, an important share of Professional services' investments in security will be driven by the implementation of GDPR (General Data Protection Regulation). This will drive the industry to raise technology barriers to protect client sensitive information and avoid data breaches. The pandemic has changed the relation between customers and services providers but **Big Data/analytics** together with **AI** and machine learning are providing deep analysis of customers, leading to more accurate customers intention prediction and competitive advantage. Digital technologies are changing the industry in their client-facing and back-end activities. For example, advanced technologies will be able to automatically process documents such as legal, shareholder and market reports, impacting positively on timing and freeing staff from tasks that can be automated.
- **Transport** has been one of the main affected industries from the pandemic, squeezed between safeguarding its workforce health and keeping a core transportation system operational. However, this crisis is expected to accelerate the digitisation of mobility. **Cloud** computing and **Big Data/Analytics** are playing a crucial role in collecting, sharing and analysing real-time data, providing an effective way to identify and quantify disruption. These data will also allow restoring adequate transport services accordingly to the increasing demand as we move towards a new normal. Mobility as a Service is offering people an available alternative to get around safely during the pandemic. Other technologies, such as **IoT** and **AI** will keep playing a key role in supporting industry companies to regulate traffic flows, streamline security checkpoints with biometrics such as facial recognition, and reduce the number of lost bags using electronic luggage tags. In logistics, heavy workloads can be eased by introducing solutions to create collaborative environments in which **humans coexist with robots**, with the latter taking over heavy, repetitive and time-consuming tasks.

- The pandemic has exacerbated the challenges **agriculture** was already facing, including increasing demand for food, and lack of workers. This is the reason why this sector has to rely even more on advanced technologies, which will increasingly play a fundamental role in addressing these issues. **Data-driven innovation** is transforming farm management through the so-called **precision agriculture** approach. By leveraging **satellites, drones and IoT sensors**[5] in farm equipment (such as tractors), an unprecedented amount of data can be collected to monitor the conditions of the crops, soil and other key elements for cultivation, as well as cattle. **Cloud computing** – that is finally taking ground in this sector, especially among large players - will help aggregating all the data gathered, allowing farmers to manage irrigation, fertilisation and all the farming processes in a scientific way, minimising costs and the use of pesticides and maximising outputs. Without a solid **Connectivity** infrastructure, a successful application of all these innovations is unthinkable. The digitisation of the farming processes represents also the first step for the emerging food track-and-tracing systems developed to guarantee quality and safety, highly appreciated in the food-agriculture value chain. Advanced technologies show interesting uses also in fighting **climate change and related risks** (such as the loss of arable land and increased urbanisation). For example, a growing trend is represented by **urban or vertical farms,** leveraging technologies to minimise the use of natural resources such as soil, water and energy. This is done by using **IoT** and **Photonics** to manage parameters such as humidity, light and irrigation to get the most out of crops. **Industrial biotechnology** shows also interesting promises for obtaining alternative healthy, protein-rich and nutritionally balanced food raw material responding to increasing population and food demand.

This overall picture of advanced technologies' deployment in the European industry is to a certain extent reflected by the analysis of the demand and supply of advanced technologies' skills carried out in the report on the General Findings within the framework of the present project[6]. In terms of skills supply, and based on the profile of registered users on LinkedIn, the share of advanced technology skilled professionals (vis-à-vis the total number of professionals) in selected industries reveals that Europe's manufacturing industry absorbs the highest number of skilled professionals. This is particularly true for the Automotive sector where technologies such as Advanced Manufacturing and IoT are clearly instrumental for the development of Industry 4.0 strategies.

Other industries such as Electronics and, to a lesser extent, Chemicals, employ a large amount of skilled professionals, especially for technologies like Advanced Manufacturing and IoT (in Electronics) and Advanced Materials and Industrial Biotech (in Chemicals), confirming that manufacturing as a whole remains at the forefront of the the digital transformation and modernisation processes in the European Union.

In terms of skills demand, manufacturing exhibits high levels of hiring positions measured by the number of online job advertisement requiring specific skills. Again, the Automotive sector requires specific skills in Advanced Manufacturing, AI and Robotics, just like the Electrical & Electronics exhibits strong demand of skills in Advanced Materials, Micro-nanoelectronics, nanotechnologies and Robotics. The prominence of the Manufacturing industry is challenged only by the Finance sector where, both in Banking and Financial Services, specialised skills for Big Data, Blockchain, Cloud Computing and cybersecurity are very much in demand across the European Union

[5] ATI Product Watch (D3.6) "Satellites and drones for less intensive farming and arable crops", January 2021, https://ati.ec.europa.eu/reports/product-watch/satellites-and-drones-less-intensive-farming-and-arable-crops

[6] ATI General findings (D3.4), Section 5, June 2020, https://ati.ec.europa.eu/reports/eu-reports/report-technology-trends-technology-uptake-investment-and-skills-advanced. An updated version of this report including the AT skills analysis will be published this year (2021).

Section 2

2 Technology Focus: Data sharing

2.1 Definition and Scope

Data is an essential resource for economic growth, job creation and societal progress

Over the past years, digital technologies have reshaped our lives drastically, at an economic level as well as a societal level.[7] Without a doubt, data is at the heart of this development as one of the most powerful factors in a digitalised and interconnected world. In connection with proper analytics, data is crucial for making informed decisions and is rapidly becoming the backbone of both the public and the private sector.

The amount of data is expected to grow, creating opportunities for businesses

Though we have already witnessed enormous growth in the amount of data collected and published, the amount of data across the world is expected to further increase exponentially, with new market players, large operators and smaller niche actors. Indeed, according to recent research conducted by IDC on behalf of European Commission, by 2025, the global data volume will have increased by 530% and the data economy of the EU27 will reach a value of €829 bn (from €301 bn in 2018).[8] This continuous growth in the amount of data and the technologies utilised to store, manage and analyse these data make up what is called 'Big Data'. This phenomenon is a combination of hardware and software that allows for the integration, organisation and presentation of data and concerns datasets of high volume, high velocity, high variety and high veracity. In order words, this technology deals with large amounts of high-quality data of various types and sources, which have to be processed at high speed. Due to this complexity and multifaceted nature this field opens up opportunities for business and technology across the supply chain and impacts not just those businesses and the tech domain, but society at large. Besides, the manner in which we process and store data will likely change fundamentally. Currently, about 80% of data processing and analysis takes place in data centres, compared to 20% in smart objects like cars, robots or appliances. Within the next five years, this ratio is expected to be reversed.[9] Furthermore, in the run-up to 2025, the amount of data supplier companies and data user companies that deal with this information will increase by 2.5%, respectively, 1.4%.[10] This presents not only an enormous potential for businesses to create tools for those that are producing and controlling data, but also for the EU to become a global leader in this field.[11]

Potential of data can only be unlocked when shared

Data holds enormous potential in various fields, from health, food security, climate and resource efficiency to energy, intelligent transport systems and smart cities – and is therefore considered "an essential resource for economic growth, job creation and societal progress" by the European Commission. However, currently, a few Big Tech firms hold the majority of the world's data, making it difficult for novel data-driven businesses to arise and expand. By sharing data, its potential can be further unlocked.

Data sharing is a collection of practices enabling the exchange of information to derive tangible benefits

Though we use the term 'data sharing' as a general notion, there still is no universally accepted definition of what 'data sharing' or 'shared data' is, as names are used interchangeably. It is not uncommon for it to take time before one of the many possible names and definitions of a new technology or practice becomes mainstream. Typically, with the term 'data sharing', we refer to the collection of practices, technologies, cultural elements and legal frameworks that are relevant to transactions of digital information between different kinds of organisations. The focus here is on the *practice of data sharing*

[7] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1593073685620&uri=CELEX%3A52020DC0066
[8] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en#projected-figures-2025
[9] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1593073685620&uri=CELEX%3A52020DC0066
[10] https://datalandscape.eu/sites/default/files/report/D2.9_EDM_Final_study_report_16.06.2020_IDC_pdf.pdf
[11] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1593073685620&uri=CELEX%3A52020DC0066

rather than the content, i.e. the actual *data*. Usually, the type of data concerned is in the hands of the public or the private sector and shared with other organisations or governments for use and re-use.

From a technical point of view, data sharing solely implies the ability to share the same data resource with multiple applications or users. From a more general perspective, data sharing can be described as the concept of sharing vital information, details, statistics or insights across people, organisations and countries to create a more efficient coexistence.[12] A universal element though is the effort to derive tangible benefits and usage from data. Sharing data can facilitate a more efficient and transparent process, create new opportunities and spur innovation.[13] In doing so, the practice enables the exchange of information and creates transparency in the data chain.[14]

Data Technological developments have changed the way we share data

Data sharing is not new. Individuals, organisations and governments have been sharing information since before computers and networks existed. Over the last decade, however, progress in digital literacy and skills, technology and the adaptation of legislative frameworks to the digital space has enabled data to be shared faster and at an unprecedented scale. Several developments have led to the sea change that can be grouped into three aspects.

Firstly, there is increased availability and quality of data. It is relatively affordable and easy today to store, process and transfer data. Secondly, the culture has changed. Today we understand data better, we are ready to see it as a resource and to invest in it – and this applies to governments, private organisations and individuals alike. Thirdly, policymakers understand better than in the past the implications of digital in people's lives and the underlying potential of data and are committed to empower and regulate data sharing. Awareness of the opportunities and risks of data sharing is integral to this process.[15]

Combining these three aspects creates a huge space of opportunities

- Organisations and public authorities can share more data between them in a way that is secure, fair, lawful and respectful of the rights of those that the data concerns.
- Combining data from different sources improves the performance and value of services by orders of magnitude. It enables better research and development and the delivery of better products.
- Sharing data enables unprecedented collaboration and data-driven decision-making, informing policy and amplifying social impact.[16]

Opening up and sharing data enables AI technologies

The amount and availability of data are also re-defining the possibilities of technologies. Across industries, we witness technologies powered by Artificial Intelligence (AI) growing and improving. Today we have smart watches that recognise driving behaviours and determine the destination without having been prompted. Alexa or Google Home can recognise lighting and heating habits. Insurance companies or banks run algorithms to determine your credit and risk profile. Datasets are the lifeblood of all of these Artificial Intelligence examples. Global platforms such as Google and Facebook dominate access to personal data.

Several data sharing models and frameworks exist and open data is one of them

There are several models of data sharing depending on the stakeholders involved and the goal of sharing data.

- **Multi-party data sharing agreement**: the traditional model where several parties, one of which at least is a public body, define the set of data, the 'requesters of data', and the 'suppliers of data' in a contractual format.

[12] https://www.lotame.com/sharing-data-within-organisation/
[13] https://www.tno.nl/en/focus-areas/information-communication-technology/roadmaps/data-sharing/
[14] https://eudatasharing.eu/examples/data-sharing-agricultural-sector
[15] https://ec.europa.eu/commission/presscorner/detail/en/IP_20_2102
[16] https://eudatasharing.eu/what-data-sharing

- **Data donorship**: regarded as a form of corporate social responsibility, i.e. data shared pro bono to serve the greater good.
- **Data partnerships**: typically, in a research or academic setting where mutual interests exist, e.g. in transport services or the pharmaceutical industry.
- **Data intermediaries**: in a scenario where trust is of the essence, a third party (intermediary) is involved to process the shared data, e.g. to gain knowledge about a given phenomenon without either party having access to all data.
- **Data sharing by regulation**: obligatory format where the government regulates, e.g. in the health, pharma, chemical manufacturing or financial sector.

When talking about data sharing, we would be mistaken if we did not address open data. Open data is for sure the pioneer of data sharing, and still one of the most valuable sources of information in a shared data environment. Open data is by definition free of charge and accessible to everyone. A key example here is the data made available by Copernicus. This programme, managed by the European Commission, acts as the main European system for monitoring the earth, and is currently the largest open space data provider in the world.[17]

The potential of data reveals itself only when data is shared

Insufficient data sharing and re-use is a major barrier to the realisation of its potential and the implementation of advanced AI. Even the most actionable and remarkably useful data is a waste if the involved parties are not making use of it. Thus, the true power of data reveals itself only when data is shared, whether it is governments publishing data for its citizens to re-use (e.g. traffic, weather or census data) or businesses, sharing data between them to work together (research or design). Data that may seem futile at first sight can be very valuable to somebody else. Handled efficiently, data has the power to transform the way governments, companies and citizens interact and shape the future of a digital age.

The European Commission aims to ensure data accessibility and re-usability to support data sharing in Europe

At the same time, the EU and its Member States face important challenges on their way to translating data into business opportunities, such as legal issues (including access and usage rights as well as liability) and technical barriers to the reuse of data[18].

To adress these challenges, the European Commission's 'European data strategy' commits to investing in innovative tools and infrastructures to store and process data and giving users rights, tools and skills to retain control over their data.[19]

The Commission considers data more and more to be a building block for economic growth, competitiveness, innovation, job creation and societal development and expresses its importance in the latest EU Digital strategies[20]. In making sure data is exploited to its full potential, the EU aims to ensure that data is accessible and reusable by stakeholders to create a powerful economy shaped by technology and in line with European values.

Recently the European Commission has released a proposal for regulation on data governance, laying out a set of measures announced in the 2020 European strategy for data[21]. The goal of this proposal is to improve access to data that is suitable for reuse through increasing trust and fostering data-sharing mechanisms across the EU.[22]

2.2 Market Potential

In the previous section we have introduced data sharing as a vital resource for economic growth and societal progress, and therefore one of the main pillars of the European Commission's strategy for the

[17] https://www.copernicus.eu/en
[18] https://digital-strategy.ec.europa.eu/en/policies/data-governance
[19] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy#examples-of-industrial-and-commercial-data-use
[20] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/shaping-europe-digital-future_en and https://digital-strategy.ec.europa.eu/en
[21] https://ec.europa.eu/digital-single-market/en/news/proposal-regulation-european-data-governance-data-governance-act
[22] https://ec.europa.eu/digital-single-market/en/news/proposal-regulation-european-data-governance-data-governance-act

future digital economy. In this segment, we explore the potential of data sharing in economic terms. That is, how the market benefits from the adoption of data sharing and respective industry trends. Additionally, we present some of the main barriers and challenges to successful data sharing.

2.2.1 Adoption and Industry Trends

Data sharing as a key driver for innovation in growth areas such as individual health, smart energy, digital retail and future mobility

Data is a key enabler of growth, employment and competitiveness for Europe across major industries.[23] The non-rivalrous nature of data combined with technological innovations such as the availability of big data analysis tools and artificial intelligence applications open up the possibility of maximising the value resulting from data. As an example, according to an SME panel consultation by the European Commission in 2019, over 30% of the SMEs consulted are actively collecting data from other companies and use or will use connected objects such as smart, industrial robots or other Internet of Things applications.[24] In a same fashion, a study[25] conducted on behalf of the European Commission a few years ago found that 39% of Europe's companies share data with other organisations, although this exchange seems to happen primarily among large companies and mostly witin their own business sector. The Internet of Things, mobile health, online retail, smart energy, Industry 4.0, connected cars and the future of insurance all rely on actionable insights as a key component to make the promise real. Data is now at the very heart of their digital transformation. This equally applies to the public sector, where more documented and real-time decision making can be achieved, as well as further tailored services for businesses and citizens. Furthermore, research and informed decision-making can be improved by services in the form of apps and websites, by new products and processes that increase productivity and efficiency, wellbeing, health, safety and sustainability.

The data market and economy are projected to grow up despite COVID-19

Quantifying the economic impact and the respective portion of data sharing is complex because the most important and significant benefits are indirect and often emerge over time. Change in the domain turns out to be incremental and not immediately visible because it is subtle and sometimes well hidden.[26] However, several studies have attempted to quantify the data market. In 2017, the SMART 2013/0063 study by the European Commission already predicted the data market to grow exponentially.[27] The profits obtained from Internet of Things related hardware, software and services for example were expected to increase from €307 bn in 2013 to roughly €1 181 bn in 2020.[28] Data sharing being an enabler to these technologies, its impact seems straightforward. The European Data Strategy laid out by European Commission estimates the size of the 'data economy' to be €829 bn in the EU27 in 2025[29].

Admittedly, this scenario does not consider the impact of COVID-19. However, the European Data Monitoring Tool also provides estimates for a scenario where the pandemic is factored in and according to a post-COVID-19 scenario, the European Data Market is expected to increase to €80 bn and the Data Economy will grow to €516 bn.[30] Though these estimates are lower than those for pre-COVID-19 scenarios (€82.5 bn, respectively, €550 bn) most of the enablers of data-driven innovation will demonstrate resilience and an ability to overcome the crisis. It is likely that the eagerness to invest in technologies to re-establish services and build new products will restore and further drive demand.[31]

Sharing open data has a potential for cost reduction as well as efficiency gains

Substantial research on the economic value of sharing open data exists, as open data is a comparably mature field of data sharing. The most recent example is 'The Economic Impact of Open Data" report'[32] which quantifies the benefit of sharing open data in economic terms, specifically reporting metrics such as market size, the potential for cost reduction and potential for efficiency gains. According to this

[23] https://www.europeandataportal.eu/sites/default/files/the-economic-impact-of-open-data.pdf
[24] https://ec.europa.eu/digital-single-market/en/news/sme-panel-consultation-b2b-data-sharing
[25] Study on data sharing between companies in Europe, European Union 2018 https://op.europa.eu/en/publication-detail/-/publication/8b8776ff-4834-11e8-be1d-01aa75ed71a1/language-en
[26] https://www.europeandataportal.eu/sites/default/files/the-economic-impact-of-open-data.pdf
[27].https://ec.europa.eu/digital-single-market/en/news/smart- 20130063-study-european-data-market-and-related-services
[28] https://ec.europa.eu/digital-single-market/en/news/smart-20130063-study-european-data-market-and-related-services
[29] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en
[30] https://datalandscape.eu/sites/default/files/report/D2.9_EDM_Final_study_report_16.06.2020_IDC_pdf.pdf
[31] https://datalandscape.eu/sites/default/files/report/D2.9_EDM_Final_study_report_16.06.2020_IDC_pdf.pdf
[32] https://www.europeandataportal.eu/sites/default/files/the-economic-impact-of-open-data.pdf

report, open data market size is currently valued at €184.45 bn for the EU27+ countries[33, 34] and has the potential to reach €199.51 or €334.20 bn in 2025, depending on the scenario. In terms of cost reduction, there is great potential in data sharing across various sectors. In healthcare, for example, €3.7 – €5.2 bn costs can be saved due to better allocation of resources to combat malaria. And €312 - €400 thousand healthcare cost can be saved because first responders can administer Cardiopulmonary resuscitation (CPR) before the arrival of emergency services due to open and shared data.

Regarding environmental costs, €5.1 bn can be saved on energy bills due to reduced household energy consumption. In terms of efficiency gains, data sharing can help save €79.6 bn in electricity bills due to more efficient use of solar panels on rooftops.

In a broad sense, the impact of data is analogous to infrastructure in its effect on the economy

To understand the impact of open data and data sharing beyond efficiency gains and cost reduction we need to consider data analogous to infrastructure in terms of its effect on the economy, i.e. the one enables the other. Its impact cannot be measured by simply taking into account the costs for e.g. the construction of roads, canals, airports, train stations and revenues created by tolls. The value lies in the fact that people, organisations and products are enabled to move from A to B as well as in people, organisations and products that are needed and used to do so.[35] In this light, data enables faster and easier access to more information, which makes for more informed decisions. Moreover, re-using data can improve existing products and services or be used to develop new ones. Especially for small and medium enterprises and start-ups, which normally may not be able to acquire access to data or generate similar data themselves, this opens up a range of opportunities.[36] Managing and effectively sharing data within a single organisation already hugely improves the way the data is analysed and increases the value of the data itself. It can be re-used, processed and provide different insights for different people across several organisational departments. Even on this small scale, the benefits of data sharing are almost incalculable. Scaling this up to the national and international level across all sectors opens up unique opportunities and ensures Europe's future leading position.[37]

2.2.2 Main Barriers and Challenges

The recently released proposal for a regulation on data governance mentioned earlier lays out a set of measures first announced in the 2020 European strategy for data[38]. This development facilitates easier reuse of public sector data, the removal of the monetisation of sharing of data between businesses and the protection of personal data by allocating a 'personal data-sharing intermediary' to individuals.[39] This is a significant achievement for Europe in becoming an increasingly data-driven economy and to further overcome barriers to large scale implementation of data sharing. To unlock the potential of data sharing, businesses and organisations must be aware of these barriers in order to overcome them. In this section, the main challenges are outlined.

- **A lack of technological knowledge.** Though organisations and companies alike might be motivated to share data, they might lack the technical skills or knowledge to do so. There can be considerable complexity and cost in data that is collected, processed and analysed.
- **A reluctance to sharing public sector information.** The INSPIRE directive, an initiative designed to generate a European spatial data infrastructure for environmental policies, concluded that – although government agencies are committed and motivated to share data– in practice this proves to be difficult[40].
- **The presence of local regulations.** In terms of open data, in the implementation of the Public Sector Information (PSI) Directive, several EU Member States and regions have introduced local

[33] https://www.capgemini.com/resources/egovernment-benchmark-2020/
[34] The term 'EU27+ countries' refers to the following 36 countries: the 27 European Union Member States, as well as Albania, Iceland, Norway, Macedonia, Montenegro, the Republic of Serbia, Switzerland, Turkey, and the United Kingdom.
[35] https://www.europeandataportal.eu/sites/default/files/the-economic-impact-of-open-data.pdf
[36] https://www.europeandataportal.eu/sites/default/files/the-economic-impact-of-open-data.pdf
[37] https://ec.europa.eu/info/sites/info/files/strategy/decision-making_process/documents/ec_digitalstrategy_en.pdf
[38].https://ec.europa.eu/digital-single-market/en/news/proposal-regulation-european-data-governance-data-governance-act
[39].https://ec.europa.eu/digital-single-market/en/news/proposal-regulation-european-data-governance-data-governance-act
[40] https://www.europeandataportal.eu/sites/default/files/analytical_report_17-form_regulation_adoption.pdf

regulations which makes it difficult for data users to know which policies and regulations they should adhere to[41].

- **Lack of commitment from the scientific domain.** Surveys suggest that scientists do not share data regularly or in a consistent format or model. Although funding agencies' regulations aim to tackle this problem, its effects do not always appear effective[42].
- **Reluctancy to share company data, putting the competitive advantage at risk.** When it comes to the private sector, companies are reluctant to share data[43]. The newly released Payment Services Directive (PSD) 2 regulation for example – requiring banks to be able to share data with third parties for the development of new value-added financial services – encounters resistance from the point of view of banks in releasing their data[44].
- **Lack of quality.** Also, there exist barriers to data re-use such as low data quality, unclear and unstandardised metadata describing it, lack of clarity about its licensing, lack of suitable infrastructure enabling discoverability and accessibility (see the European Data Portal's 'Analytical Report 11: Re-use of PSI in the public sector' for more detail)[45].

2.2.3 Use Case and Business Opportunities

The practice of data sharing and the asset of open data can be applied across industries and to multiple business processes, thus generating a wide variety of opportunities. Because the economic impact is complex to quantify due to its indirect nature and network characteristics, we exemplify the impact via use cases. In this section of the report, we highlight data sharing use cases, representing business opportunities for both the providers and the re-users. A use case is defined here as an example of the implementation of data sharing to achieve a business or societal objective. The identification of the main use cases of any new technology helps pinpoint its market and business value and to track users' choices and priorities.

Data Sharing in Research

A key European use case of data sharing in a research environment is European Open Science Cloud (EOSC)[46] [47]: an open data platform for the scientific community. Initiated in 2015, this initiative has created an open platform to store, share, process and reuse research documentation (including data, publications, software) across borders and scientific disciplines. Bringing together stakeholders (on institutional, national and international level), initiatives and data infrastructures, a European open science ecosystem has been developed which supports improved reproducibility in science, improved availability of new insights, and higher research productivity. It aims to realise a web of FAIR data and services, supporting data to be interoperable and machine actionable following the FAIR guiding principles: Findability, Accessibility, Interoperability and Reusability.[48]

EOSC offers the possibility to access and reuse all publicly funded research data in the EU and is an enabler of open science and of the digital transformation of science. As such, EOSC leverages national investments and adds value in terms of scale, interdisciplinarity and faster innovation. EOSC is being recognised as being the key data space initiative for science, research and innovation in the European Data Strategy[49] and it supports the EU Open Science policy.[50]

The EOSC Portal[51] provides access to scientifical data in sectors that currently include medical and health, natural sciences, physics, earth sciences, arts, humanities, agriculture and engineering. Through the portal, researchers and professionals are able to access open data, services and other resources from a wide range of national, regional and institutional public research infrastructures across the EU, enabling them to perform their work more quickly and disseminate research results wider. The portal is

[41] https://www.europeandataportal.eu/sites/default/files/analytical_report_17-form_regulation_adoption.pdf
[42] https://www.europeandataportal.eu/sites/default/files/analytical_report_17-form_regulation_adoption.pdf
[43] https://www.europeandataportal.eu/sites/default/files/analytical_report_17-form_regulation_adoption.pdf
[44] https://www.europeandataportal.eu/sites/default/files/analytical_report_17-form_regulation_adoption.pdf
[45] https://www.europeandataportal.eu/sites/default/files/analytical_report_11_psi_re-use_in_the_public_sector.pdf
[46] https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science/european-open-science-cloud-eosc_en
[47] https://digital-strategy.ec.europa.eu/en/policies/open-science-cloud
[48] https://www.nature.com/articles/sdata201618
[49] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en
[50] https://ec.europa.eu/digital-single-market/en/open-science
[51] https://eosc-portal.eu/

currently being enhanced to make it more inclusive, to cover all phases of the research cycle, to cover all scientific communities and to widen the user base to the public and private sector.[52]

From a data sharing perspective, another compelling use case of shared data in a research environment is Social Science One. Compelling for its utilisation of a big tech company owned dataset for advancements in research and social good.

This project establishes a data sharing partnership between the private sector and academia to understand and solve some of the big societal challenges we face today. By providing researchers with access to information from the private industry in a way that is responsible and socially beneficial, more and better analyses can be executed. On the other hand, it enables the companies that offer data to generate social good, without losing their competitive advantage.[53]

Born in response to the 2016 US elections, Social Science One was initially a partnership between researchers and Facebook, who held the so-called 'URLs dataset' and were looking for ways to analyse the effects of social media – particularly Facebook - on democracy and elections. This 'URLs dataset' consists of roughly 38 million URLs of posts that gain a lot of traction in terms of views, shares, likes, reactions, etc. Additionally, it included detail such as the country they were shared in and whether or not they were fact-checked or flagged as hate speech and the aggregated data regarding the background of people who responded to the URLs.

Here, Facebook acts as a data provider and researchers use the dataset for their analyses. In turn, Social Science One Acting acts as an independent intermediary that connects the parties, assesses research proposals put forward by the academics on scientific merit and releases authorisations accordingly.

From a legal perspective, the main difficulty was getting Facebook's legal department to feel comfortable in sharing their data. From a technical perspective, the main challenge was ensuring Facebook users' privacy. A method called 'differential privacy/ was used to achieve this, as this manipulates a dataset in such a way that the statistics remain unaltered, though the data point cannot be traced back to the original Facebook users.

Social Science One is unique in that it offers an incentive to a big tech company to release its data, thereby benefiting society rather than offering economic gain. Moreover, historically governments and universities were the prime locations for valuable data for social science research but this has significantly changed with the advent of social media. Digital platforms today have a better perspective on social behaviour than anyone else. This initiative nicely demonstrates how academia can collaborate with these platforms and how they can make a big difference in the world.

Data Sharing in Agriculture

Examples of data sharing practices in agriculture are abundant but in the Dutch setting, one of the most well-known examples is JoinData, an initiative connecting all players involved in the agri-food chain.

Today, farms create a wealth of data as machines are equipped with sensors measuring ground conditions, temperature and water usage. Pest developments can be monitored and GPS-guided tractors produce data about the dimensions of the fields, the positions of obstacles and crop positions.[54] In combination with meteorological data and artificial intelligence technologies, these data can predict droughts and diseases, not only for crops but also for cattle through data from milk machinery.[55] This potential can only be unlocked, however, if the data is shared. Besides, the data from individual farms might not even be interesting to examine as they reveal nothing particular by itself, but aggregating data over thousands of farms might show interesting patterns.

Though data sharing is not new in the agricultural sector, i.e. application developers, hardware suppliers, agribusinesses and banks are often already involved in data sharing initiatives, JoinData was founded in the Dutch setting where data is still contained in silos and sharing only occurs between groups that have a long-standing tradition of doing so. JoinData addresses this fragmentation but at the same time leaves control in the hand of the farmers. In agriculture, this is not necessarily a given, as data from

[52] https://eosc-portal.eu/enhance
[53;36] https://eudatasharing.eu/examples/social-science-one-and-facebook-urls-dataset
[54] https://eudatasharing.eu/examples/data-sharing-agricultural-sector
[55] Ibidem

milk machinery, for instance, could be shared with the machinery's producers without the farmers being aware of it.

The solution that JoinData provides is a digital platform that facilitates secure data sharing where data providers have the option of sharing data with interested parties. Farmers control which data is shared with whom and for which purpose through granting permission and explicit authorisations. Alternatively, laboratories can share their data with application developers, who can, in turn, merge it with different farms' data to create new software. Ultimately, the users of data are permitted to use it according to pre-agreed terms and conditions. This way, control over the data is left entirely in the hand of the farmers.

JoinData in this sense benefits the entire value chain. From the perspective of farmers, sharing data helps them gain new insights but also remain in control over their data. Moreover, the innovation that is developed through the data helps them run their business more efficiently and effectively. On the other end, application developers capture the potential of the data through easy access to thousands of different data sources.

The JoinData initiative is a prime example of an application of sharing data that leads to developing novel and better products, discover patterns and at the same time leaves control in the hand of those who produce the data thereby unlocking the potential of data and revolutionise the agricultural sector.

Data Sharing in Smart Mobility

In the smart mobility realm, the amount of use cases of data sharing – and also open data – is astonishing. Although numerous metropolises present mobility services utilising shared data, a well-known example that covers a very wide domain of services is MaaS Madrid, which we focus on here.

In cities across the world, many public and private mobility companies exist that specialise in different services or modes of transportation, for instance, subways, buses, trains, trams, bicycles and cars. In metropolitan cities such as Madrid, Amsterdam, Prague or Helsinki this is particularly the case. Several studies have found that in most metropolitan cities many people are not aware of the different public transport offers in their city. For example, the Spanish association for public transport operators – Asociación de transportes públicos urbanos y metropolitanos (ATUC)[56] – published a report in 2017 that found that in cities with more than 1 m inhabitants there is a high percentage of people that are either unaware or have limited knowledge about the public transport services offered in their city.[57] This lack of awareness and difficulty in finding information about the different public transport options in a city can inhibit citizens from using it, thereby increasing private car usage and leading to traffic jams and poor air quality.[58]

Zooming in on the case of Madrid specifically, there are roughly 70 mobility operators with services such as buses, trains, trams, cars, e-scooters, bicycles and motorcycles. Of these, 41 are public transport operators while the others are private shared-mobility operators such as Coup, Car2Go, Muving, Emov and VOI. [59]

Combining the information of these various services and efficiently coordinating them is a challenge due to the sheer abundance of providers. To facilitate smooth coordination between the mobility operators nonetheless, the regional transport authority Consorcio Regional de Transportes de Madrid (CRTM)[60] developed, in collaboration with the municipality's public transport company Empresa Municipal de Transportes de Madrid (EMT Madrid)[61], a multi-modal platform: Mobility as a Service (MaaS Madrid).

MaaS Madrid[62] offers the official mobile app of EMT Madrid and aims to encourage sustainable mobility in the city. As a collaborative initiative between businesses and government bodies, it enables users to access itinerary information in real-time directly from various mobility operators on a single integrated platform, including a travel planner where users can find the fastest travel options based on their preferences, purchase history and payment options.[63] As the involved private and public organisations share their data, citizens and tourists have more accurate and timely information

[56] https://www.atuc.es
[57] https://www.idae.es/publicaciones/estudio-sobre-habitos-y-actitudes-de-los-no-usuarios-habituales-hacia-el-transporte
[58] https://eudatasharing.eu/examples/data-sharing-smart-mobility
[59] https://eudatasharing.eu/examples/data-sharing-smart-mobility
[60] https://www.crtm.es/
[61] https://www.emtmadrid.es/Home
[62] https://play.google.com/store/apps/details?id=com.emt.maas&hl=en
[63] https://eudatasharing.eu/examples/data-sharing-smart-mobility

relatively easily at their disposal. New data-driven services can provide users with information on the duration of a trip, the cost for different options and calculate which route is the fastest or cheapest.[64]

Though this has a clear benefit from a user perspective, the City of Madrid reaps the benefits of this data sharing platform as well. The platform collects aggregated, anonymous and real-time data that can be utilised to improve city planning. This aggregated data enables the municipality to improve Madrid's infrastructure, reduce road congestion and update its public transport services to tailor to the needs of its citizens and tourists.[65] In this sense, MaaSMadrid presents a clear application of how data sharing can work as a business model, benefiting all parties involved.

Data Sharing in Manufacturing

Though not an example of a company or a use case example, data sharing in the manufacturing sector is worth mentioning in this section as this is one of the biggest drivers of industrial innovation and competition. Advanced analytics and applications of Artificial Intelligence dominate production today and manufacturers are at the forefront of this development. However, implementing technology at scale proves difficult as companies tend to keep their data in-house.

A recent white paper by the World Economic Forum describes several ways in which data sharing benefits manufacturers and supports effective sharing to unlock the hidden value of data.

Firstly, data sharing improves asset optimisation. This is especially true for artificial intelligence solutions that run on vast amounts of data. By combining data from sensors of various machines, the algorithms that predict maintenance or ensure product quality can be significantly improved.[66]

Secondly, product tracing becomes easier through end-to-end visibility. Typically, an overview of the supply chains is held by an individual manufacturer. Yet if this information is shared and companies collaborate, the entire chain can be visualised and unexpected events and stock problems will become less prevalent. This extends to regulatory requirements, which become more transparent when shared as well. Permanent access and the presence of a digital record of supplies enable all involved parties to keep track of the production processes and conditions and whether or not they are followed.[67]

Furthermore, data sharing facilitates the exchange of product details such as shape and composition. This helps manufacturers align with and improve the production process and create a 'digital product twin', which is particularly useful for quality checks.[68]

Finally, provenance can be verified as a result of shared data. There is an increasing demand from customers to verify the authenticity of products and track their origins. By exchanging information on parts and supplies, transparency improves and authenticity can be guaranteed.[69]

Open Data – EU and National Portals

One of the most comprehensive examples of data sharing in a public sector setting are national and European (open) data portals. The European Commission has recognised the value of open data and data sharing, which is reflected not only in strategy but also by the creation of two major data hubs, i.e. The European Union Open Data Portal (ODP) and the European Data Portal (EDP). While the first is a central place for open datasets across the EU, the latter harvests national open data portals and provides meta-data on open datasets as well as case studies and examples of data re-use.[70]

Data can be made available and discoverable in many ways and these European open data portals, as well as dedicated portals of public institutions or even regional and national open data portals, are prime locations for doing so. Generally, these national portals make open data from public institutions and government bodies in the country discoverable. These national open data portals are created and managed by a national open data team. Apart from being responsible for the portal, they are typically also tasked with coordinating open data initiatives throughout the country, creating supporting materials to publish and re-use open data, offering trainings or workshops to those working in the public domain, and promoting of open data and re-use events.[71] On the European Data Portal, a library of over 700

[64] https://eudatasharing.eu/examples/data-sharing-smart-mobility
[65] https://eudatasharing.eu/examples/data-sharing-smart-mobility
[66] http://www3.weforum.org/docs/WEF_Share_to_Gain_Report.pdf
[67] http://www3.weforum.org/docs/WEF_Share_to_Gain_Report.pdf
[68] http://www3.weforum.org/docs/WEF_Share_to_Gain_Report.pdf
[69] http://www3.weforum.org/docs/WEF_Share_to_Gain_Report.pdf
[70] https://www.europeandataportal.eu/en
[71] https://ec.europa.eu/digital-single-market/en/open-data-portals

case studies of open data re-use are assembled and well documented. By providing access to datasets on a national and European level and providing the infrastructure needed to make data both published and discoverable, these portals contribute greatly to the use and re-use of open data.[72]

The data sharing agreement for healthcare data between Estonia and Finland is another compelling example of data sharing in the public domain, and demonstrates the benefit of cooperation between Member States. As of 2019, this agreement allows patients to use digital prescriptions issued by their home doctor when visiting a pharmacy in another EU country. Now, Finnish and Estonian patients can make use of this service, but the eHealth Digital Service Infrastructure[73] that facilitates this exchange is being progressively introduced in all EU Member States. The infrastructure allows health data to be shared in a secure, efficient and interoperable way and offers services such as ePrescription and eDispensation of medicines and access to patient's medical background information across borders.[74]

2.3 Social and Sustainability Impacts

In previous sections, we have addressed the benefits of data sharing in economic as well as practical terms and provided practical examples of use cases. In this section, we focus on the societal and environmental impact of data sharing addressing how the technology increases energy efficiency and biodiversity, improves health care and contributes to the United Nations Sustainable Development Goals[75].

Data sharing supports humanitarian services

Starting with the UN Sustainable Development Goals (SDG), an example is put forward by the case of Twitter, which provides UN Global Pulse with access to their data tools to support efforts to achieve SDGs, which were specified in 2015. Tweets can contain real-time information on topics such as the cost of food, the availability of jobs, access to health care, quality of education or reports of natural disasters. Tweets are available in the public domain yet Twitter's tools to access and analyse content are typically only commercially available to third parties. This partnership allows the humanitarian services of the UN to utilise these social conversations into actionable information, supporting communities around the globe.[76]

Data sharing fosters an inclusive and collaborative social environment

From a social perspective, data sharing is a model for a collaborative framework with high social involvement. This is demonstrated by the Social Science One example mentioned earlier, which clearly shows how social data can be used to shed light on the workings of elections and democracy.[77] From a societal perspective, individuals that actively participate in a data-driven environment are also better prepared for socio-economic challenges such as demographic change or poverty, as data sharing enables the inclusion of marginalised groups. For instance, in several Austrian cities, new applications and services have been developed to facilitate the movement of disabled people through the re-use of Open Data, including the location of car parks for disabled people or maps of accessible public transport stations[78]. Additionally, the level of equality in a society can be increased as a result of enhanced citizen participation. Moreover, this reduces the need for traditional policy-making processes where reports have to be produced by those who control the data. Now citizens can examine and draw conclusions about the data on their own account.[79]

There is a large potential for improving health care due to open data

Another meaningful example of how data sharing through open data positively impacts society is through increased efficiency in health care. Looking at the Economic Impact of Open Data report by the European Data Portal[80] we find that 54 - 202 thousand lives can be saved as a result of emergency

[72] https://www.europeandataportal.eu/sites/default/files/the-economic-impact-of-open-data.pdf
[73] https://ec.europa.eu/health/ehealth/electronic_crossborder_healthservices_en
[74] https://ec.europa.eu/commission/presscorner/detail/en/IP_18_6808
[75] https://sdgs.un.org/goals
[76] https://www.un.org/sustainabledevelopment/blog/2016/09/twitter-and-un-global-pulse-announce-data-partnership/
[77] https://socialscience.one/
[78] https://www.data.gv.at/anwendungen/barrierefrei-parken-salzburg/
[79] https://www.europeandataportal.eu/sites/default/files/the-economic-impact-of-open-data.pdf
[80] https://www.europeandataportal.eu/sites/default/files/the-economic-impact-of-open-data.pdf

services arriving at the scene of an incident one minute faster, and 290 - 400 thousand lives can be saved due to better allocation of resources to combat malaria globally.[81]

Access to real-time necessary information enables a faster response when someone needs medical assistance. In the United States, it was estimated that opening up private healthcare databases could have saved 90 000 people from suffering unnecessary heart attacks and could have prevented 25 000 deaths in the United States alone[82]. In Europe, based on the number of citizens having a cardiac arrest outside the hospital and the percentage that received CPR from bystanders, 7 000 lives a year can be saved only by introducing applications that make it possible for bystanders to be at the emergency location one minute earlier.[83]

Open data drives innovation in the private sector and creates transparency in the public domain

Furthermore, data sharing – specifically in the case of open data – opens up a potential for collaboration between the public and the private sector. This can already be observed for instance through hackathons, where private sector entrepreneurs work on specific challenges based on publicly available datasets. Regarding public sector data, the potential of sharing data can be observed in the increased transparency and accountability. Several applications in Romania exist to combat corruption by showing how taxpayer's money is spent, clearly increasing transparency on government spending.[84]

Data sharing contributes to more sustainable energy consumption

Apart from social benefits, data and the practice of sharing data also has the potential to contribute to a more sustainable environment. For instance, thanks to sharing real-time data on energy use, the United Kingdom Windsor and Maidenhead Council used 16% less gas, electricity, oil and transport fuel in its buildings and vehicles since 2009-2010[85]. In Bulgaria, a website is created to list recycling sites. The project was prompted by the distrust of citizens if their garbage was actually recycled. The website displays recycling sites on a map[86].

Data sharing helps ensure biodiversity in forests

In terms of biodiversity, the benefit of data sharing becomes evident as well. A study by Liang et al. (2016)[87] on the relationship between biodiversity and productivity in forests shows that continued biodiversity loss leads to accelerated decline in forest productivity worldwide. There seems to be a positive and consistent relationship between tree diversity and ecosystem productivity. The estimated economic value of biodiversity in maintaining commercial forest productivity alone is €137 bn to €406 bn per year.[88] Through sharing biodiversity data, research can emphasise the importance of biodiversity to policymakers who are in a position to conserve biodiversity in forests.

Data sharing helps ensure biodiversity in oceans

A similar argument can be made for biodiversity in oceans. According to the 2016 report of the Food and Agriculture Organisation of the United Nations, more than 3.1 bn people around the world depend on fish for almost 20% of their diet and fishing helps sustain the economies of dozens of countries. One of the major impacts on marine biodiversity is overfishing which leads to a disbalance in the regenerative power of species and is destructive for their habitat. Moreover, more than 15% of the global fishing catch is illegal, unreported and unregulated. In collaboration with Global Fishing Watch, the government of Indonesia gained insights into Indonesian vessels that were fishing for longer than an allowed period or in regions where they did not have a license to operate. Research by Cabral et al. (2018)[89] shows that due to Indonesian policy to tackle illegal, unreported and unregulated fishing, foreign fishing in its waters has dropped by more than 90% and total fishing by 25%. None of this would have been possible without the sharing of data.

[81] https://www.europeandataportal.eu/sites/default/files/the-economic-impact-of-open-data.pdf
[82] https://techcrunch.com/2013/01/18/we-must-choose-privacy-or-medical-breakthroughs/
[83] https://www.europeandataportal.eu/sites/default/files/edp_creating_value_through_open_data_0.pdf
[84] https://www.europeandataportal.eu/sites/default/files/open_data_maturity_report_2019.pdf
[85] https://www.europeandataportal.eu/sites/default/files/edp_creating_value_through_open_data_0.pdf
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[88] https://www.europeandataportal.eu/sites/default/files/edp_creating_value_through_open_data_0.pdf
[89] https://www.europeandataportal.eu/sites/default/files/the-economic-impact-of-open-data.pdf

2.4 Policy, Regulatory and Ethical Implications

The final chapter of this report provides a brief overview of legislation, regulation and policy regarding data sharing and ethical implications that the industry must be aware of. The legislation discussed in this chapter is twofold. On the one hand, EU policy is determined to protect the intellectual property, confidentiality and privacy of both citizens and businesses when data is being shared, while on the other hand, it focuses on fostering the sharing of data by public and private institutions. The chapter continues with a closer look at the European Data Strategy. Finally, this chapter ends with a brief overview of the ethical implications of data sharing.

Data sharing policies need to define specific levels or conditions for access, ranging from fully open access to limited access with permission or against payment. Formulating data sharing policies requires a careful balancing of rights and responsibilities, and benefits and burdens, across the relevant stakeholders[90]. When one knows the boundaries of data sharing one can find opportunities for data sharing.

2.4.1 Policies Guide and Facilitate Data Sharing While Protecting Data Rights

Policy measures fostering sharing of data under the open licence – the pioneer of data sharing

Fostering the publication and re-use of public sector data in Europe was one of the first policy measures 'pioneering' data sharing as we can witness it now. A common legislative open data framework, which enables the sharing and re-use of public data is the Public Sector Information Directive (PSI Directive), currently known as the Open Data Directive[91]. The first publication of the Directive was in 2003 showing that there is a lot of history and commitment from Europe to open up and share data. It started with the Member States sharing their data and recently enabled other European organisations to do the same.

Another European initiative that encourages organisations to share data is the INSPIRE Directive[92]. The INSPIRE Directive aims to create an open spatial data infrastructure for EU environmental policies and policies or activities which may have an impact on the environment. This European Spatial Data Infrastructure will enable the sharing of environmental spatial information among public sector organisations, facilitate public access to spatial information across Europe and assist in policymaking across boundaries.

Sharing non-open data is increasingly emphasised

Currently, the majority of government initiatives focus on enabling open access and the sharing of public sector data. While still the largest share of those initiatives is attributed to open data, around 15% is devoted to facilitating data sharing within the public sector[93]. One of the reasons for the trend is that governments are increasingly becoming more data-driven and take advantage of technological trends exploiting the potential of data analytics. Data held by companies can be relevant to guide policy decisions or improve public services, such as targeted responses to pandemics, improved road safety and traffic management, or better environmental protection. The Commission, therefore, offers guidance on private sector data sharing, both with other businesses (B2B), as well as with governmental institutions (B2G)[94]. One of the main initiatives from the European Commission here is the Support Centre for Data Sharing (SCDS), focusing specifically on researching, documenting and reporting about data sharing practices.

Safeguarding the sharing of non-open data

Data protection law can roughly be divided into the regulation of personal data and the regulation of non-personal data.

In terms of personal data, the European Commission argues that "citizens will trust and embrace data-driven innovations only if they are confident that any personal data sharing in the EU will be subject to full compliance with the EU's strict data protection rules" [95]. Fortunately, the legal conditions for the

[90] https://www.apa.org/science/leadership/bsa/data-sharing-report.pdf
[91] https://ec.europa.eu/digital-single-market/en/public-sector-information-psi-directive-open-data-directive
[92] https://inspire.ec.europa.eu/about-inspire/563
[93] https://www.oecd-ilibrary.org/sites/baf19328-en/index.html?itemId=/content/component/baf19328-en
[94] https://ec.europa.eu/digital-single-market/en/guidance-private-sector-data-sharing
[95] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0066&from=EN

sharing and re-use of personal data – or to use the parlance of data protection law: making personal data available to third parties to enable processing for different purposes than those for which it was originally collected – are relatively clearly regulated by the General Data Protection Regulation (GDPR)[96]. The GDPR became applicable in May 2018 and defines a series of principles and requirements that must be adhered to when processing personal data within the scope of the GDPR.

Conversely, the law and legal practice for non-personal data is much less clear fostering industries specific governance. Non-personal data is regulated on an ad hoc basis in the EU. Arguably, an explanation may be the assumption that non-personal data can be freely shared, and thus that only exceptions need to be regulated. As a result, the legislation by necessity focuses on these exceptions, which may create an appearance of fragmentation. Additionally, some of the data will be subject to sector-specific rules, such as the Payment Services Directive (PSD2 Directive)[97] in the case of the financial transaction data and the Clinical Trial Regulation[98] in case of clinical trial data. Nonetheless, it is difficult to give a complete picture and there is a wide body of EU law that can affect the terms of data sharing[99].

An example where an industry dealt with legislative uncertainties using a code of conduct by contractual agreement is found in the agricultural data. This EU code of conduct on agricultural data sharing looks at general principles for sharing agricultural data from farm to farm products within the agro-food chain. Compliance with the code is completely voluntary. It constitutes a joint effort from signatory organisations to shed greater light on contractual relations and provide guidance on the use of agricultural data.[100]

Copyright and intellectual property rights

Some of the most common examples where the EU policies protect the lawful rights of holders of non-personal data are copyright and intellectual property rights. Copyright protects various types of works, as long as they are original and can be expressed in a material, concrete form. In the context of data sharing, this means that copyright protection can be granted to data representing a creative expression, but not to non-creative factual data as such[101]. To modernise copyright legislation in Europe the Copyright Digital Single Market (DSM) Directive[102] was introduced, which aims to ensure that the rules are fit for the digital environment.

Moreover, intellectual property rights are the rights given to creators over the use of their creations for a certain period of time. The European Union implemented the Database Directive[103], which is a legal framework for two types of intellectual property rights relating to databases. Firstly, it qualifies for copyright protection discussed above. Secondly, it created an entirely new type of intellectual property right, the so-called *sui generis* right. This right protects, as an intangible asset, the results of the financial and/or professional investment carried out towards the methodical and systematic classification of independent data[104]. It grants the right to prevent the extraction or re-utilisation of either all or a substantial part of the database.

EU Data Strategy to motivate and govern data sharing

Next to the focus on the important topic of safety and protection of data rights, the Commission argues that "at the same time, the increasing volume of non-personal industrial data and public data in Europe, combined with technological change in how the data is stored and processed, will constitute a potential source of growth and innovation that should be tapped" [105]. Indicating that it is important to encourage data sharing by motivating and informing institutions about the potential benefit accompanied by data sharing.

To improve consistency in policymaking, it is beneficial to explicitly define high-level strategic objectives for data sharing in the EU in general, and to derive the implications (and thus required legislative

[96] https://gdpr-info.eu/
[97] https://ec.europa.eu/info/law/payment-services-psd-2-directive-eu-2015-2366_en
[98] https://www.ema.europa.eu/en/human-regulatory/research-development/clinical-trials/clinical-trial-regulation
[99]https://eudatasharing.eu/sites/default/files/2020-02/EN_AR%20on%20EU%20law%20applicable%20to%20sharing%20of%20non-personal%20data.pdf
[100] https://copa-cogeca.eu/img/user/files/EU%20CODE/EU_Code_2018_web_version.pdf
[101]https://eudatasharing.eu/sites/default/files/2020-02/EN_AR%20on%20EU%20law%20applicable%20to%20sharing%20of%20non-personal%20data.pdf
[102] https://ec.europa.eu/digital-single-market/en/modernisation-eu-copyright-rules
[103] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:31996L0009&from=LT
[104] http://www.iprhelpdesk.eu/node/2018
[105] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0066&from=EN

intervention) for each regulatory initiative, taking into account other legitimate policy objectives. The European Commission formulated a clear Data Strategy[106].

The European Commission acknowledges the benefits of data and the global move towards a data economy. It aims at creating a single market for data, referred to as Digital Single Market (DSM)[107], that will ensure Europe's global competitiveness and data sovereignty. To reach a DSM, the European Commission stresses the importance that a wide free flow of data[108] across organisations needs to be accompanied by high levels of privacy, security, safety and ethical standards. Therefore, one of the main goals of the DSM is to facilitate data sharing from both public and private institutions to contribute to a data economy.

To achieve the benefits of data-driven applications, the European Commission has proposed a Regulation on European data governance[109] as part of its data strategy. This regulation plays a vital role in ensuring the EU's leadership in the global data economy. The regulation empowers users to stay in control of their data and encourages the creation of common European data spaces in crucial sectors, such as health, environment, energy, agriculture, mobility, finance, manufacturing, public administration and skills[110]. The creation of common European data spaces is one of the key pillars of European strategy that foster data sharing and serve as data governance mechanisms or ecosystems, to provide access to high-value datasets needed to drive innovative technologies.[111] The International Data Spaces Association (IDSA) plays a significant role in the execution of this strategy as a provider of secure and sovereign data ecosystems for SMEs.[112]

The way forward

Key recurring drivers for comprehensive legislation around data sharing include encouraging transparency, consumer protection, stimulating fair competition, supporting innovation and research, increasing security and protection of fundamental rights. There is however not always a clear statement of the drivers behind data sharing governance. As a result, regulatory approaches are not always consistent from topic to topic, which implies additional effort for aspiring users: a case by case assessment is always required[113].

The encouragement of data sharing is clearly and structurally on the rise. As a result of this rise, the European Commission, on 25 November 2020, published the 'Proposal for a Regulation on European data governance (Data Governance Act)'[114]. It entails new measures to boost data sharing and support European data spaces. These measures will facilitate data sharing across the EU and between sectors to create wealth for society, increase control and trust of both citizens and companies regarding their data and offer an alternative European model to data handling practice of major tech platforms.

2.4.2 Data Sharing and Ethical Implications

The amount of data is increasing and data sharing is becoming more common. It is, therefore, crucial to discuss the ethics of data sharing. Ethics is fundamentally different than compliance. Being compliant means following a strict set of rules, such as the legislation and regulations mentioned before; being ethical means doing what is 'good'.[115]

Data sharing enables the gathering of new insights from existing data and, as discussed throughout this report, multiple examples demonstrate the benefits and successes it brings forth. However, we should not forget that it also introduces ethical risks, which can be overlooked when focusing too much on the endless digital possibilities. The technical advancements and market dynamics driving towards ever more data sharing also set the stage for ethical risks. Sharing data does not necessarily mean it serves as a public good. While the unethical use of data can be the outcome of malicious intent, it often actually results from a lack of digital literacy or too little awareness or consideration of the complex implications of using digital technologies and tools. Data sharing is becoming the new way of working, thus stressing

[106] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0066&from=EN
[107] https://ec.europa.eu/digital-single-market/en/shaping-digital-single-market
[108] https://ec.europa.eu/digital-single-market/en/free-flow-non-personal-data
[109] https://ec.europa.eu/digital-single-market/en/european-data-governance
[110] https://ec.europa.eu/digital-single-market/en/european-strategy-data
[111] https://datalandscape.eu/sites/default/files/report/EDM_Story_9_Leveraging_data_12.06.2020.pdf
[112] https://internationaldataspaces.org/we/ids-in-europe/
[113]https://eudatasharing.eu/sites/default/files/2020-02/EN_AR%20on%20EU%20law%20applicable%20to%20sharing%20of%20non-personal%20data.pdf
[114]https://ec.europa.eu/digital-single-market/en/news/proposal-regulation-european-data-governance-data-governance-act
[115] https://www.capgemini.com/ch-en/2020/04/doing-the-right-thing-with-data-start-exploring-data-ethics-now/

the importance of boosting people's digital skills to better understand how data is used and how data should be used.

Current legislation dedicated to avoiding unethical practices is not airtight and knowing the delicacy of the topic it is unlikely that it is even possible. Nevertheless, awareness around the ethics of data sharing is growing and finding their feet within the current legislation. A great example is the Open Data Institute's (ODI) Data Ethics Canvas[116]. The methodology is distributed under an open licence and can be implemented freely by anybody. It provides a framework to identify and manage ethical issues in data-driven projects, by encouraging project teams to ask themselves important questions about their data and how they use it.

2.5 Conclusions

Throughout this report, we have demonstrated that data is an essential resource for economic growth and societal progress, and for this reason, it is the backbone of the European Commission's digital strategy. As the amount of data is forecasted to grow exponentially in the coming years, opportunities for businesses and innovative technologies will continue to evolve. The true potential of data however can only be unlocked when it is shared outside of traditional data silos. In light of this, the European Commission aims to ensure that data is both accessible and re-usable so that it can continue to drive key areas of innovation such as health, smart energy, digital retail and future mobility. Taking a wider look at society, there are numerous examples of data sharing supporting humanitarian services, improving health care, contributing to more sustainable energy consumption and ensuring biodiversity. To make this possible though, European legislation regarding the data sharing practice is vital and serves as a guide for businesses and citizens to know where the boundaries and opportunities lie. Creating value from data – at the different stages of the data value chain – represents the cornerstone of the data economy vision envisaged by the European Commission. Looking at the global market for data sharing and applications, Europe is yet to position itself as a global player in the field. In this regard, the Commission undertakes efforts to further strengthen all links of the data value chain, ensuring that the European Data value ecosystem can evolve and thrive in Europe.

[116] https://theodi.org/article/data-ethics-canvas/

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Appendix A: Advanced Technology uptake

Figure 1: Advanced Technologies Uptake by European Industries – Question: Which of the following technologies is your organisation using or planning to use?

Technology	Financial Services	Gov/Edu	Healthcare	Manufacturing discrete	Manufacturing process	Professional Services	Retail, Wholesale	Telecom, Media	Transport, Logistics	Utilities, Oil, Gas	Agriculture
Fixed or mobile connectivity	84%	78%	81%	88%	82%	81%	75%	89%	84%	86%	88%
Security technology solutions	84%	78%	78%	84%	77%	81%	80%	88%	85%	89%	68%
Public cloud	63%	66%	68%	76%	71%	82%	72%	80%	75%	69%	83%
IoT	58%	55%	60%	64%	60%	63%	55%	66%	68%	65%	64%
Big Data and analytics solutions	77%	53%	48%	63%	65%	70%	47%	66%	55%	58%	41%
Internet-Enabled Mobile Solutions	74%	60%	47%	44%	61%	67%	55%	72%	62%	57%	36%
AI	61%	45%	57%	66%	56%	59%	44%	69%	49%	59%	34%
B2B industrial digital platforms	46%	24%	27%	64%	60%	58%	40%	47%	53%	47%	39%
Robotics	36%	25%	38%	76%	65%	33%	30%	29%	29%	52%	26%
Other connectivity	42%	37%	29%	33%	41%	46%	37%	59%	34%	31%	19%
Vehicle-related mobility IT solutions	35%	28%	19%	27%	36%	42%	30%	26%	65%	28%	14%
ARVR	29%	32%	42%	33%	34%	33%	24%	41%	22%	19%	5%
Advanced materials	29%	23%	21%	39%	28%	31%	24%	22%	24%	21%	6%
Nanotechnology	25%	21%	22%	36%	21%	32%	23%	18%	19%	23%	9%
Blockchain	53%	17%	15%	21%	25%	31%	22%	22%	18%	17%	6%
Micro and nanoelectronics	25%	20%	16%	38%	24%	26%	21%	20%	20%	17%	8%
Industrial biotechnology	19%	18%	13%	8%	49%	26%	18%	15%	16%	11%	23%
Photonics	23%	16%	11%	27%	22%	25%	19%	19%	16%	22%	10%

Source: Advanced Technologies for Industries Survey, November 2020

Legend: sum of % of respondents already using or planning to use the technology

About the 'Advanced Technologies for Industry' project

The EU's industrial policy strategy promotes the creation of a competitive European industry. In order to properly support the implementation of policies and initiatives, a systematic monitoring of technological trends and reliable, up-to-date data on advanced technologies is needed. To this end, the Advanced Technologies for Industry (ATI) project has been set up. It provides policymakers, industry representatives and academia with:

- Statistical data on the production and use of advanced technologies including enabling conditions such as skills, investment or entrepreneurship;
- Analytical reports such as on technological trends, sectoral insights and products;
- Analysis of industrial value chains and policy needs;
- Analysis of technological trends in competing economies such as in the US, China or Japan;
- Access to technology centres and innovation hubs across EU countries and city mapping.

You may find more information about the 16 technologies here: https://ati.ec.europa.eu.

The project has been undertaken on behalf of the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and SMEs Executive Agency (EISMEA) by IDC, Technopolis Group, Capgemini, Fraunhofer, IDEA Consult and NESTA.

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