Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project

Gap Analysis report (D.2)

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Abbreviations

Abbreviation	Definition
AI	Artificial intelligence
ADR	Authority for the Digitalisation of Romania
APICCAPS	Portuguese Footwear Association
ATP	Textile and Clothing Association of Portugal
BERD	Business enterprise R&D expenditure
B2B	Business-to-business
B2C	Business-to-consumer
CEAP	Circular Economy Action Plan
CEE	Central and Eastern Europe
COVID-19	Coronavirus disease 2019
CTCP	Portuguese Technological Footwear Centre
DESI	Digital Economy and Society Index
DigComp	The Digital Competence Framework
DIH	Digital Innovation Hub
DII	Digital intensity index derived from the Eurostat survey on ICT usage and e-commerce in enterprises
DSTRI	Digital services trade restrictiveness indicator
EEA	European Economic Area
EIB	European Investment Bank
EPO	European Patent Office
ERP	Enterprise resource planning
EU	European Union
FTTP	Fibre to the premises
GDP	Gross domestic product
HIPA	Hungarian Investment Promotion Agency
ICT	Information and communication technologies
IDC	International Data Corporation
NACE	Nomenclature of Economic Activities
NDA	Fast broadband
NDS	National Digitalisation Strategy
OECD	The Organisation for Economic Co-operation and Development
OEM	Original equipment manufacturer

Abbreviation	Definition
PL	Product life cycle management
PON	Passive optical network
R&D	Research and development
RDP	Rural development policy
RRF	Recovery and Resilience Facility
RRP HU	Hungary's Recovery and Resilience Plan
RRP LT	Lithuania's Recovery and Resilience Plan
RRP PL	Poland's Recovery and Resilience Plan
RRP PT	Portugal's Recovery and Resilience Plan
RRP RO	Romania's Recovery and Resilience Plan
SCM	Supply chain management
SIP	Start in Poland
SIR	Smart industrial remoting
SMEs	Small and medium enterprises
UK	United Kingdom
US	United States
VHCN	Very High-Capacity Network
VSEs	Very small enterprises

Executive summary

Digitalisation is an important enabler for industry growth and its increased competitiveness. Nevertheless, European industrial firms face several challenges in their attempt to adopt digital technologies. Lack of know-how, digital skills and resources all negatively affect companies' capacity for digitalisation. In the recent years, these challenges have been further exacerbated by the ongoing consequences of the COVID-19 pandemic and the Russian invasion of Ukraine.

In this context, the report is part of a study 'Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project'. The objective of the study is to propose smart industrial remoting (SIR) measures for five industries with a particularly high proportion of SMEs that were hard hit by the COVID-19-related crisis: construction, textile, retail, automotive and agrifood. This report analysed the existing gaps preventing industry digitalisation in five country-industry pairs: automotive in Hungary; retail in Poland; textile in Portugal; agrifood in Lithuania; and construction in Romania. The five country-industry pairs were chosen based on the Digital Intensity Index scores for each industry and taking into consideration the industry's economic importance for the given country.

For each of the five industries, the gap analysis considered two groups of factors that influence industry digitalisation: industry-level factors and external shocks. The former were further broken down into policy, social and economic factors that directly or indirectly impact the uptake of digital technologies. External shocks are sudden, drastic, and unforeseen changes that affect the entire economy. In this report, the COVID-19 crisis and the Russian invasion of Ukraine were considered to be such shocks.

The gap analysis was performed by analysing secondary data in each of the five country-industry pairs in collaboration with experts from five Digital Innovation Hubs based in each country of focus. The secondary data was complemented by interview findings as well as take-aways from a workshop on 'European industry digitalisation – the challenges ahead', which was organised as part of this study and took place on 28 June.

Automotive in Hungary

The automotive industry is one of the most important sectors of the Hungarian economy, contributing 4.1% of Hungary's GDP. Hungary is specialised in midstream production activities within the supply chain. Hungary has approximately 700 automotive companies, five of which are major car manufacturers, three are major engineering service providers, eight are original equipment manufacturers (OEMs), and 66 are TIER1 suppliers, with the rest being lower-tier suppliers.

While the Hungarian automotive industry has higher uptake of robotics and e-commerce than the EU on average, the uptake of other technologies (ERP, CRM, cloud computing, big data, 3D printing, IoT, AI) and the overall level of industry's digital intensity falls below the EU average. Most (83%) of Hungarian automotive enterprises have 'low' or 'very low' digital intensity, while the EU average is 76%.

SMEs find it difficult to implement Industry 4.0 technologies due to a lack of economies of scale and their position in the value chain. As many SMEs in the Hungarian automotive sector are mid-tier suppliers, they have limited impact on and benefit from the digitalisation of end products or implementation of 'manufacturing as a service' concepts. Hence the benefits of Industry 4.0 tend to accrue to OEMs. Additionally, vulnerability to demand and supply chain shocks and possible changes in OEM business models due to, for example, the introduction of electric vehicles, can create significant and sudden pressure for SMEs

to significantly alter their operations. Moreover, shocks related to COVID-19 and the war in Ukraine have forced companies to reduce or completely cease their operations. In these situations, investment in digitalisation may be deprioritised in favour of maintaining operations.

Moreover, many EU-funded initiatives support digitalisation and most of them are targeted specifically at SMEs. Despite this support, some SMEs do not pursue digitalisation as they perceive the process as too risky or they lack managerial know-how. While SMEs tend to be aware of the need to digitalise, it is often unclear to them how digital technologies can be applied in their business, or how their implementation can be broken down into smaller projects. Finally, stakeholders who can support automotive companies with expertise, such as researchers, academics, and consultants, usually work with OEMs, instead of SMEs.

Retail in Poland

As of June 2021, the Polish retail industry consisted of 98,017 shops in total. Almost all Polish retailers are SMEs (99.92%), and almost every fifth SME in Poland operates in the retail sector. However, the Polish retail market has been undergoing market consolidation for several years, with smaller companies increasingly struggling to remain competitive. Furthermore, the Polish retail market was hard hit by the pandemic due to both social distancing measures and changes in consumer demand.

More (86%) Polish retailers show a 'low' or 'very low' level of digital intensity than in the EU retail market on average. Gap analysis showed that digitalisation is mainly driven by large companies. For example, large companies benefit from customers who have started using e-commerce and other digital channels during the pandemic. Similarly, digital product and service innovations (for example, NFTs, virtual boutiques, and digital clothing to be worn by avatars in the metaverse) are mainly implemented by large retailers, while SMEs lack the resources and know-how to use them. This trend might make it even more difficult for small companies to maintain competitiveness.

Nevertheless, small stores can benefit from a wide range of opportunities to outsource certain processes using intermediary marketplaces, digital marketing services and fulfilment services. Meanwhile, small retail chains would benefit the most from external support in the form of public financing and expertise, as their value chains are too complex to use outsourcing to address the knowledge and resource gaps.

While Poland has implemented some public policy initiatives for supporting digitalisation and e-commerce, it lacks initiatives targeting the retail industry specifically. As a result, retail enterprises are not usually considered and systematically engaged as a key target group as part of SME support initiatives.

Textile in Portugal

The Portuguese textile industry represents 3.6% of the total national workforce and constitutes 4.5% of the country's GDP. In 2020, more than 8,700 companies made up the Portuguese textile ecosystem, 99.2% of which were SMEs. The industry represents a complete value chain for textile products, making it resilient to supply chain disruptions, including the ones related to the COVID-19 crisis.

The Portuguese textile industry shows good results in the adoption of certain technologies, such as AI. Yet, the proportion of Portuguese textile ecosystem enterprises with 'low' or 'very low' digital intensity amounts to 97%, compared to the EU average of 88%. This is

likely due to several factors, including the large proportion of SMEs in the industry, who find the digitalisation journey more challenging than large enterprises. From a structural perspective, the difficulty of automating certain industry processes (for example, sewing), especially on a small scale, also contributes to limited uptake.

The industry is undergoing significant structural changes, mainly due to environmental and ethical standards and shifting consumer expectations. New requirements related to marketing and labelling, due diligence, traceability, and sustainability reporting will likely lead to rapid digitalisation, as companies will be required to automate processes and collect data across the value chain. Yet, at the moment there is a shortage of competences required for digital transformation and some SMEs may face difficulties to devote resources to the selection and implementation of digital solutions.

To support SMEs in their digitalisation journey, Portugal has fostered a support ecosystem for textile SMEs. Several initiatives are planned to boost digitalisation, such as promoting sustainable solutions in the Portuguese footwear sector and FAIST project under Portugal's Recovery and Resilience Plan. Considering that most textile enterprises are integrated into complex value chains, the SME support organisations will aim to bring together ICT providers and textile companies to solve common problems, such as lack of standardisation.

Agrifood in Lithuania

The agrifood industry in Lithuania plays an important economic and social role. In 2019, the industry contributed a total of 7.1% of the country's GDP. Similarly to the other four industries analysed in this report, 85% of Lithuanian agrifood companies are SMEs, mostly focusing on the key segments of cereals, dairy, and meat.

Lithuania's agrifood industry is relatively more digitalised than the other industries in the scope of the study. Lithuania has a lower share of companies (82%) in the accommodation, food and beverage services sector, with 'very low' and 'low' digital intensity score. Lithuania ranks 14th in the 2021 DESI. It scores the lowest in the 'connectivity' dimension, ranking 25th in the EU. The adoption of digital technologies in Lithuania's manufacturing of food, beverages and tobacco industry is higher than the EU average. Most companies in this industry have a website, use social media, and have ERP and CRM systems. The industry performs below the EU average regarding the uptake of robotics.

The gap analysis revealed that among the main problems facing the industry today is the lack of a holistic approach to digitalisation. Until recently, Lithuanian policymakers viewed agriculture and food production as two separate industries. Two social factors affect the digitalisation of the agrifood industry in Lithuania – human capital and changing consumer behaviour. Lithuania lags behind the EU average in the availability of ICT specialists. There is also a significant gap in the uptake of digital skills between urban and rural areas, which stood at 20% in 2019. Coupled with the ageing workforce, this creates a significant barrier to the uptake of digital skills. Finally, the Lithuanian agrifood industry is adversely affected by a fragmented approach to innovation with low collaboration between businesses, social partners involved in the ecosystem and the government. The country has yet to harness the potential of clusters operating in this sector.

Nevertheless, the agrifood industry in Lithuania has strong potential for rapid digitalisation and for becoming a testbed for Agrifood Tech. Players in the agrifood industry are increasingly collaborating with the public sector to bring attention to its digital potential. A plan is already in place to adopt an AgriFoodTech roadmap in Lithuania by the end of 2022.

Construction in Romania

Construction is the third largest sector in Romania by the number of enterprises, constituting a total of 11.1% of companies operating in the country in 2020. In 2020, the sector employed 9% of the Romanian workforce and made up 6.3% of Romania's GDP. However, the sector faces a challenge of significant labour shortage, driven by low wages, migration to Western Europe, and lack of specialist training.

Romania is among the least digitalised countries in the EU, ranking last in the DESI 2021. Looking at the construction industry specifically, the sector appears to be among the least digitalised in both Romania and the EU. A total of 90% of construction companies in Romania have a 'very low' Digital Intensity Index, compared to the EU average of 62%. The construction industry in Romania falls behind other Romanian industries when it comes to digital technology adoption, with only 8% of companies using ERP or CRM systems. The Romanian construction industry is at the early stages of digital technology adoption, with large differences in digitalisation observed along the value chain. Companies that participate in high-value-added activities, such as architects and engineers, are more digitalised than those on the other end of the value chain. At the moment, BIM technology has the biggest potential for the industry. Overall awareness about the potential of digital technologies and the capacity for their application in the construction sector is low.

Our analysis revealed a significant gap at the policy level when it comes to facilitating the digitalisation of the construction industry. Despite construction being announced as the priority industry in Romania for the next decade, few policy initiatives focus on facilitating industry digitalisation. Lack of digital skills is another key challenge affecting the industry's uptake of digital technologies. The country lags significantly below the EU average regarding the availability of ICT specialists, who constitute only 2.4% of individuals in employment between ages 15-74 as compared to the 4.3% EU average. In addition, limited connectivity in rural areas further limits the adoption of digital technologies on construction sites.

COVID-19 has put digitalisation on top of the Romanian government's agenda. It is likely that this will also have a positive spillover in the construction industry as well. The creation of the Authority for the Digitalisation of Romania is one favourable development. Finally, several bottom-up initiatives supporting industry digitalisation and promoting the uptake of BIM technologies are emerging in the country. For example, the Romanian Green Building Council is participating in the UrbanBIM initiative, which aims to put together training on the use of BIM systems, LCA (Life Cycle Analysis) and Energy Efficiency of construction materials.

Overall conclusions

A total of six cross-cutting factors that impact industry digitalisation have emerged through the analysis of the five industries included in the study:

- Enterprise size and its position in the value chain – larger enterprises and those that are on the higher end of the value chain, i.e., produce higher-value-added goods and services, tend to be more digitalised. In turn, the uptake of digital technologies varies not only across industries but within them. Evidence also shows that in some industries the diffusion of digital technologies along the value chains is slow due to lack of collaboration, different company needs, and structural issues such as lack of digital infrastructure.

- Ongoing broader business transformation – several industries in the scope of the study are facing structural changes due to the green transition and increased focus on sustainability. Consumer expectations are also changing, with the increasing demand for more personalised products. As a result, companies will face the need to pursue large-scale business transformation that includes digitalisation, instead of having the option to adopt digital technologies in smaller steps. This may prove challenging to SMEs as they tend to approach digitalisation incrementally, by transforming individual aspects of their operation.

- COVID-19 has had an ambiguous impact on most industries – on the one hand, it acted as a catalyst for digitalisation, especially for larger and already more digitalised companies. On the other hand, for smaller companies, it often decreased the pace of digitalisation and led to a pause in investments.

- Digital skills shortage – all five industries face a significant digital skills shortage. Coupled with an ageing workforce and a low level of internal company training, this creates a barrier to digital technology adoption. In addition, agrifood and textile industries are also facing an insufficient number of graduates choosing to pursue a career in those industries, further reducing the capacity for the uptake of new technologies.

- Limited availability of financing and support – analysis of agrifood and retail industries points to a lack of public support instruments tailored for these industries. Furthermore, where financial instruments exist, their uptake tends to be low among SMEs.

- SMEs have limited capacity to participate in existing digitalisation programmes – this appears to be due to time-consuming application processes and lack of know-how. Yet, smaller companies can greatly benefit from the existing support networks, including the (European) Digital Innovation Hubs. Because of their size, SMEs have a low tolerance for risk. Given that digitalisation often results in short-term productivity losses, SMEs tend to be risk-averse when it comes to investing in digitalisation. In turn, the supporting ecosystem should consider offering tailored digital solutions that meet SMEs' needs. It is also important to demonstrate the value added from digitalisation as some industrial SMEs perceive digitalisation as a cost rather than a benefit.

Introduction

Europe's industrial landscape faces several significant challenges in 2022. The COVID-19 pandemic triggered a period of economic turbulence. This was followed by the supply chain crisis, which is currently being exacerbated, in part, by Russia's invasion of Ukraine. These developments have impacted the digital transformation of industries in ways that have often been contradictory, by making digitalisation simultaneously more essential and more challenging.

To make the EU economy more resilient in the future, the European Commission and the EU Member States have proposed the Recovery and Resilience Facility (RRF), endowed with close to EUR 700 billion and set to be implemented between 2021 and 2027.[1] At least 20% of these funds are dedicated to digital investments. This comes on top of the EUR 750 billion already allocated to the Commission's Digital Europe Programme for the current financial framework to support the adoption of advanced digital technologies in the EU through the implementation of various initiatives.

One such initiative is the establishment of European Digital innovation hubs (EDIHs), which will provide businesses with support services[2] to respond to digital challenges and become more competitive.[3] The EDIH initiative aims to create '[…]an EU-wide network of more than 200 EDIHs covering all sectors, technologies, and regions'. The objective is to address the digitalisation needs of all SMEs so that a high level of digital intensity can be reached in Europe.

Furthermore, the European Commission has recently published the 2030 Digital Compass, which includes the following objectives for industry digitalisation:

- at least 90% of SMEs reach at least a basic level of digital intensity;
- at least 75% should use cloud computing services, big data, and artificial intelligence (AI).[4]

The EDIH initiative will make an important contribution toward achieving these targets. In this context, it is important to understand the needs of ecosystems affected by the pandemic, to identify the best approaches to providing support for their digitalisation and to ensure that no company is left behind in the digitalisation effort.

This report is part of a study 'Smart Industrial Remoting: remote working in non-digitalised industries – Pilot Project'. In the context of this study, smart industrial remoting (SIR) measures refer to measures that support the uptake of digital technologies by businesses to facilitate their remote operations internally or externally. The objective of the study is to propose SIR measures for five country-industry pairs with a particularly high proportion of small and medium enterprises (SMEs) that were hard hit by the COVID-19-related crisis: construction, textile, retail, automotive and agrifood. The study will put forward user-friendly and targeted advice on digitalisation for five industries. Each industry is studied in

[1] European Commission (n.a.). Programme Statement – Recovery and Resilience Facility. Available at: https://ec.europa.eu/info/sites/default/files/about_the_european_commission/eu_budget/ps_db2023_rrf_h2.pdf

[2] For example, technical expertise, experimentation, 'test before invest', financing advice, training, skills development

[3] European Commission (2022). European Digital Innovation Hubs. Shaping Europe's digital future. Available at: https://digital-strategy.ec.europa.eu/en/activities/edihs

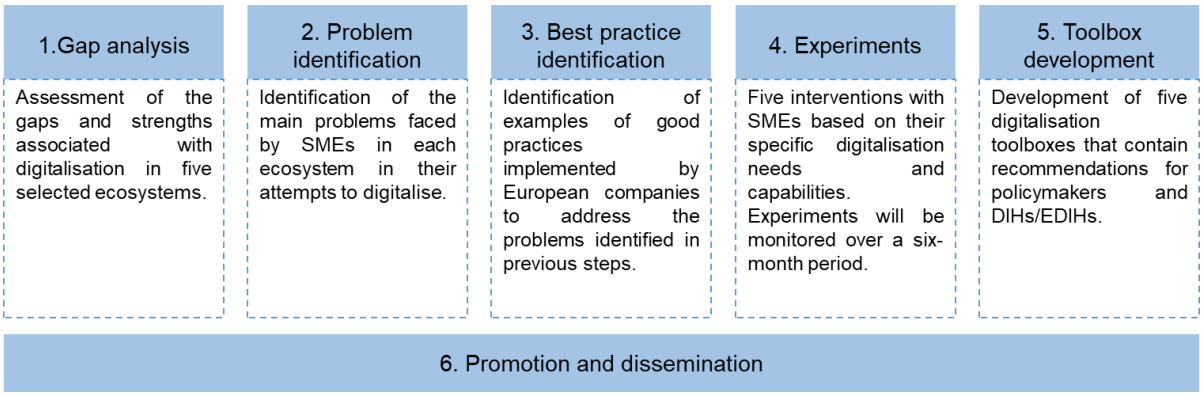
[4] European Commission (2022). Europe's Digital Decade: digital targets for 2030. Available at: https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en

a dedicated country, resulting in five country-industry pairs (described in more detail in Section 1.1). The country-industry pairs selected for the study are:

- automotive in Hungary;
- agrifood in Lithuania;
- construction in Romania;
- retail in Poland;
- textile in Portugal.

The study includes five main tasks, as illustrated in Figure 1 below. Throughout the study, these tasks will be complemented by several promotion and dissemination activities.

Figure 1. Overview of study tasks



Source: own elaboration.

The purpose of this report is to identify and analyse, through gap analysis, the main challenges and strengths facing the five country-industry pairs regarding their digitalisation and adoption of SIR measures. This report examines the local economic situation as it pertains to a specific industry, the extent to which it was affected by the COVID-19 pandemic, as well as more recent economic trends, including supply chain issues, rising inflation, and the effects of the Russian attack on Ukraine.

While the uptake of digital technologies has been increasing, especially during the COVID-19 crisis, significant differences in the level of digitalisation can be observed based on sector, enterprise size and country.[5,6] Without sufficient support for so-called 'laggards', digitalisation can favour established companies and exacerbate existing inequalities

[5] EIB (2021). Desperate for digital. Available at: https://www.eib.org/en/essays/european-digitalisation-study.

[6] European Commission, Executive Agency for Small and Medium-sized Enterprises, Pedersen, B., Probst, L., Wenger, J. (2019). Skills for industry: skills for smart industrial specialisation and digital transformation: executive summary, Publications Office. Available at: https://data.europa.eu/doi/10.2826/117696.

between firms.[7,8] In this context, it is important to identify exactly where the gaps in digitalisation are present and what factors can influence industry uptake of digital technologies. Therefore, this report employs a gap analysis approach to determine the discrepancy between where the selected country-industry pairs currently are and a desired future state.

The results of the gap analysis reflected in this report will feed into further phases of the study, such as problem identification, digitalisation best-practice collection, experiments, and the development of a toolbox for each industry.

The Gap Analysis report is structured as follows:

- **Chapter 1. Methodology** – outlines the methodological approach taken to select the country-industry industry pairs for the completion of the gap analysis.
- **Chapter 2. Context and background** – introduces the broader context of the study, including the role of industry digitalisation in Europe and an overview of the main factors affecting it.
- **Chapter 3. Presentation of the gap analysis** – includes the results of the gap analysis for each of the five country-industry pairs analysed for the study.
- **Chapter 4. Conclusions** – details cross-cutting findings for the five industries in the scope of the study.

[7] European Commission (2021). Staff working document - Annual Single Market Report 2021. Available at: https://ec.europa.eu/info/files/staff-working-document-annual-single-market-report-2021_en.

[8] Cirera, X.; Vargas Da Cruz, MJ.; Grover, AG.; Iacovone, L.; Medvedev, D.; Pereira Lopez, MDLP.; Reyes, S. (2021). Firm Recovery during COVID-19 : Six Stylized Facts (English). Policy Research working paper,no. WPS 9810,COVID-19 (Coronavirus) Washington, D.C. : World Bank Group. Available at: http://documents.worldbank.org/curated/en/862851634563353449/Firm-Recovery-during-COVID-19-Six-Stylized-Facts

1. Methodology

This chapter describes the methodology used in the preparation of this report. Firstly, Section 1.1 includes a description of how a country of focus was selected for each of the five industries (construction, textile, retail, automotive and agrifood) included in the study. Secondly, Section 1.2 presents the factors that will be used to structure the gap analysis and the chosen gap analysis approach.

1.1. Country selection

This report aims to analyse digitalisation gaps in five selected country-industry pairs:

- which have a low level of digitalisation;
- which are characterised by a high degree of relevance to the economy of the industry in question;
- which were hard-hit by the COVID-19 pandemic.

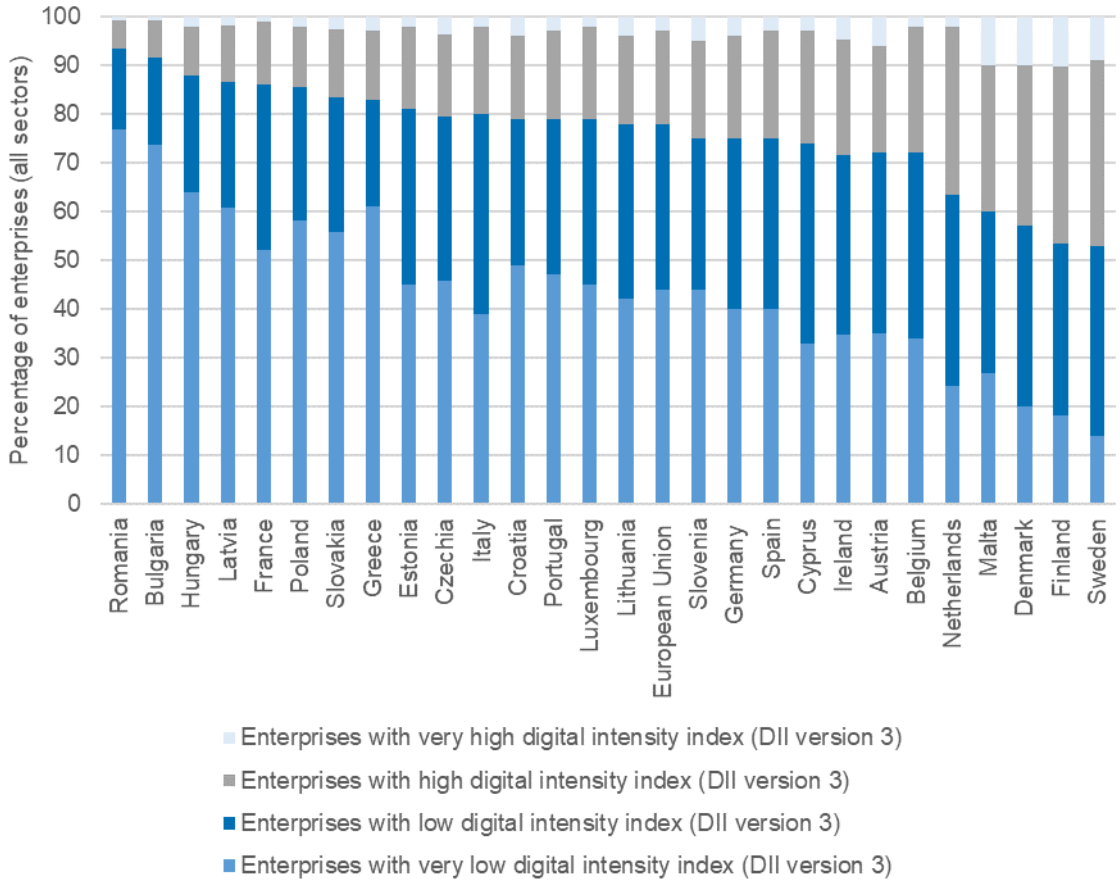
This section describes the selection of countries for the five industries included in this study: construction, textile, retail, automotive and agrifood.

For assessing the digitalisation level of country-industry pairs, this study used the Digital Intensity Index (DII). The DII is a composite indicator that measures the use of digital technologies by enterprises based on 12 selected technologies. DII scores represent the proportion of companies that have very high (10-12 technologies adopted), high (7-9), low (4-6), and very low (0-3) digital intensity. This indicator is derived from the Eurostat survey on Information and communication technology (ICT) usage and e-commerce in enterprises[9] and is a part of the Digital Economy and Society Index (DESI) dimension 'integration of digital technologies' that measures the digitalisation of business and e-commerce.[10] The first step in selecting the country-industry pairs for each industry was to identify countries where the DII falls below the industry average. Using 2020 data, the following countries fall into this category: Bulgaria, Romania, Greece, Latvia, Hungary, Cyprus, Portugal, Poland, Slovakia, Lithuania, France, and Czechia. During the preparation of this report, 2021 data for the DII was published. The latest DII is shown in Figure 2 below. Countries are displayed in descending order based on the sum of their 'very low' and 'low' intensity scores. Looking at the DII scores for 2021, two more countries fall within the scope of the study: Croatia and Luxembourg.

[9] Eurostat (2021). Eurostat – How digitalised are EU's enterprises? Available at: https://nocash.ro/eurostat-how-digitalised-are-eus-enterprises/#:~:text=Digital%20Intensity%20Index%20%28DII%29%20is%20a%20composite%20indicator%2C,survey%20on%20ICT%20usage%20and%20e-commerce%20in%20enterprises.

[10] European Commission (2021). DESI 2021: Thematic Chapters. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

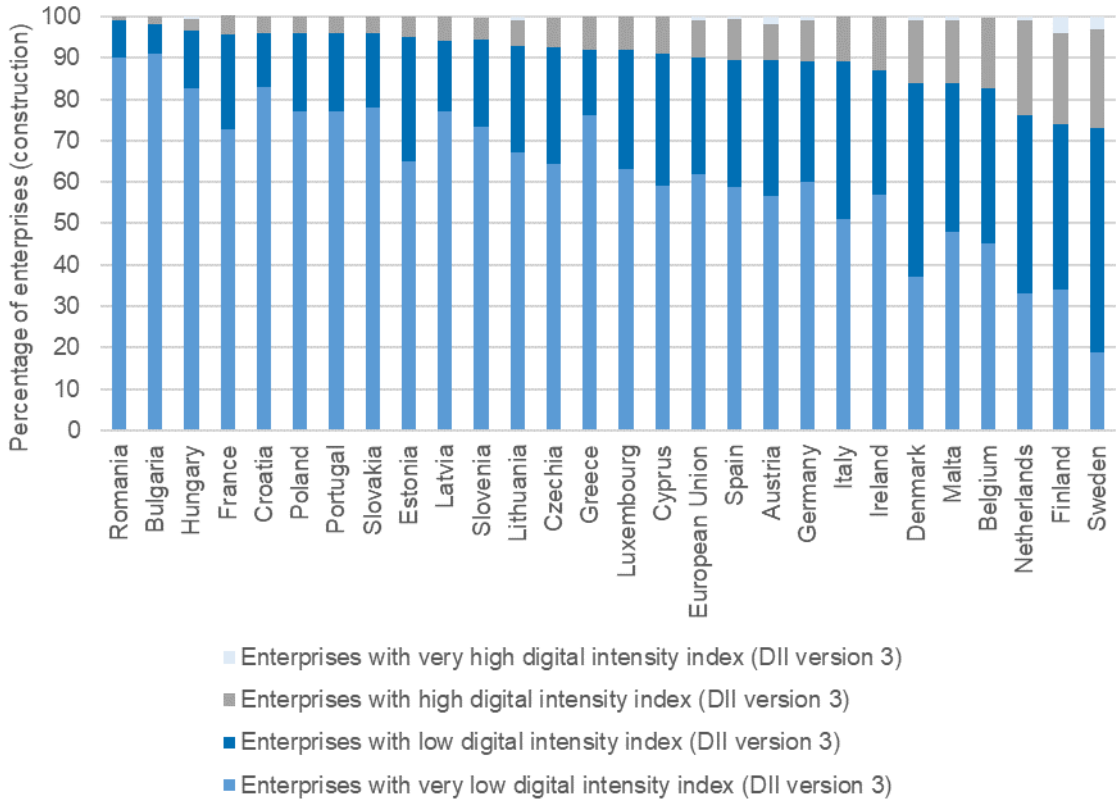
Figure 2. Digital intensity score for enterprises, by level of digital intensity, 2021



Source: own elaboration based on data from Eurostat: Tables isoc_e_dii: Digital Intensity.
Note: the figure is sorted by the sum of the Very Low and Low Digital Intensity Index scores.

The DII scores for 2021 also include data for different economic sectors (17 Nomenclature of Economic Activities (NACE) specifications of economic activity), including construction; retail trade, except for motor vehicles and motorcycles; manufacture of textiles, wearing apparel, leather, and related products; manufacture of motor vehicles, trailers and semi-trailers, other transport equipment; and manufacture of beverages, food, and tobacco products. These datasets were useful in assessing the level of digitalisation in the industries in the scope of the study. Nevertheless, it should be noted that the agrifood industry is much broader than the 'manufacture of beverages, food and tobacco', and hence the DII indicator might not capture the full picture of the agrifood industry's digitalisation levels. As an example, the DII 2021 scores for European construction companies are included in Figure 3 below. The construction industry appears to have the lowest levels of digitalisation in Romania, Bulgaria, and Hungary. Annex 1 contains DII 2021 scores for the other four industries.

Figure 3. Digital Intensity Score for construction enterprises, 2021



Source: own elaboration based on data from Eurostat: Tables isoc_e_dii: Digital Intensity.
Note: the figure is sorted by the sum of the Very Low and Low Digital Intensity Index scores.

As a second step, the extent to which the industries included in this study are relevant for the countries listed above was explored. The indicators analysed were:

- gross value added by industry (as a share of total gross value added by all industries);[11]
- employment by industry (as a share of total employment);[12]
- share of SMEs (excluding micro-enterprises) among all enterprises, by industry.[13]

For each industry, countries were listed based on the average score of the three indicators. The results concerning the agrifood industry are presented below, whereas the figures concerning other industries are available in Annex 1. As shown in Figure 4 below, the

[11] Own elaboration based on Eurostat (2021). National accounts aggregates by industry (up to NACE A*64) [NAMA_10_A64].

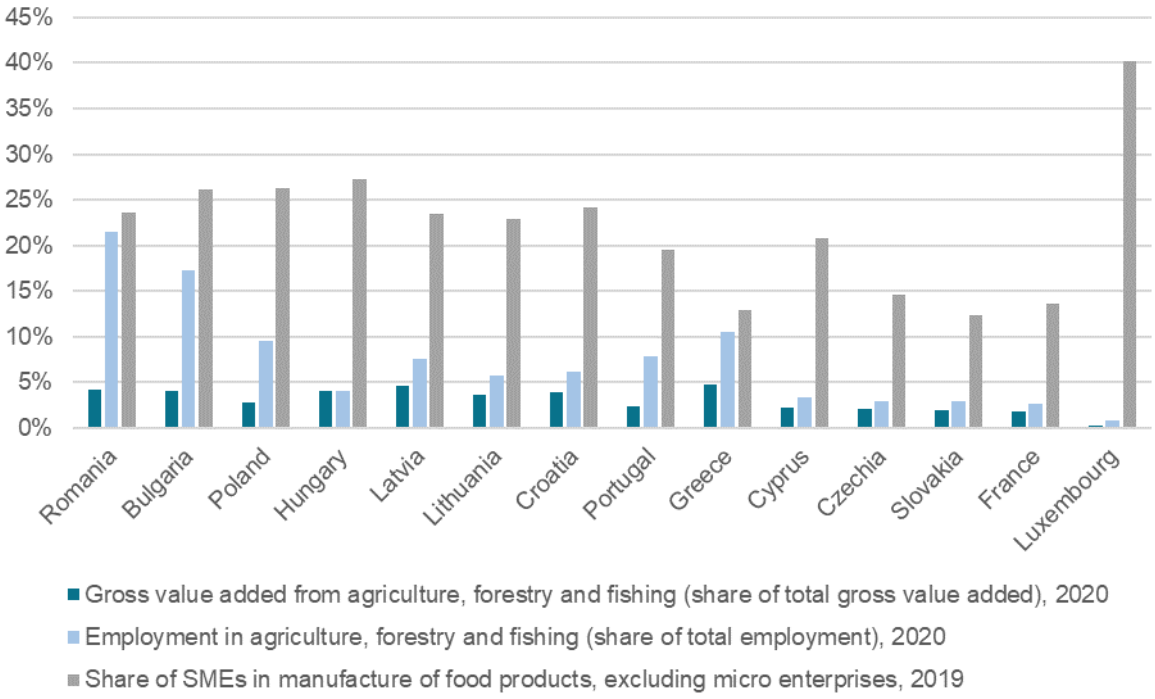
[12] Own elaboration based on Eurostat (2021). National accounts employment data by industry (up to NACE A*64) [NAMA_10_A64_E].

[13] While the definition of an SME typically also includes businesses that employ up to 10 people (micro businesses), virtually all the businesses in the industries and countries selected (with the exception of automotive) employ up to 250 people. Thus, including micro businesses would not allow us to identify any variability between countries. Furthermore, micro businesses might not have the capacity to introduce technological changes during the experiment. The indicator is based on Eurostat (2021). Annual enterprise statistics by size class for special aggregates of activities (NACE Rev. 2) [SBS_SC_SCA_R2].

agrifood industry is the most relevant in Romania, Bulgaria, Poland, Hungary, Latvia, Lithuania, and Croatia. The results in other industries show that:

- the textile industry is the most relevant in Portugal, Bulgaria and Romania;
- automotive – in Romania, Czechia, and Hungary;[14]
- construction – in Luxembourg, Romania, Latvia, and Bulgaria; and
- retail – in Latvia, Croatia, and Poland.

Figure 4. Key indicators regarding the agrifood industry, by country



Source: own elaboration based on data from Eurostat: Tables NAMA_10_A64, NAMA_10_A64_E and SBS_SC_SCA_R2.
Note: the figure is sorted by the average of the three indicators. The latest year of available data was chosen.

For selecting specific country-industry pairs, the following criteria were also considered:

- Geographical diversity. For example, based on the preliminary analysis above, Portugal was selected to study the textile industry, given that most of the countries relevant for other industries are in Eastern or Central Europe. Similarly, both Bulgaria and Romania represent several of the industries in the scope of the study. However, to ensure geographical balance, one of those countries was chosen based on other selection criteria.
- Existence of a Digital Innovation Hub (DIH) that specialises in the relevant industry. This is because industry knowledge and contacts with relevant businesses and business associations will be extremely important for future phases of the study

[14] Based on the average score calculated for the three indicators, automotive industry appears to be most relevant in Lithuania. However, we discard this result as there are only 55 companies operating in the automotive industry in Lithuania and the industry contributes only 1% to the national GDP.

(problem analysis, identification of best practices, recruitment of businesses to participate in an experiment and dissemination of the toolbox). For example, while Portugal, Bulgaria and Romania seem like a good fit for the textile industry, there is a dedicated DIH specialising primarily in textile in Portugal, Citeve[15] Similarly, there is a DIH specialising in the agrifood industry in Lithuania, AgriFood Lithuania.[16]

- Country and the industry DII score.[17] For instance, the construction industry appears to be important for both Luxembourg and Romania. However, Romania has a lower DII score in the construction industry than Luxembourg (see Annex 1). Hence, Romania was chosen to study this industry. Similarly for retail, Poland has a lower digital intensity score than both Latvia and Croatia (see Annex 1), therefore, Poland was selected for the retail industry.

Based on the analysis of the above-described indicators and selection criteria, the following country-industry pairs were selected for the study:

- automotive for Hungary;
- agrifood for Lithuania;
- construction for Romania;
- retail for Poland;
- textile for Portugal.

1.2. Gap analysis

For the purposes of this report, gap analysis is defined as the process of determining the discrepancy between where industries currently are and a desired future state. This section includes a description of the framework of analysis used to study digitalisation gaps in the five country-industry pairs. The structure of gap analysis centres around factors that influence industry digitalisation. The factors can be divided into two types:

- Industry-level factors include several policy, social and economic factors that characterise the ecosystem in question.
- External shocks are sudden, drastic, and unforeseen changes affecting the entire economy,[18] for example, the COVID-19 crisis or the Russian invasion of Ukraine. External shocks can have far-reaching consequences on the industry, including its supply chain, labour force, and consumer demand and through various cascading effects of changes in the overall economic situation.

For a list of factors influencing industry digitalisation, see Figure 5. This list of factors and their effects is defined based on a review of existing literature and indicators used for

[15] More information at: https://www.citeve.pt/.

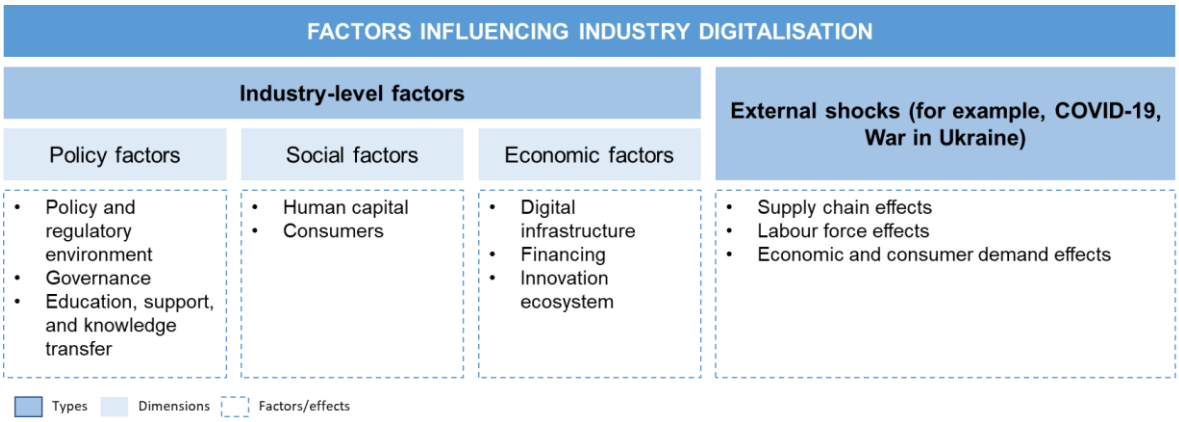
[16] More information at: https://www.agrifood.lt/en/.

[17] With the potential exception of agrifood, since the indicator for the manufacture of beverages, food and tobacco does not capture the whole agrifood industry.

[18] Economic shock. (n.d.) Financial Glossary. (2011). Available at: https://financial-dictionary.thefreedictionary.com/Economic+shock.

assessing the level of industry digitalisation, including the DESI,[19] the Digital transformation scoreboard 2018,[20] the European Investment Bank (EIB) Investment Survey,[21] the Digital Intelligence Index,[22] the Readiness for the Future of Production Report 2018[23] and other sources. These factors are elaborated in Annex 3.

Figure 5. Factors influencing industry digitalisation

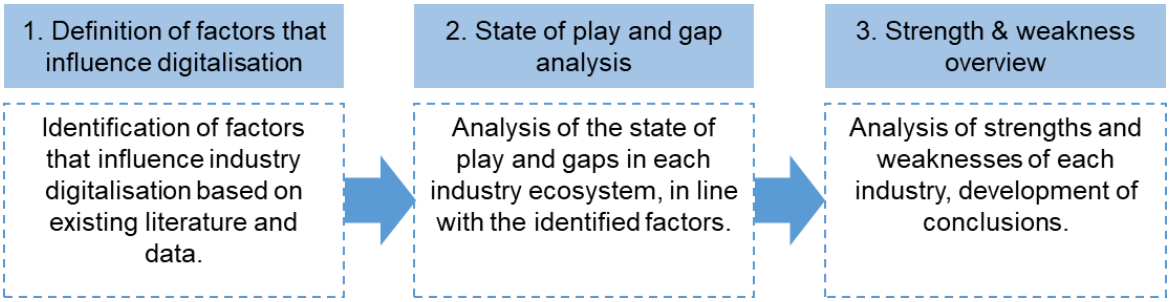


Source: own elaboration.

While these factors can be considered horizontal (country and industry-agnostic), it is important to note that their importance may vary from industry to industry. For example, industries with a large proportion of business-to-business (B2B) sales would be less affected by the ability of the general population to engage with digital products or services than an industry where sales are mainly business-to-consumer (B2C).

A gap analysis was performed based on the defined factors and effects to identify the challenges and strengths of each country-industry pair, as illustrated in the Figure 6 below.

Figure 6. Gap analysis approach



Source: own elaboration.

[19] European Commission (2021). The Digital Economy and Society Index (DESI). Available at: https://digital-strategy.ec.europa.eu/en/policies/desi.

[20] European Commission (2019). Digital transformation scoreboard 2018: EU businesses go digital: opportunities, outcomes and uptake. Executive Agency for Small and Medium-sized Enterprises. Publications Office, 2019. Available at: https://data.europa.eu/doi/10.2826/821639.

[21] EIB (2021). Digitalisation in Europe 2020-2021 Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2020-2021.

[22] The Fletcher School (n.d.). Digital Intelligence Index. Available at: https://sites.tufts.edu/digitalplanet/digitalintelligence/.

[23] World Economic Forum (2018). Readiness for the Future of Production Report 2018. Available at: https://www3.weforum.org/docs/FOP_Readiness_Report_2018.pdf.

The first step of identifying factors that influence industry digitalisation is described above. Secondly, the country-industry pair's state of play and gaps were assessed by analysing available international and national statistics, relevant policy documents, regulations, research, and information provided by stakeholders. Finally, based on the analysed factors, we summarised the main strengths and weaknesses of each industry.

The research on the five country-industry pairs is led by five Digital Innovation Hubs participating in the study: Agrifood Lithuania DIH[24] representing the agrifood industry, Innomine[25] in Hungary representing the automotive industry, Iceberg+[26] in Romania, leading research on the construction industry, dih4.eu[27] in Poland providing insights on retail and finally, Citeve[28] in Portugal focusing on the textile industry. In addition, experts specialising in each of the industries included in the study complement industry-specific findings.

The gap analysis was performed using these methods:

- Literature review and analysis of relevant national and European policies, strategies and regulations that focus on the adoption of technologies in the chosen country-industry pairs.

- Analysis of international indicators and national-level statistics to provide both a general overview of the industry as well as a deep dive into aspects regarding its digitalisation. Relevant indicators include economic, digital technology uptake and contextual (for example, digital infrastructure, skills, innovation) indicators.

- Semi-structured interviews with stakeholders (SMEs, business associations, clusters of SMEs, chambers of commerce, policymakers and/or academics).

- Research findings were further complemented and validated at an online workshop on 'European industry digitalisation – the challenges ahead' organised on 28 June 2022 as part of the study.

The presentation of the results of the gap analysis is structured around the five selected country-industry pairs. It includes an overview of the overall state of play in the pairs, including the effects caused by external shocks, and a description of digitalisation in the industry, including an analysis of policy, social and economic factors, main strengths, and challenges. The results of the gap analysis are presented in Chapter 3 of this report.

[24] More information available at: https://agrifood.lt/.

[25] More information at: https://innomine.com/.

[26] More information at: https://www.iceberg.ro/en/digital-innovation-hub/.

[27] More information at: https://dih4.eu

[28] More information at: https://www.citeve.pt/.

2. Context and background

This chapter aims to present the context and background of this study. It details the importance of industry digitalisation in Europe and introduces factors that affect industry digitalisation. These include both industry-level factors (policy, economic and social) and recent external shocks, such as the COVID-19 crisis and the Russian invasion of Ukraine.

2.1. Importance of industry digitalisation in Europe

Industry is the backbone of the EU economy, making up 25% of EU-27 value added in 2020[29] and more than 30% of its economy.[30] It is viewed by the European Commission as instrumental in achieving the EU's sustainable growth objectives to remain competitive globally, while ensuring the Union's strategic autonomy.[31] Europe's guiding principle of competitive sustainability for the future,[32] which aims to achieve a climate-neutral, resource-efficient and agile digital economy. To implement the principle of competitive sustainability, European industry is currently undergoing a twin transition, paving the way for climate neutrality by 2050 and making Europe fit for the digital age.[33]

The adoption of digital technology is associated with new business opportunities and significant gains in productivity.[34] In 2017, the EU invested around 2% of gross domestic product (GDP) in ICT. This compares with an investment of 3.5% by the United States (US) and 3% by Japan.[35] By 2030, new digital technologies could add an additional EUR 2.2 trillion to the EU's GDP – an increase of 14.1% compared with 2017. This amount would more than offset the required investment. However, to achieve it would be necessary to address the EU's digital investment gap of about EUR 125 billion per year.[36] Adopting the necessary measures and increasing investment by 2022 instead of 2025 could result in an increase in GDP of 3.2% by 2030.[37,38] As global competition in digital

[29] Own elaboration based on Eurostat nama_10_a10 statistics. Available at: http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

[30] European Commission (2020). A New Industrial Strategy for Europe. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1593086905382&uri=CELEX:52020DC0102

[31] European Commission (2020). Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. A New Industrial Strategy for Europe. COM/2020/102 final. Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1593086905382&uri=CELEX%3A52020DC0102

[32] European Commission (2021). Communication from The Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery. COM (2021) 350 final. Available at https://ec.europa.eu/info/sites/default/files/communication-industrial-strategy-update-2020_en.pdf

[33] European Commission (2021). DESI 2021: Thematic Chapters. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

[34] MGI (2018). Assessing the economic impact of artificial intelligence, ITU Trends, Issue Paper No. 1, September 2018.

[35] EIB (2021). Innovation for inclusive Green and Digital Transition. Innovation, Digital & Human Capital (IDHC) Orientation 2021-2027. Available at: https://www.eib.org/attachments/publications/innovation_for_inclusive_green_and_digital_transition_en.pdf

[36] McKinsey (2020). Shaping the Digital Transformation in Europe. European Commission. ISBN 978-92-76-19509-2. Available at: https://www.standict.eu/sites/default/files/2021-02/McKinsey%20report.pdf

[37] European Commission (2020). Communication on shaping Europe's digital future. Available at: https://ec.europa.eu/info/sites/default/files/communication-shaping-europes-digital-future-feb2020_en_4.pdf

[38] McKinsey (2020). Shaping the Digital Transformation in Europe. European Commission. ISBN 978-92-76-19509-2. Available at: https://www.standict.eu/sites/default/files/2021-02/McKinsey%20report.pdf

technologies increases, Europe can no longer afford to miss out on the full potential of industrial digitalisation.[39]

During the COVID-19 crisis, many companies that had previously not adopted any advanced digital technologies began to invest in digital transformation.[40] While the uptake of digital technologies in Europe is growing, it still trails behind other big economies such as the US.[41] For example, 66% of firms in the US have adopted advanced technologies, while 61% have done so in the EU.[42] Moreover, Europe remains dependent on Asia and the US for digital capacities including hardware, computing power, and software.[43] When compared to other large economies, the EU has a relatively large proportion of SMEs, that tend to have a lower overall level of digitalisation than large companies.[44,45] However, discrepancies in performance persist even when looking at SME digitalisation performance. When compared to Norway and the United Kingdom (UK) in 2019, fewer SMEs based in the EU were using computers with access to the World Wide Web, had a website, used social media, sold online, or used cloud computing.[46]

Recognising the digitalisation challenges faced by SMEs, the European Commission adopted the EU's Digital Compass, that translates EU's digital ambitions for 2030 into concrete targets.[47] This sets an ambitious goal of more than 90% of SMEs achieving at least a basic level of digital intensity by 2030 (currently, the figure stands at around 61%). Evidence shows that the ability to benefit from digital technologies depends on company size. Noticeable gaps exist between large companies and SMEs, both in terms of overall digital intensity and in the uptake of advanced technologies. For example, 80% of large enterprises have adopted enterprise resource planning (ERP) systems, compared with only 35% of SMEs. Only 17% of SMEs currently sell online, compared with 39% of large enterprises.[48] Among SMEs, there is also a lower uptake of medium-sophistication cloud services (24.9% as opposed to 48.1% in large companies), big data analysis (13.6%

[39] European Commission (2022). Shaping Europe's digital future. Supporting industry. Available at: https://digital-strategy.ec.europa.eu/en/policies/supporting-industry

[40] EIB (2022). Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022

[41] BCG (2020). As the COVID-19 Crisis Reveals, Europe Urgently Needs to Digitize Its Industry. Available at. https://www.bcg.com/publications/2020/covid-crisis-reveals-europe-urgently-needs-industry-digitization

[42] EIB (2022). Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022

[43] European Commission (2021). Staff working document - Annual Single Market Report 2021. Available at: https://ec.europa.eu/info/files/staff-working-document-annual-single-market-report-2021_en

[44] Revoltella, D., Rückert, D. and Weiss, C. (2020). Adoption of digital technologies by firms in Europe and the US. VoxEU, 18 March 2020

[45] EIB (2022). Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022

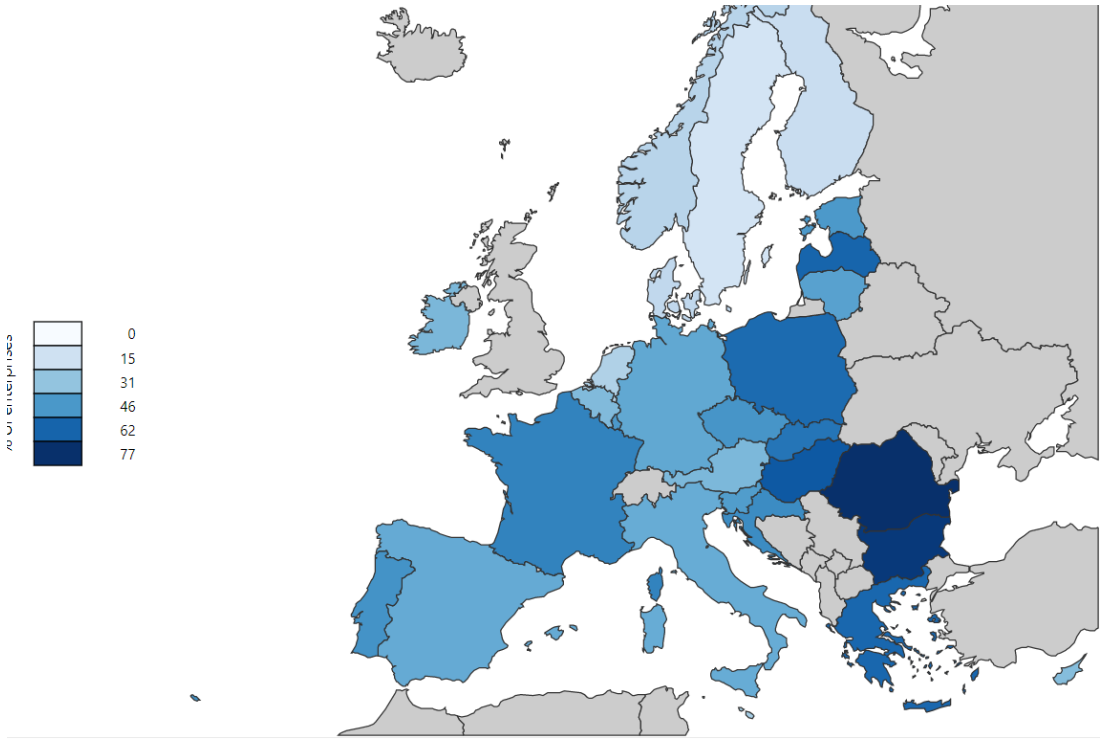
[46] European Commission (2021). Executive Agency for Small and Medium-sized Enterprises. Muller, P., Devnani, S., Ladher, R., et al., Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document, Hope, K.(editor), Publications Office, 2021. Available at: https://op.europa.eu/en/publication-detail/-/publication/4b9b0f42-dade-11eb-895a-01aa75ed71a1/language-en/format-PDF/source-search

[47] European Commission (2022). Europe's Digital Decade: digital targets for 2030. Available at: https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en

[48] European Commission (2021). DESI 2021: Thematic Chapters. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi

versus 34.3% in large companies)[49] and AI (7.31% versus 28.5% in large companies).[50] The uptake of digital technologies is especially low in traditional sectors such as construction and basic goods manufacturing, and in Eastern and Southern European countries (see Figure 7).[51]

Figure 7. SMEs with very low digital intensity index (DII v3), without financial sector, 2021



Source: European Commission (2021). DESI 2021.
Note: darker colour indicates a higher rate of SMEs with very low digital intensity.

According to the annual report on European SMEs 2020/2021, the majority of SMEs still do not consider digital technologies suitable for their business (59% of companies do not use ICT); 34% think the costs outweigh the benefits; and 30% lack the necessary digital skills. National SME associations and SME digitalisation support organisations also point to a lack of skills, as well as a lack of internal and external financing, as major barriers to the adoption of digital technology.[52] It is thus important to study those measures that can support the uptake of digital technologies by SMEs.

2.2. Factors influencing industry digitalisation

Several factors influence digital technology uptake in the European industry. These factors can be divided into three broad categories: policy, economic, and social**.** For example,

[49] European Commission (2020). DESI 2020.

[50] European Commission (2021). DESI 2021.

[51] EIB (2020). Financing the digitalisation of small and medium-sized enterprises: The enabling role of digital innovation hubs. Available at: https://www.eib.org/attachments/thematic/financing_the_digitalisation_of_smes_en.pdf

[52] European Commission (2021). Executive Agency for Small and Medium-sized Enterprises. Muller, P., Devnani, S., Ladher, R., et al., Annual report on European SMEs 2020/2021 : digitalisation of SMEs : background document, Hope, K.(editor), Publications Office, 2021, https://data.europa.eu/doi/10.2826/120209

good governance and efficient institutions have a positive effect on digitalisation,[53] while the availability of digital skills and connectivity correlates with higher rates of investment and adoption of digital technologies.[54,55] Beyond industry-level factors, external shocks can have profound effects on technology uptake as well, for example, by being a catalyst or an impediment to more innovation and technological advancement.[56] Some evidence suggests that COVID-19 widened the digital divide between larger, established enterprises and SMEs.[57] Therefore, to evaluate digitalisation gaps, it is important to not only analyse the uptake of technologies but also to look at various enabling factors for successful industry digitalisation and the consequences of external shocks.

2.2.1. Industry-level factors

Regarding policy, governance and the regulatory framework, the European landscape is fragmented, as the regulatory framework is different between the Member States, especially for emerging technologies.[58] While all EU countries have adopted strategies or action plans to support industry digitalisation, the scope, objectives, allocated resources, and intensity differ from country to country.[59] Therefore, good governance, efficient institutions and support initiatives for businesses are key preconditions for further digitalisation efforts. This is supported by businesses, including SMEs, that point to a need for access to public support schemes.[60,61]

Sufficient digital skills are essential for the successful uptake of digital technologies. Even though most jobs require them, only 56% of the EU population have at least basic digital skills. To reach the 2030 target of 80%, the growth rate of this indicator needs to increase threefold. Demand for programming skills and skills that fit hybrid jobs are increasingly sought after as well.[62] The majority of European businesses consider the lack of personnel with sufficient digital skills as a barrier to investment. The lack of specialised education

[53] Anderton, Bob et al. (2020) : Virtually everywhere? Digitalisation and the euro area and EU economies: Degree, effects, and key issues, ECB Occasional Paper, No. 244, ISBN 978-92-899-4250-8, European Central Bank (ECB), Frankfurt a. M. Available at: https://doi.org/10.2866/339471.

[54] EIB (2022). Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022.

[55] EIB (2022). Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022.

[56] Bain & Company (2022). Ukraine crisis: respond and reposition. Available at: https://www.bain.com/globalassets/noindex/2022/bain_insights_ukraine-crisis-respond-reposition.pdf.

[57] EIB (2022). Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022.

[58] McKinsey (2020). Shaping the Digital Transformation in Europe. European Commission. ISBN 978-92-76-19509-2. Available at: https://www.standict.eu/sites/default/files/2021-02/McKinsey%20report.pdf.

[59] VVA & Wik Consult (2020). Study on Monitoring Progress in National Initiatives on Digitising Industry. SMART 2018/0002. Available at: https://digital-strategy.ec.europa.eu/en/events/workshop-monitoring-progress-national-initiatives-digitising-industry-support-digital.

[60] EIB (2022). Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022.

[61] European Commission (2021). Executive Agency for Small and Medium-sized Enterprises. Muller, P., Devnani, S., Ladher, R., et al., Annual report on European SMEs 2020/2021: digitalisation of SMEs: background document, Hope, K.(editor), Publications Office, 2021, https://data.europa.eu/doi/10.2826/120209.

[62] European Commission, Executive Agency for Small and Medium-sized Enterprises, Siebes, C., Linden, N., Kolding, M. (2019). Digital organisational frameworks and IT professionalism, Publications Office. https://data.europa.eu/doi/10.2826/335797.

programmes and insufficient integration of digital subjects in other disciplines further exacerbate the problem.[63]

Consumer expectations are also changing. As a result of the global pandemic, consumers have increasingly started using digital channels to buy goods and services.[64] In 2021, 90% of individuals in Europe had accessed the internet in the last 12 months, and 74% of them had ordered goods or services online. Of people who had used the internet in the last three months, 74% obtained information on goods and services online.[65] At the same time, trust in new technologies is an important incentive for adoption, yet a significant proportion of consumers still do not trust digital services (44% in 2021).[66]

COVID-19 has led to increased digital customer interaction, remote work, and the operation of industrial processes.[67] For this to succeed, ultrafast connectivity is a necessary precondition, and lack thereof can increase the digital divide.[68] One in six firms sees access to digital infrastructure as an obstacle for investment, an indicator that is positively correlated to average latency in transferring data.[69]

Furthermore, access to financing and investment, including through public support programmes, can accelerate the uptake of digital technologies. Globally, companies have made unprecedented investments in digitalisation, increasing from 3.5% of revenue in 2020, to 4.7% in 2021 and an estimated 5.8% of revenue in 2022.[70] However, SMEs perceive the lack of availability of financing from both private and public sources as a significant barrier.[71] At the same time, the companies that received public support during the COVID-19 crisis were much more likely to increase their level of digitalisation than those that did not.[72]

Fostering innovation is especially important for the adoption of new and advanced digital technologies. In 2020, for the first time in over a decade, digital technologies took the lead in European Patent Office (EPO) applications. In 2021, digital communication and

[63] Feijao, C., Flanagan, I., Van Stolk, C. & Gunashekar, S. (2021). The global digital skills gap: Current trends and future directions. Santa Monica, CA: RAND Corporation. Available at: https://www.rand.org/pubs/research_reports/RRA1533-1.html.

[64] McKinsey (2021). What's next for digital consumers? Available at: https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/whats-next-for-digital-consumers.

[65] European Commission (2021). DESI 2021: Thematic Chapters. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi.

[66] McKinsey (2021). What's next for digital consumers? Available at: https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/whats-next-for-digital-consumers.

[67] European Commission (2021). DESI 2021: Thematic Chapters. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi.

[68] Cavallini, S. & Soldi, R. (2021). The state of digital transformation at regional level and COVID-19 induced changes to economy and business models, and their consequences for regions. Publication Office of the European Union. ISBN 978-92-895-1103-2 doi:10.2863/37402.

[69] EIB (2022). Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022.

[70] EY Parthenon (2022). How can your digital investment strategy reach higher returns? Available at: https://www.ey.com/en_gl/strategy/digital-investment-report.

[71] Cavallini, S. & Soldi, R. (2021). The state of digital transformation at regional level and COVID-19 induced changes to economy and business models, and their consequences for regions. Publication Office of the European Union. ISBN 978-92-895-1103-2 doi:10.2863/37402. Available at: https://op.europa.eu/en/publication-detail/-/publication/3fb4164e-f0dc-11eb-a71c-01aa75ed71a1.

[72] EIB (2022). Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022.

computer technology showed the biggest growth.[73,74] However, the worldwide share of R&D spending by European companies has declined in the last five years, while the shares of US and Chinese R&D spending increased.[75] The EU also is behind the US and China in digital innovation and Industry 4.0-related patent applications.[76]

Individual factors affecting the digitalisation of the five industries within the scope of this study are further detailed in Chapter 3.

2.2.2. External shocks

External shocks are sudden, drastic, and unforeseen changes affecting the entire economy,[77] that often have far-reaching effects on the industry. These shocks result in both direct (for example, price increases in inputs subjected to sanctions) and cascading (for example, reduced consumer demand due to an overall economic downturn) effects. In this study, particular emphasis is placed on two consecutive 'black swan' events: the COVID-19 pandemic and the Russian invasion of Ukraine on 24 February 2022.

The COVID-19 pandemic had a profound effect on European industry and the role, perception, and pace of digitalisation.[78] Moreover, the ongoing COVID-19 recovery has been dampened by the Russian invasion of Ukraine, which has resulted in a worsened European economic outlook in comparison to 2021.[79] Limited research currently exists on the impact of the war on European industry digitalisation. Nevertheless, the supply chain shocks, commodity price increases, and uncertainty have already had observable consequences on certain industries, for example, energy-intensive manufacturing sectors[80] and the agrifood sector.[81]

2.2.2.1. Consequences of the COVID-19 pandemic

The pandemic caused wide-ranging effects from supply chain disruptions to labour shortages impacting every sector of the economy. In response, policymakers established short-term support mechanisms and interventions to promote resilience and recovery in the long term. During the crisis, digital technologies have become a key driver of competitiveness, a critical component of crisis response,[82] and helped to strengthen

[73] EPO (2020). Digital technologies take top spot in European patent applications. Available at: https://www.epo.org/news-events/news/2020/20200312.html.

[74] EPO (2022). Patent applications in Europe reach record level in 2021. Available at: https://www.epo.org/news-events/news/2022/20220405.html.

[75] European Commission (2020). A New Industrial Strategy for Europe. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1593086905382&uri=CELEX:52020DC0102.

[76] EIB (2022). EIB Investment Report 2021/2022: Chapter 5: Investing in Europe's digital transformation. Part III Recovery as a springboard for structural change. Available at: https://www.eib.org/attachments/publications/economic_investment_report_2021_chapter05_en.pdf.

[77] Economic shock. (n.d.) Financial Glossary. (2011). Available at: https://financial-dictionary.thefreedictionary.com/Economic+shock.

[78] McKinsey (2021). COVID-19: An inflection point for Industry 4.0. Available at: https://www.mckinsey.com/business-functions/operations/our-insights/covid-19-an-inflection-point-for-industry-40.

[79] Euromonitor (2022). Global Economic Outlook: Q2 2022. Available at: https://www.euromonitor.com/article/global-economic-outlook-q2-2022.

[80] Accenture (2022). The war in Ukraine: Addressing the crisis and preparing for its impact. Available at: https://www.accenture.com/us-en/insights/strategy/ukraine-addressing-crisis-preparing-impact.

[81] World Bank (2022). Commodity Markets Outlook April 2022. Special Focus: The Impact of the War in Ukraine on Commodity Markets. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/37223/CMO-April-2022-special-focus.pdf.

[82] McKinsey (2021). COVID-19: An inflection point for Industry 4.0. Available at: https://www.mckinsey.com/business-functions/operations/our-insights/covid-19-an-inflection-point-for-industry-40.

resilience from economic shocks.[83] In turn, COVID-19 created incentives for an unprecedented acceleration of digital transformation across the EU.[84]

The COVID-19 crisis has had a detrimental impact on the European economy, while the war in Ukraine dampens the forecasted recovery from the initial shock of COVID-19.[85] A sharp decline in industrial production was observed between March and April of 2020, with signs of recovery emerging by the beginning of 2021. From February 2021 until February 2022, industrial production fell by 2% in the eurozone and by 3% in the EU.[86] Around 10% of businesses suspended their operations, with more than one-third (36%) partially suspending activities due to the crisis.[87] Because of social distancing measures, many companies had to scale down operations or switch to remote working. According to Eurofound, teleworking was the normal form of work for 30% of the European labour force during the COVID-19 crisis. However, due to structural characteristics, not all sectors adopted remote work equally. For example, less than 20% of employees in the industry worked fully from home, with 14% doing so partially.[88] According to a recent European Economy Discussion Paper, between March 2020 and December 2021, about 10% of firms that were considered viable before the COVID-19 crisis shifted into insolvency. The shock of the pandemic explains most of the observed liquidity distress and higher financial vulnerability between countries and industries in this period. The discussion paper also outlines a significant sectoral heterogeneity in impact, with certain industries being affected more significantly than others (see Table 1).[89]

Table 1. Industries with the highest turnover and insolvency consequences from the pandemic

Ten industries with the highest cumulative turnover impact (2020-2021):	Highest proportion of firms at risk of insolvency as a consequence of COVID-19 where solvency concerns can be attributable to the pandemic:
1. accommodation and food; 2. textiles; 3. transport; 4. professional and admin services; 5. transport equipment; 6. food; 7. construction;	1. accommodation and food; 2. transport; 3. textiles; 4. professional and admin services; 5. transport equipment; 6. food; 7. information and communication;

[83] Dilyard, J., Zhao, S., & You, J. J. (2021). Digital innovation and Industry 4.0 for global value chain resilience: Lessons learned and ways forward. *Thunderbird International Business Review*, *63*(5), 577-584.

[84] European Commission (2021). DESI 2021: Thematic Chapters. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi.

[85] European Commission (2022). Spring 2022 Economic Forecast: Russian invasion tests EU economic resilience. Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3070.

[86] Eurostat (2022). Euroindicators 43/2022 - 20 April 2022. Industrial production up by 0.7% in the euro area and by 0.6% in the EU. Available at: https://ec.europa.eu/eurostat/documents/2995521/14497733/4-20042022-AP-EN.pdf/74340f94-56cf-f070-eeb3-4433fd7ddea5?t=1650441499757.

[87] Van Loo, J.; Eiffe, F. and Van Houten, G. (2021). Adapting business practices to new realities in the middle of a crisis: first findings from the COVID-19 European company survey. Luxembourg: Publications Office of the European Union. Cedefop working paper; No 5. Available at: http://data.europa.eu/doi/10.2801/92218.

[88] Eurofound (2020). Regulations to address work–life balance in digital flexible working arrangements, New forms of employment series, Publications Office of the European Union, Luxembourg.

[89] Archanskaia, L., Canton, E., Hobza A., Nikolov, P. & Simons, W. (2022). The Sectoral Nature of the COVID-19 Shock: A Novel Approach to Quantifying its Economic Impact. European Commission. Luxembourg: Publications Office of the European Union, 2022. Discussion paper 162. ISSN 2443-8022. Available at: https://ec.europa.eu/info/sites/default/files/economy-finance/dp162_en.pdf.

Ten industries with the highest cumulative turnover impact (2020-2021):	Highest proportion of firms at risk of insolvency as a consequence of COVID-19 where solvency concerns can be attributable to the pandemic:
8. other mineral products; 9. other manufacturing; 10. wood and paper.	8. construction; 9. basic metals; 10. other manufacturing.

Source: adapted from Van Loo, J.; Eiffe, F. and Van Houten, G. (2021).
Note: industries are presented in descending order (highest to lowest impact/proportion).

All sectors included in this study (agrifood, textile, automotive, retail and construction) observed the biggest drop in turnover or production during 2020 Q2, with most recovering to pre-pandemic levels since then. A notable exception is the automotive sector, which saw a drastic fall in production,[90] demand,[91] and turnover. In 2021 Q4 the automotive sector turnover still had not fully recovered to pre-pandemic levels.[92] This sector will also likely be affected by further supply chain shocks related to the Russian invasion of Ukraine (see Section 2.2.2.2). Manufacturing of textiles, wearing apparel, leather and related products also saw a drop of 26.6% in turnover in 2020 Q2 as compared to the previous quarter but made a recovery to its pre-pandemic level by 2021 Q4. At the same time, both retail and manufacturing of food and beverages saw turnover decrease by less (-5.1% and -9.7% in 2020 Q2 as compared to Q1, respectively) and bounced back relatively quickly (2020 Q3 and 2021 Q2). In the construction sector, industrial production dropped by 10.6% during the onset of the pandemic and reached the pre-pandemic level by the second quarter of 2021.[93]

COVID-19 has had a particularly severe impact on SMEs,[94] which also faced a slower recovery in comparison to larger firms.[95] In 2020, 60% of European SMEs reported experiencing a decrease in turnover.[96] Overall, the value added generated by SMEs declined by 7.6% in 2020.[97] They were affected by temporary shutdowns, supply chain

[90] ACEA (2021). Truck makers gear up to go fossil-free by 2040, but EU and Member States need to step up their game. Available at: https://www.acea.be/news/article/interactive-map-covid-19-impact-on-eu-automobile-production-up-until-septem.

[91] ACEA (2020). Passenger car registrations. Available at: https://www.acea.be/press-releases/article/passenger-car-registrations-28.8-ninemonths-into-2020-3.1-in-september.

[92] 2019 Q4 is used as a reference for 'pre-pandemic' level of turnover.

[93] Eurostat Short-term Business statistics. Available at: https://ec.europa.eu/eurostat/databrowser/explore/all/icts?lang=en&subtheme=sts.sts_ind&display=list&sort=category&extractionId=STS_TRTU_Q__custom_2786321.

[94] Adian, I.; Doumbia, D.; Gregory, N.; Ragoussis, A.; Reddy, A.; Timmis, J. David. (2020). Small and Medium Enterprises in the Pandemic: Impact, Responses and the Role of Development Finance (English). Policy Research working paper,no. WPS 9414,COVID-19 (Coronavirus) Washington, D.C.: World Bank Group. Available at: http://documents.worldbank.org/curated/en/729451600968236270/Small-and-Medium-Enterprises-in-the-Pandemic-Impact-Responses-and-the-Role-of-Development-Finance.

[95] Cirera, X.; Vargas Da Cruz, MJ.; Grover, AG.; Iacovone,L.;Medvedev,D.; Pereira Lopez,MDLP.; Reyes,S. (2021). Firm Recovery during COVID-19 : Six Stylized Facts (English). Policy Research working paper,no. WPS 9810,COVID-19 (Coronavirus) Washington, D.C. : World Bank Group. Available at: http://documents.worldbank.org/curated/en/862851634563353449/Firm-Recovery-during-COVID-19-Six-Stylized-Facts.

[96] European Commission/European Central Bank (2020). Survey on the access to finance of enterprises (SAFE).

[97] European Commission (2021). SME Annual Report 2020/2021. Available at: https://ec.europa.eu/docsroom/documents/46062.

disruptions, and shortages of staff.[98] The Annual report on European SMEs 2020/2021 found that SMEs implemented different mitigation measures to respond to the COVID-19 crisis. These included ceasing trade, using existing government support programmes, and adopting digital tools and online sales to continue operations.[99] Nearly 25% of SMEs operating in the construction industry, and 20% of those operating in retail, indicated that COVID-19 has negatively affected their ability to obtain production inputs.[100]

The COVID-19 pandemic evoked a strong policy response, with both Member States and the European Commission adopting measures to respond to disruption and eventually facilitate recovery and foster digitalisation. As the COVID-19 pandemic entered a new phase of renewal and growth, the policy responses needed to become more structural and promote SME resilience in the long term. These policies need to focus on innovation, internationalisation, and networking.[101] The RRF was established in February 2021[102] and constitutes the largest programme under the Next Generation EU recovery plan. The RRF pursues a twin (green and digital) transition, with a minimum of 20% of each Member State's allocated budget devoted to fostering the digital transition and/or addressing the resulting challenges.[103]

The pandemic brought about years' worth of change in digitalisation in a matter of months.[104] Faced with the reality of social distancing, operation shutdowns, and supply chain disruptions, many companies relied on digital technologies to maintain their business activities. The 2021 EIB Investment Survey found that 46% of EU firms have acted or made investments to become more digital as a response to COVID-19. In 2020, around 33% of EU enterprises increased the share of employees with remote access to ICT systems and the e-mail system, while half of all enterprises increased the number of remote meetings. Remote access and meetings were more common in large enterprises than in SMEs.[105] E-commerce saw a large increase in 2020, with all countries experiencing a rise in e-commerce turnover and share of GDP.[106]

Most enterprises also foresee that COVID-19 will impact their long-term needs and priorities (72%), especially the need to use digital technologies (reported by 55% of firms).[107] There are indications that telework is here to stay as well. Most employers do

[98] European Commission (2021). Annual Single Market Report 2021. SWD (2021) 351 final. Available at https://ec.europa.eu/info/sites/default/files/swd-annual-single-market-report-2021_en.pdf.

[99] European Commission (2021). Annual report on European SMEs 2020/2021: Digitalisation of SMEs. Available at: https://op.europa.eu/en/publication-detail/-/publication/4b9b0f42-dade-11eb-895a-01aa75ed71a1/language-en/format-PDF/source-search.

[100] Vodafone SME Understanding Survey, 2020.

[101] Juergensen, J., Guimón, J. & Narula, R. European SMEs amidst the COVID-19 crisis: assessing impact and policy responses. J. Ind. Bus. Econ. 47, 499–510 (2020). https://doi.org/10.1007/s40812-020-00169-4.

[102] European Commission (2021). REGULATION (EU) 2021/241 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 February 2021 establishing the Recovery and Resilience Facility. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0241&from=EN.

[103] European Commission (2021). DESI 2021: Thematic Chapters. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi.

[104] McKinsey (2020). How COVID-19 has pushed companies over the technology tipping point—and transformed business forever. Available at: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever.

[105] Eurostat. Impact of COVID-19 on the use of ICT in enterprises. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Impact_of_COVID-19_on_the_use_of_ICT_in_enterprises#Impact_of_COVID-19_pandemic_on_remote_access_to_enterprise_resources_and_remote_meetings.

[106] Lone, S., Harboul, N. & Weltevreden, J.W.J. (2021). 2021 European E-commerce Report. Amsterdam/Brussels: Amsterdam University of Applied Sciences & Ecommerce Europe. Available at: https://ecommerce-europe.eu/wp-content/uploads/2021/09/2021-European-E-commerce-Report-LIGHT-VERSION.pdf.

[107] EIB (2021). Investment Survey 2021: European Union. Available at: https://www.eib.org/attachments/publications/eibis_2021_european_union_en.pdf.

not expect the proportion of teleworkers to decrease in the next three years.[108] However, there is also evidence to suggest that the gaps in digitalisation and innovation have widened based on firm size.[109] Therefore, to avoid the benefits accruing only to already large and productive firms, it is important to support SMEs in their digital transformation journey.

2.2.2.2. Consequences of the Russian invasion of Ukraine

As a response to Russia invading Ukraine on 24 February 2022, the EU has implemented wide-reaching sanctions on Russia and Belarus.[110] Both sanctions and war-related disruptions to global supply chains have had spillover effects on the entire European economy. As a result, the global economic outlook has significantly worsened in comparison to 2021.[111] Shocks are particularly notable concerning energy, commodity, fertiliser, and food prices, and have resulted in record-high inflation.[112,113] Moreover, cascading effects from supply chain disruptions affect many industries, including construction, automotive, transport and petrochemicals.[114,115] For example, according to the World Bank, Ukraine is a key exporter of inputs for various industries, such as:

- rolled iron products that are used in heavy manufacturing and construction;
- neon gas that is used in the production of semiconductors (approximately 40-50% of global output);
- various inputs (for example, ignition wiring sets, axles, and wheels) used in transport vehicles.[116]

The economic exposure to war-related shocks varies based on region and country. According to the Spring 2022 European Economic Forecast, the countries with the most

[108] Van Loo, J.; Eiffe, F. and Van Houten, G. (2021). Adapting business practices to new realities in the middle of a crisis: first findings from the COVID-19 European company survey. Luxembourg: Publications Office of the European Union. Cedefop working paper; No 5. Available at: http://data.europa.eu/doi/10.2801/92218.

[109] Cirera, X.; Vargas Da Cruz, MJ.; Grover, AG.; Iacovone,L.; Medvedev,D.; Pereira Lopez,MDLP.; Reyes,S. (2021). Firm Recovery during COVID-19 : Six Stylized Facts (English). Policy Research working paper,no. WPS 9810,COVID-19 (Coronavirus) Washington, D.C. : World Bank Group. Available at: http://documents.worldbank.org/curated/en/862851634563353449/Firm-Recovery-during-COVID-19-Six-Stylized-Facts.

[110] European Commission (2022). EU sanctions against Russian following the invasion of Ukraine. Available at: https://ec.europa.eu/info/strategy/priorities-2019-2024/stronger-europe-world/eu-solidarity-ukraine/eu-sanctions-against-russia-following-invasion-ukraine_en.

[111] Euromonitor (2022). Global Economic Outlook: Q2 2022. Available at: https://www.euromonitor.com/article/global-economic-outlook-q2-2022.

[112] Ozili, Peterson. (2022). Global Economic Consequence of Russian Invasion of Ukraine. SSRN Electronic Journal. 10.2139/ssrn.4064770.

[113] Benton, T. G., Froggatt, A. and Wellesley, L. (2022), The Ukraine war and threats to food and energy security: Cascading risks from rising prices and supply disruptions, Research Paper, London: Royal Institute of International Affairs, https://doi.org/10.55317/9781784135225.

[114] World Bank (2022). Commodity Markets Outlook April 2022. Special Focus: The Impact of the War in Ukraine on Commodity Markets. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/37223/CMO-April-2022-special-focus.pdf.

[115] McKinsey (2022). War in Ukraine: Twelve Disruptions Changing the World. Available at: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/war-in-ukraine-twelve-disruptions-changing-the-world.

[116] World Bank (2022). The Impact of the War in Ukraine on Global Trade and Investment. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/37359/IDU0008eed66007300452c0beb208e8903183c39.pdf?sequence=1.

significant exposure are Latvia, Estonia, Bulgaria, Lithuania, Czechia, Slovakia, Hungary, Poland, Slovenia, and Cyprus.[117]

While research on the effects of the invasion is still limited, different sources outline multiple observed and/or potential effects (see Table 2).

Table 2. Disruptions caused by the Russian invasion of Ukraine

Type of disruption	Description
Supply chain and commodity impact	
Supply chain disruption	The Russian invasion of Ukraine further challenges industries already struggling with supply chain disruption caused by COVID-19. Causes of the disruption include bans on imports and exports, restrictions on foreign cargo flows, flight bans, a refugee crisis and halted logistics and/or production in Ukraine (for example, Black Sea ports not being in operation from April 2022), affecting cross-border flow of goods.[118,119,120] Specific parts of the supply chain are particularly affected; for example, German car production dropped by 30% in the first quarter of 2022 due to a lack of materials imported from Ukraine.[121] The proportion of supply chain leaders that say they have implemented dual sourcing has increased from 55% to 80% since the beginning of the invasion.[122] Cascading effects include reorganisations in global supply chains, more emphasis on the EU internal market, and the building of more resilient production structures in the future.[123]
Oil and gas prices	Rising oil and gas prices are mainly caused by considerable restrictions on imports and exports from Russia. The energy price hike from April 2020 to March 2022 was the largest since 1973.[124,125] This, in turn, affects the industry, especially energy-intensive manufacturing.[126] As a response, the EU plans to significantly reduce its reliance on Russian energy and invest in renewables. If high commodity prices persist, a refocus toward less energy-intensive sectors is also possible.[127]

[117] European Commission (2022). European Economic Forecast Spring 2022. Available at: https://ec.europa.eu/info/system/files/economy-finance/ip173_en.pdf.

[118] European Commission (2022). EU sanctions against Russian following the invasion of Ukraine. Available at: https://ec.europa.eu/info/strategy/priorities-2019-2024/stronger-europe-world/eu-solidarity-ukraine/eu-sanctions-against-russia-following-invasion-ukraine_en.

[119] World Bank (2022). Commodity Markets Outlook April 2022. Special Focus: The Impact of the War in Ukraine on Commodity Markets. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/37223/CMO-April-2022-special-focus.pdf.

[120] Ozili, Peterson. (2022). Global Economic Consequence of Russian Invasion of Ukraine. SSRN Electronic Journal. 10.2139/ssrn.4064770.

[121] VDA (2022). Production and market also down in April. Press release. Available at: https://www.vda.de/vda/en/Press/press-releases/220504_PM_Production-and-market-also-down-in-April.

[122] McKinsey (2022). War in Ukraine: Twelve Disruptions Changing the World. Available at: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/war-in-ukraine-twelve-disruptions-changing-the-world.

[123] European Commission (2022). European Economic Forecast Spring 2022. Available at: https://ec.europa.eu/info/system/files/economy-finance/ip173_en.pdf.

[124] World Bank (2022). Commodity Markets Outlook April 2022. Special Focus: The Impact of the War in Ukraine on Commodity Markets. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/37223/CMO-April-2022-special-focus.pdf.

[125] Ozili, Peterson. (2022). Global Economic Consequence of Russian Invasion of Ukraine. SSRN Electronic Journal. 10.2139/ssrn.4064770.

[126] Accenture (2022). The war in Ukraine: Addressing the crisis and preparing for its impact. Available at: https://www.accenture.com/us-en/insights/strategy/ukraine-addressing-crisis-preparing-impact.

[127] European Commission (2022). European Economic Forecast Spring 2022. Available at: https://ec.europa.eu/info/system/files/economy-finance/ip173_en.pdf.

Type of disruption	Description
Agriculture and food inputs and products	Russia and Ukraine are some of the largest global exporters of wheat, sunflower oil, and maize. Both Russia and Belarus are also significant fertiliser exporters.[128] In Ukraine, agricultural production is heavily impacted due to labour shortages, shortage of inputs, destroyed equipment and safety concerns. Moreover, Russia is being accused of actively weaponising the food crisis by confiscating grain stocks and machinery, as well as blockading shipping in the Black Sea.[129] The forecasted decline in agriculture production falls between 20-50%.[130] Commodity prices have risen to a level not seen since 2007/2008, threatening both global food security as well as the agrifood industry.[131] The immediate effect of this is threatening low-income and vulnerable populations in all economies, including in Europe. Potential indirect risks include unrest and conflict in some parts of the world, further supply shocks, resource insecurity, market volatility, displacement of people and geopolitical impacts.[132]
Other materials and goods	In response to the war, the EU has applied sanctions to many goods and services. Sanctioned types of goods include dual-use goods and technology, military goods and technology, aviation or the space industry, luxury goods and maritime navigation goods. Sanctions also include an import ban on goods generating revenue for Russia (fertilisers, cement, wood, glass products, etc.) and an export ban on goods, which could contribute to the enhancement of Russian industrial capacities (chemicals, wood, textiles, construction material, metals, machinery).[133] Commodity price increases are affecting many industries. For example, the automotive industry has seen the cost of materials used for gasoline-powered cars rise by 17% in the time until April 2022.[134]
Economic and financial market impact	
Financial markets	Financial markets impacts include financial asset repricing, tightening of financing conditions and potentially increased fragmentation of the payment system. Stock markets experienced increased market volatility, negative returns in the aftermath of 24 February, proximity effects[135] and negative effects on the stocks of companies that are choosing to remain in Russia.[136] Negatively affected sectors include apparel, fashion and luxury, automotive and assembly, and retail, among others.[137]

[128] Chatham House (2022). Resource Trade Earth Dashboard. Available at: https://resourcetrade.earth.

[129] Reuters (2022). EU's von der Leyen says Russia is using food supplies as a weapon. Available at: https://www.reuters.com/world/europe/eus-von-der-leyen-says-russia-is-using-food-supplies-weapon-2022-05-24/.

[130] FEWS NET (Famine Early Warning Systems Network) (2022). Ukraine. Targeted Analysis. U.S. Agency for International Development, Washington, DC.

[131] World Bank (2022). Commodity Markets Outlook April 2022. Special Focus: The Impact of the War in Ukraine on Commodity Markets. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/37223/CMO-April-2022-special-focus.pdf.

[132] Benton, T. G., Froggatt, A. and Wellesley, L. (2022). The Ukraine war and threats to food and energy security: Cascading risks from rising prices and supply disruptions, Research Paper, London: Royal Institute of International Affairs, https://doi.org/10.55317/9781784135225.

[133] European Commission (2022). EU measures following the Russian invasion of Ukraine (europa.eu). Available at: https://ec.europa.eu/taxation_customs/customs-4/international-affairs/eu-measures-following-russian-invasion-ukraine_en.

[134] McKinsey (2022). War in Ukraine: Twelve Disruptions Changing the World. Available at: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/war-in-ukraine-twelve-disruptions-changing-the-world.

[135] Federle, J, Meier, A, Muller, G and Sehn, V. (2022). 'Proximity to War: The stock market response to the Russian invasion of Ukraine'. London, Centre for Economic Policy Research. Available at: https://cepr.org/active/publications/discussion_papers/dp.php?dpno=17185.

[136] Tosun, OK, and Eshraghi, A. (2022). Corporate decisions in times of war: Evidence from the Russia-Ukraine conflict. Finance Research Letters, Volume 48, ISSN 1544-6123.

[137] McKinsey (2022). War in Ukraine: Twelve Disruptions Changing the World. Available at: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/war-in-ukraine-twelve-disruptions-changing-the-world.

Type of disruption	Description
Decline in economic output and growth	Higher producer and retail prices and expenditure on oil and gas result in reduced consumer demand and business and consumer confidence.[138] Foreign trade and global growth are also hit by higher costs and reduced trade with regions involved in the war. In the long term, these impacts may lead to a partial reversal of globalisation gains.[139]
Rising inflation	A March 2022 McKinsey global survey on executive sentiment found that executives rank inflation as the second-highest risk after geopolitical instability.[140] Inflation will impact the industries with a large share of their costs composed of material, labour, and energy inputs the most.[141]

Source: compiled by the research team based on various sources.

Note: the list of disruptions is non-exhaustive and presents impacts that were considered most relevant for industries included in this study.

A majority of European executives (86%) are planning fundamental operational changes in response to the crisis.[142] First and foremost, assessing exposure to supply chain risks from the war may become increasingly relevant and may entail using analytic methods, such as 'digital twins' to simulate potential disruption. To respond to a supply chain shock, companies might use advanced algorithms and data to optimise procurement and production yield or anticipate disruptions based on market signals.[143] Finally, as the employees continue to face uncertainty and pressure, many of the work arrangements that became commonplace during the global pandemic, such as remote working, will likely remain relevant.[144]

Cybersecurity risks have been on the rise since 2017 and have increased significantly since the onset of the war. Cyberattacks directly affect their original targets but can also have spillover effects[145] and cause operational disruption.[146] Even before the invasion, 28% of European SMEs had experienced cybercrime and were especially concerned about the hacking of online bank accounts, phishing, account takeover or impersonation

[138] Ozili, Peterson. (2022). Global Economic Consequence of Russian Invasion of Ukraine. SSRN Electronic Journal. 10.2139/ssrn.4064770.

[139] European Commission (2022). European Economic Forecast Spring 2022. Available at: https://ec.europa.eu/info/system/files/economy-finance/ip173_en.pdf.

[140] McKinsey (2022). War in Ukraine: Twelve Disruptions Changing the World. Available at: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/war-in-ukraine-twelve-disruptions-changing-the-world.

[141] Accenture (2022). From disruption to reinvention: The future of supply chains in Europe. Available at: https://www.accenture.com/us-en/insights/strategy/ukraine-future-supply-chains-europe.

[142] Accenture (2022). From disruption to reinvention: The future of supply chains in Europe. Available at: https://www.accenture.com/us-en/insights/strategy/ukraine-future-supply-chains-europe.

[143] KPMG (2022). Immediate and long-term impacts of the Russia-Ukraine war on supply chains. Available at: https://advisory.kpmg.us/blog/2022/impacts-russia-ukraine-war-supply-chains.html.

[144] Accenture (2022). The war in Ukraine: Addressing the crisis and preparing for its impact. Available at: https://www.accenture.com/us-en/insights/strategy/ukraine-addressing-crisis-preparing-impact.

[145] McKinsey (2022). War in Ukraine: Twelve Disruptions Changing the World. Available at: https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/war-in-ukraine-twelve-disruptions-changing-the-world.

[146] Harvard Business Review (2022). The Cybersecurity Risks of an Escalating Russia-Ukraine Conflict. Available at: https://hbr.org/2022/02/the-cybersecurity-risks-of-an-escalating-russia-ukraine-conflict.

attacks, and viruses, spyware, or malware.[147] In the current climate, companies should be motivated to pursue actions to mitigate and ensure long-term resilience to cyber threats.[148]

The war can also create threats to digital growth. These can include technology-related sanctions, divestment, cybersecurity risks, including those concerning critical infrastructure and connectivity networks, supply chain disruptions and general economic slowdown.[149] For example, according to the International Data Corporation, ICT spending growth in Europe will shrink by 1.7% in 2022 relative to previous forecasts.[150] Ukraine is also an important provider of ICT services. One in five Fortune500 companies uses services from Ukraine, and its exports amount to more than EUR 6.4 billion.[151] The largest export markets for ICT services are North America and Western Europe, and exports include a wide range of services, such as e-commerce, banking, fintech, DevOps, software quality assurance, and user experience design.[152]

[147] Eurobarometer (2022). SMEs and Cybercrime. Available at: https://europa.eu/eurobarometer/surveys/detail/2280.

[148] Accenture (2022). The war in Ukraine: Addressing the crisis and preparing for its impact. Available at: https://www.accenture.com/us-en/insights/strategy/ukraine-addressing-crisis-preparing-impact.

[149] Lim, W. M., et al. (2022). What is at stake in a war? A prospective evaluation of the Ukraine and Russia conflict for business and society. Global Business and Organizational Excellence, 1–14. https://doi.org/10.1002/joe.22162

[150] IDC (2022). Russia-Ukraine War to Adversely Impact Europe ICT Spending, IDC Says. Available at: https://www.idc.com/getdoc.jsp?containerId=prEUR249010522.

[151] Business Standard (2022). Not just energy markets: war in Ukraine disrupts tech industry. Available at: https://www.business-standard.com/article/international/not-just-energy-and-markets-russia-s-war-on-ukraine-disrupts-tech-industry-122030900241_1.html.

[152] World Bank (2022). The Impact of the War in Ukraine on Global Trade and Investment. Available at: https://openknowledge.worldbank.org/bitstream/handle/10986/37359/IDU0008eed66007300452c0beb208e8903183c39.pdf?sequence=1.

3. Presentation of the gap analysis

This chapter describes the results of gap analysis in five selected country-industry pairs (automotive in Hungary, agrifood in Lithuania, construction in Romania, retail in Poland, and textile in Portugal). Each section contains an overview of the general state of play of each pair, including an economic overview of the industry, recent trends concerning its growth and a description of the impacts of external shocks. Furthermore, each section includes an analysis of digitalisation in the industry, including key factors affecting digitalisation (policy, economic and social), and the main digitalisation strengths and challenges.

3.1. Automotive in Hungary

The section presents the results of the gap analysis for the automotive industry in Hungary. It first provides an overview of the industry's economic performance, before proceeding with the overview of the state of play of digitalisation of Hungary's automotive industry. It then presents key factors that impact the Hungarian automotive industry's digitalisation before concluding with an overview of the industry's strengths and weaknesses.

3.1.1. State of play overview

Hungary saw a GDP contraction of 4.5% in 2020, rebounding to 7.1% growth in the following year. The expansion continued in 2022 as the industry began recovering from pandemic-related supply chain disruptions. However, the war in Ukraine and its impact on import prices, trade disruptions, uncertainty, and risk premia will slow GDP growth in 2022. Moreover, strong cost and demand pressures will contribute to rising inflation, which is projected to reach 9% in 2022. Inflation in Hungary is mainly driven by commodity and energy prices. However, wage increases also play a role.[153] While price inflation in non-energy industrial goods was outpaced by other categories (most notably, energy and processed food), at 5% in April 2022, it still showed a significant increase relative to 3.2% in 2021.[154]

The automotive industry is one of the most important sectors of the Hungarian economy. Hungary is specialised in midstream production activities within the supply chain.[155] The industry produces approximately half a million cars and more than two million engines annually. Besides Germany, Hungary is the only European country to host production units of three premium car manufacturers.[156]

Proportionate to the prominence of the sector in the country, Hungary has approximately 700 automotive companies that contribute to 4.1% of GDP with EUR 26.2 billion in production value.[157] Of those, five are major car manufacturers (Audi, BMW, Mercedes,

[153] European Commission (2022). Spring 2022 Economic Forecast. Available at: https://ec.europa.eu/info/business-economy-euro/economic-performance-and-forecasts/economic-forecasts/spring-2022-economic-forecast_en.

[154] European Commission (2022). Convergence Report. Available at: https://ec.europa.eu/info/sites/default/files/economy-finance/ip179_en.pdf.

[155] European Commission (2020). Country Report Hungary 2020. COMMISSION STAFF WORKING DOCUMENT. Available at: https://ec.europa.eu/info/sites/default/files/2020-european_semester_country-report-hungary_en.pdf.

[156] HIPA (2021). Automotive Industry in Hungary. Available at: https://hipa.hu/main#publications.

[157] HIPA (2021). Automotive Industry in Hungary. Available at: https://hipa.hu/main#publications.

Opel, and Suzuki), three are major engineering service providers (JLR, Ford and Nissan), eight are original equipment manufacturers (OEMs), and 66 are TIER1 suppliers.[158]

The automotive industry, machinery, and means of transport account for almost one-tenth of product exports in Hungary. Their share in exports has traditionally been higher than their share in imports. For example, in 2020, the export share of machinery and means of transport was 57%, while the import share was 48%. In 2020, the turnover of machinery and transport equipment decreased by 3-4% compared to the previous year at constant prices.[159]

The COVID-19 pandemic caused major disruptions to global production chains which have also affected the Hungarian automotive industry. This is mainly due to the protracted shortage of chips that has lasted for two years. As a result, at the end of the third quarter of 2021, the volume of industrial production had decreased significantly compared to one year earlier.[160] The volume index of total sales also showed a significant decline in 2020 due to the COVID-19 pandemic. Only in 2022, the volume index of automotive sales reached pre-pandemic levels.[161]

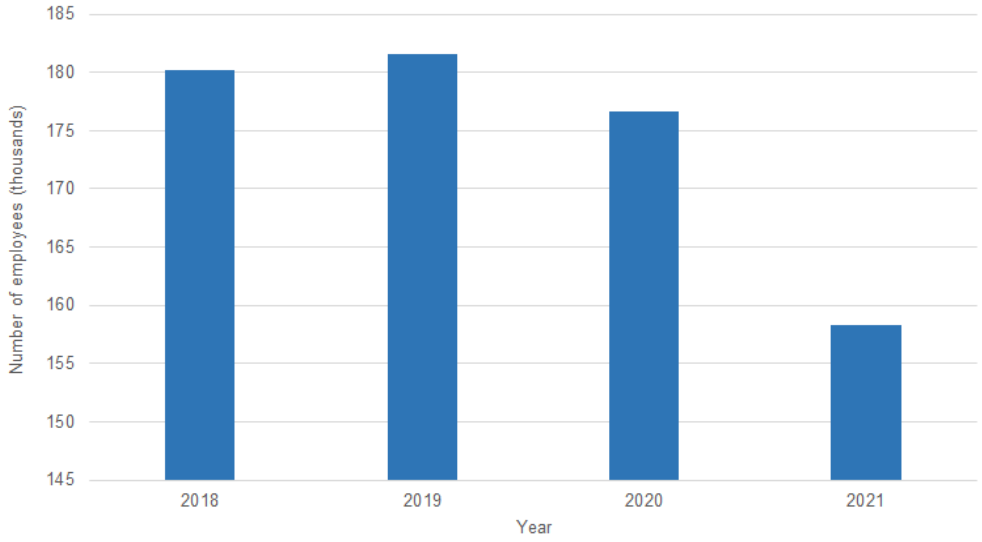
In terms of vehicle production, significant expansion continued in the first two months of 2020, but output fell sharply thereafter. In the second half of March, domestic car factories shut down, rendering the production of road vehicles almost non-existent in April, with the production of vehicle parts also operating at a very limited capacity. With the gradual reopening of the car factories later in 2020, the volume of production increased. From August, it exceeded 2019 production levels. However, the return to growth did not make up for the significant losses in the first wave of the COVID-19 crisis, and vehicle production output in 2020 was still 11% lower than in the previous year. This was mainly due to the decline in the volume of the entire industry.[162] The Russian invasion of Ukraine has caused further supply chain disruptions. For example, in electrical cable distribution units[163] and soot for carbon black that's used in rubber products.[164]

The pandemic and supply shock-related production disruptions also resulted in significant changes in the number of people employed in the automotive industry between 2018 and 2021. As illustrated by the graph below, a decline was already recorded in 2020, but 2021 showed a drastic decline. In 2018, approximately 180,000 people worked in the Hungarian automotive industry, accounting for nearly 4% of total employment. In 2019, this number increased by 1,600, still accounting for almost 4% of total employment. In 2020 only 176,000 people worked in the automotive industry, accounting for 3.8% of total employment. 2021 saw an even more significant reduction, with the industry employing 10% fewer workers than the previous year, accounting for 3.4% of total employment.[165]

[158] HIPA (2019). Automotive Industry Hungary 2019: Automotive CEO Survey. Hungarian Investment Promotion Agency, Budapest. Available at: https://hipa.hu/images/dokumentumok/hipa-automotive-ceo-survey-2019.pdf.

[159] Hungarian Central Statistical Office. Available at: https://www.ksh.hu.

Figure 8. Number of persons employed in the automotive industry



Source: own elaboration based on data from ksh.hu.

The midstream[160] production activities that the Hungarian automotive sector specialises in generate a relatively low value added in comparison to, for example, the German automotive industry. In the long term, the Hungarian automotive industry is likely to face new challenges due to rising labour costs, environmental regulations, technological advancements, and global supply chain risks. To tackle these challenges, the automotive industry will need to engage in functional upgrading, which requires investment in R&D and innovation.[161] Furthermore, advanced technologies, such as IoT, robotics and AI, can lead to more efficient and intelligent production, while advanced materials, photonics, IoT and big data can help build smarter and more connected vehicles.[162]

3.1.2. Digitalisation in the industry

Hungary ranks 23rd out of 27 in the EU in DESI 2021. Out of the four DESI dimensions, Hungary shows the strongest performance in the categories of 'connectivity' (12th) and 'human capital' (22nd). By contrast, the country performs relatively poorly in the 'integration of digital technology' dimension (ranking 26th) and the 'digital public services' dimension (25th). In recent years, Hungary's DESI score has grown at roughly the same rate as the EU average.[163] For Hungary's relative performance by dimension in 2021, see Figure 9.

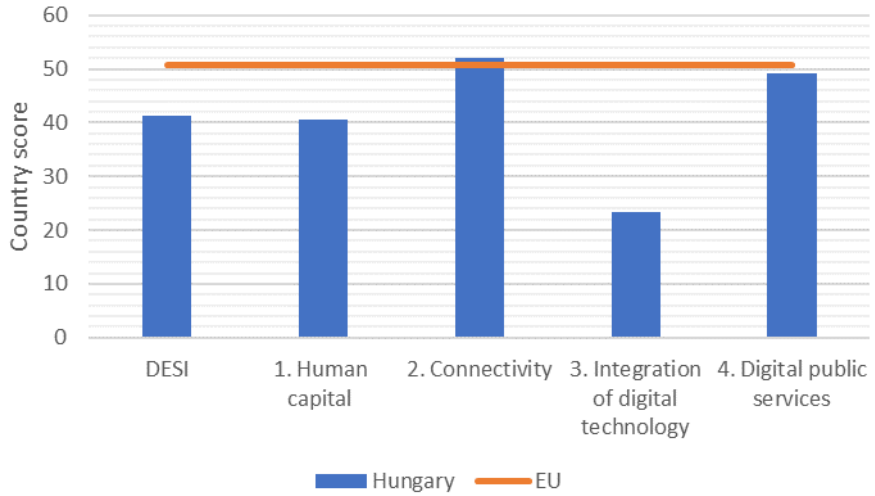
[160] Activities that contribute modestly to the completed vehicle.

[161] European Commission (2020). Country Report Hungary 2020. COMMISSION STAFF WORKING DOCUMENT. Available at: https://ec.europa.eu/info/sites/default/files/2020-european_semester_country-report-hungary_en.pdf.

[162] European Commission (2020). Advanced Technologies for Industry – sectoral watch. Technological trends in the automotive industry. Available at: https://ati.ec.europa.eu/reports/sectoral-watch/technological-trends-automotive-industry.

[163] European Commission (2021). DESI 2021: Hungary. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-hungary#:~:text=Hungary%20ranks%2021st%20in%20DESI%202017.%20Hungary%20performs,skills%2C%20but%20stands%20still%20slightly%20below%20the%20average.

Figure 9. DESI relative performance by dimension, Hungary, 2021



Source: own elaboration based on European Commission (2021). DESI 2021: Hungary.

On average, Hungarian businesses are less likely to innovate or adopt digital technologies than European businesses. Cooperation between academia and business remains low and limited mostly to large companies.[164] Examining the 'integration of digital technologies' dimension further, only 46% of SMEs in Hungary show at least a basic level of digital intensity (the EU average is around 60%).[165] Similarly, a 2021 survey conducted by Innomine to assess the digital maturity of enterprises found that enterprises had a relatively low average level of digital maturity (58 out of a maximum score of 100).[166] The survey also helped identify several problematic areas, including lack of digital strategy and planning, digital skills and development among employees, adoption of integrated enterprise systems, and employee commitment towards digital transformation.[167]

According to the DII for 2021, Hungary has a higher proportion of automotive industry enterprises with 'very low' (53%) levels of digital intensity than the EU average (39%). Low levels of digital intensity are also exhibited by 30% of Hungarian automotive enterprises, which is just below the EU average of 37%. 'Low' and 'very low' digital intensity enterprises make up 83% of all automotive companies in Hungary, while in the EU, on average, 76% have 'low' or 'very low' digital intensity.[168] For a comparison between the Hungarian and EU automotive industry DII scores, see Figure 10.

[164] European Commission (2022). 2022 Country Report – Hungary. Recommendation for a COUNCIL RECOMMENDATION on the 2022 National Reform Programme of Hungary and delivering a Council opinion on the 2022 Convergence Programme of Hungary. Available at: https://ec.europa.eu/info/system/files/2022-european-semester-country-report-hungary_en_0.pdf.

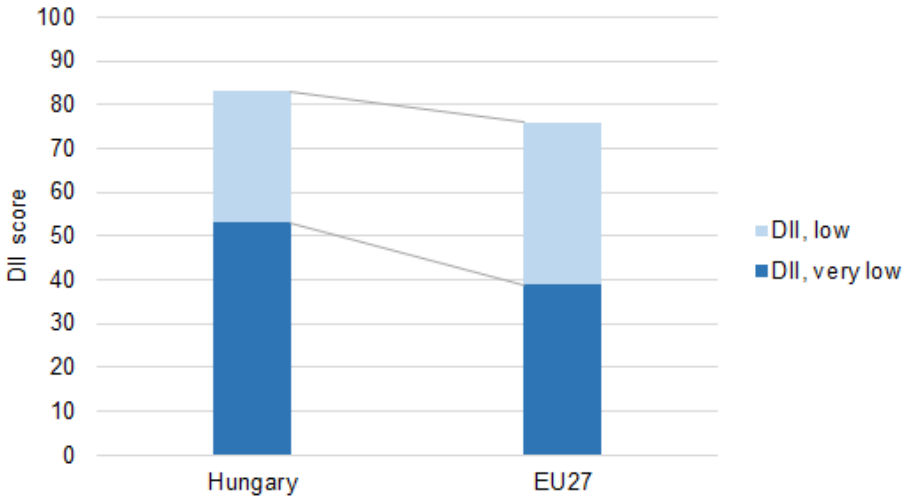
[165] European Commission (2021). DESI 2021: Hungary. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-hungary#:~:text=Hungary%20ranks%2021st%20in%20DESI%202017.%20Hungary%20performs,skills%2C%20but%20stands%20still%20slightly%20below%20the%20average.

[166] The sample included 123 respondents.

[167] Innomine research (2022).

[168] Eurostat (2021). Tables isoc_e_dii, NACE sectors C29-30.

Figure 10. Very low and low DII score comparison, automotive industry, Hungary and EU27, 2021



Source: own elaboration based on data from Eurostat: Tables isoc_e_dii, NACE sectors C29-30.

For TIER2-3 suppliers, implementation of Industry 4.0 can be especially difficult. While they can digitalise their production, they often have little influence over the final product. Therefore, they may not be able to reap the benefits of product innovation and have limited opportunities to implement 'manufacturing as a service' concepts. This is due to a small number of clients and a lack of end-customer interaction.[169]

While many SMEs recognise the need to digitalise, they often lack awareness of practical implementation aspects. Some of the main drivers for SME innovation in the automotive industry are management-level competences and commitment to digitalisation, and availability of support instruments. Moreover, due to a lack of knowledge or experience, SMEs may be concerned with the risk associated with investing in digital technologies.[170]

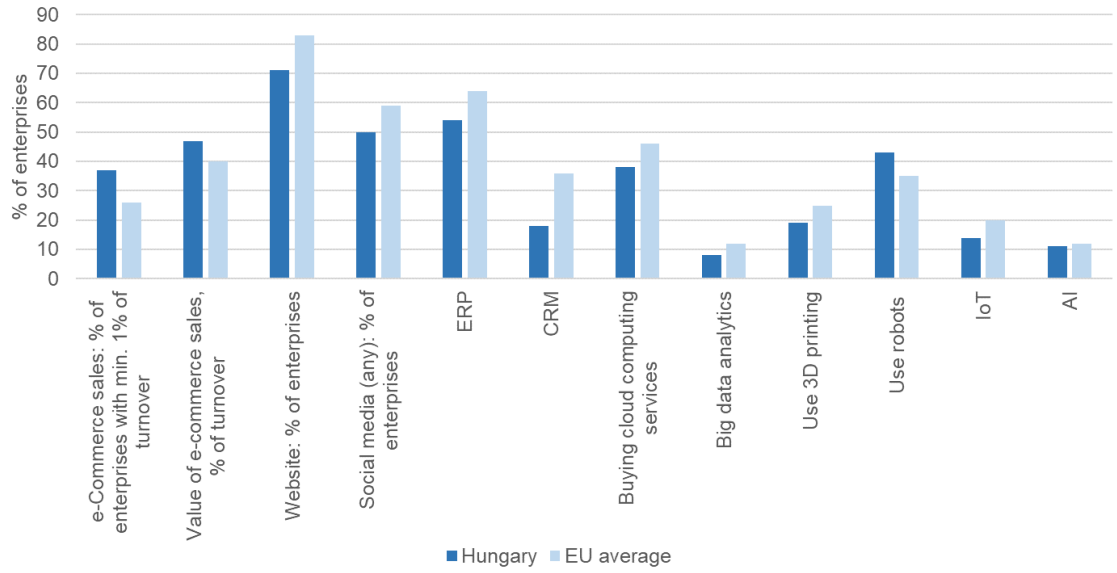
According to a 2019 survey of CEOs in the automotive industry, automotive companies considered the following technological and innovation trends as important: robotisation (67%), big data – analysis of manufacturing data (49%), digitalisation/paper-free operations (35%) and application of AI (20%). This is reflected in Eurostat data which shows that, when compared to the EU average, the Hungarian automotive industry has higher uptake of robotics and e-commerce. However, the uptake of many other technologies falls below the EU average (see Figure 11). Stakeholders in interviews note that the focus of recent digitalisation efforts has been on administrative processes, such as payroll, accounting, project management and integrated enterprise management.[171] Meanwhile, interview respondents indicate that production planning, production organisation, production optimisation and monitoring is more common among large multinational companies is more common among large multinational companies than SMEs.

[169] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[170] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[171] Findings from interviews with an SME and a large company operating in the automotive industry in Hungary.

Figure 11. Uptake of digital technologies, automotive industry, Hungary and EU27



Source: own elaboration based on Eurostat: Tables EISOC_EC_ESELN2, ISOC_CIWEB, ISOC_CISMT, ISOC_EB_IIP, ISOC_CICCE_USE, ISOC_EB_BD, ISOC_EB_P3D, ISOC_EB_IOT, ISOC_EB_AI, NACE sectors C29-30.

Many companies face a high level of uncertainty about technology shifts and the future evolution of the automotive industry.[172] Over the coming decade, industry actors may face new challenges associated with digital transformation, tightening of environmental standards and changes in consumer habits. Cutting-edge innovations and evolving technological and social trends will transform the mobility landscape.[173] However, while digitalisation in the Hungarian automotive industry is driven primarily by large companies, many smaller enterprises still struggle to reach a basic level of digital intensity.[174]

3.1.3. Key factors influencing digitalisation in the industry

3.1.3.1. Policy factors

According to the 2021 Digital Intelligence Index's[181] 'state of institutions' dimension, Hungary ranks below the European and Central Asia and high-income country group medians. In this dimension, Hungary shows strong performance in the ICT regulatory environment (ranked 3rd out of 90 economies), the legal environment for business (39th) and transparency (41st). The lowest relative performance can be observed in government digital uptake (57th), government facilitation of ICT (62nd) and bureaucracy (65th).[182] Hungary also has a high score in the Organisation for Economic Co-operation and Development (OECD) digital services trade restrictiveness index (DSTRI)[183] (6th highest out of European Economic Area (EEA) countries listed), which points to significant regulatory barriers for digital trade (see Annex 5).[184]

Hungary's Recovery and Resilience Plan (RRP HU) was submitted to the European Commission in May 2021, amounting to EUR 7.17 billion in grants, and remains under

[172] HIPA (2019). Automotive Industry Hungary 2019: Automotive CEO Survey. Hungarian Investment Promotion Agency, Budapest. Available at: https://hipa.hu/images/dokumentumok/hipa-automotive-ceo-survey-2019.pdf.

[173] Ferincz, A., Baksa, M., Kárpáti, Z., & Taródy, D. (2021). Autóipar a gyártáson túl: Stratégiai dilemmák és trendek az iparág belátható jövőjében.

[174] Eurostat (2021). Tables isoc_e_dii, NACE sesctors C29-30.

consideration.[185] The submitted plan tackles five policy areas: green transition, health care, research, digital, cohesion and public administration.[186] Approximately 23% of the funding is allocated to digital transformation, with around EUR 1.4 billion linked to Digital Decade targets. Around EUR 5 million is linked to the digitalisation of SMEs.[187,188]

Hungary has adopted multiple policies, strategies, and initiatives to support industry digitalisation, including the Irinyi Plan, the Digital Success Programme, a National Digitalisation Strategy (NDS), the Supplier Development Programme, the Hungarian Industry 4.0 Programme, and its Smart Specialisation Strategy.

On 5 February 2016, the Hungarian government adopted the Irinyi Plan for the development of domestic industry, which is under the responsibility of the Ministry for Innovation and Technology.[189] The main objective of the plan is to increase domestic industry in terms of the share of GDP. To achieve this, companies that belong to priority sectors that contribute significantly to growth but lack capital are supported through development and investment. Production of vehicles, including passenger cars, buses, and fixed-track vehicles, was included among the seven priority areas listed in the plan. It cited specialised machine and vehicle manufacturing as a key priority, highlighting 3D printing, electronics, and nanotechnology as promising areas. According to this plan, the pillars for industrial development were innovation, the application of new technologies, increasing energy and material efficiency, resolving territorial inequalities, stimulating job creation, and using domestic resources as efficiently and as much as possible.[190]

Several existing programmes have the potential to indirectly foster the digitalisation of Hungary's automotive industry. In 2016, Hungary adopted an updated version of the Digital Success Programme as an umbrella programme for multiple strategies and initiatives. The programme aimed to 'make everyone a digitalisation winner', reduce the digital divide and turn Budapest into a start-up centre.[175] Similarly, in 2021 Hungary adopted a new NDS for the upcoming ten years. The strategy aligns with the DESI dimensions of digital infrastructure, skills, economy, and government. According to the NDS, Hungary aims to be one of the top 10 leading EU countries in terms of digital development by 2030. The new strategy aims to increase the use of digital technologies by SMEs and develop digital start-ups, among other priorities.[176,177]

Furthermore, Hungary has adopted a Supplier Development Programme that aims to support enterprise transformation by bridging the gap between large companies and domestic suppliers. It grants support to large 'integrator' companies and SMEs. The programme intends to support the involvement of domestic suppliers in the development of production of higher value-added items. It also aims to increase their efficiency and productivity by using Industry 4.0 technologies, organisational development, training, innovation, and R&D. Applicants can receive support to help them respond to business challenges, pursue innovation, expand their capacity in ways that require significant organisational change, and for the 'integrator' companies to systematically improve their supplier network.[194]

The Hungarian Industry 4.0 Programme aims to contribute HUF 1.5 billion to the development of enterprises to pursue innovative re-industrialisation. It focuses on R&D and innovation activities and their industrial application. In addition to developing and

[175] Digital Success Programme (n.d.). Available at: https://digitalisjoletprogram.hu/hu/tartalom/ipar-40.

[176] Ministry of Innovation and Technology, Ministry of Interior (2020) National Digitisation Strategy. Available at: https://2015-2019.kormany.hu/download/f/58/d1000/NDS.pdf.

[177] European Commission (2021). DESI 2021: Hungary. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-hungary#:~:text=Hungary%20ranks%2021st%20in%20DESI%202017.%20Hungary%20performs,skills%2C%20but%20stands%20still%20slightly%20below%20the%20average.

introducing new technologies and business models, the programme also helps support the emergence of high-value-added services in Hungary. Support is provided in the following areas:

- automation of production-related internal logistics processes, horizontal and vertical system integration;
- development and use of cloud-based technologies in manufacturing and logistics processes;
- development and implementation of intelligent mechatronic systems (autonomous robots, autonomous vehicles) in the field of manufacturing and logistics;
- development and application of additive production technologies, including small series and custom manufacturing;
- projects based on the concept developed by the Industry 4.0 National Technology Platform Working Group.[178]

Hungary's Smart Specialisation Strategy was adopted in 2014 and aimed to strengthen excellence in competitiveness, increase the performance of science-technology and innovation stakeholders, and develop a territorial approach to the knowledge-based economic development of regions. The strategy prioritises advanced technologies in the vehicle and other machinery manufacturing sectors.[179,180]

Several additional initiatives aim to boost the innovation ecosystem, including:

- The Industry 4.0 National Technology Platform helps with the implementation of the Industry 4.0 Industry Development Strategy and supports digital transformation.
- The Model Factory Programme enables SMEs to benefit from digital and automation development through the design of Industry 4.0 model applications.
- The DIH network supports businesses with digital transformation and implementation of the latest digital technologies.
- The National Laboratories Programme[181] brings together research institutions, academia, and industry to create future-oriented technologies and implement research and innovation programmes. [182]

[178] National Research and Development Centre (2018). Industry 4.0 Programme. Available at: https://nkfih.gov.hu/hivatalrol/hazai-nemzetkozi-kfi/ipar-4-0-program.

[179] VVA & Wik Consult (2020). Study on Monitoring Progress in National Initiatives on Digitising Industry. Country report: Hungary. SMART 2018/0002. Available at: https://digital-strategy.ec.europa.eu/en/events/workshop-monitoring-progress-national-initiatives-digitising-industry-support-digital.

[180] Smart Specialisation Platform, Hungary. Available at: https://s3platform.jrc.ec.europa.eu/region-page-test/-/regions/HU.

[181] National Research and Development Centre (2021). National Laboratories Programme. Available at: https://nkfih.gov.hu/for-the-applicants/innovation-ecosystem/national-laboratories-programme.

[182] European Commission (2021). DESI 2021: Hungary. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-hungary#:~:text=Hungary%20ranks%2021st%20in%20DESI%202017.%20Hungary%20performs,skills%2C%20but%20stands%20still%20slightly%20below%20the%20average.

- The Modern Enterprises Programme: includes a financing scheme to support enterprise digitalisation.[183,184]

Finally, in 2022 the first call, the European Commission selected three EDIHs from Hungary, with two additional hubs expected to receive funding during the second call.[185]

Most of the initiatives adopted in Hungary to support industry digitalisation are targeted at SMEs and are supported by EU funding.[186] Horizon Europe, RRF, and other funding programmes create a major opportunity for SMEs to obtain support in their digital transformation. However, according to the 'Study on Monitoring Progress in National Initiatives on Digitising Industry', many enterprises lack knowledge of the available support initiatives and how to capitalise on them, although various stakeholders are working to boost their visibility.[187] Some SMEs do not pursue digitalisation as they perceive the process to be too risky, and some of them lack commitment from the management to launch digitalisation initiatives.[188]

3.1.3.2. Social factors

The European automotive sector is facing profound structural changes brought by emission standards, new mobility models and the increasing use of digital technologies in vehicles. The shift towards Industry 4.0 will require new skills that can bridge the gap between automotive and ICT competencies.[189]

In 2021, Hungary ranked 22nd among EU countries in the DESI 'human capital' dimension. According to the index, almost half (49%) of the population possess basic digital skills, while the EU average is 56%. The proportion of ICT specialists also falls below the EU average (3.8% versus 4.3%), while the share of ICT graduates is higher than in the EU (4.9% versus 3.9%). In 2020, only 16% of enterprises in all sectors provided ICT training to employees, while in the EU, this proportion stood at 20%.[190] These indicators confirm that the development of digital skills and relevant education and vocational training are of paramount importance.

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[183] European Commission (2021). DESI 2021: Hungary. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-hungary#:~:text=Hungary%20ranks%2021st%20in%20DESI%202017.%20Hungary%20performs,skills%2C%20but%20stands%20still%20slightly%20below%20the%20average.

[184] VVA & Wik Consult (2020). Study on Monitoring Progress in National Initiatives on Digitising Industry. Country report: Hungary. SMART 2018/0002. Available at: https://digital-strategy.ec.europa.eu/en/events/workshop-monitoring-progress-national-initiatives-digitising-industry-support-digital.

[185] DG CNECT A4 - Digital Transformation of Industrial Ecosystems (2022). Presentation 'Digitalisation of Businesses and the network of European Digital Innovation Hubs (EDIH)' during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[186] VVA & Wik Consult (2020). Study on Monitoring Progress in National Initiatives on Digitising Industry. Available at: https://digital-strategy.ec.europa.eu/en/events/workshop-monitoring-progress-national-initiatives-digitising-industry-support-digital.

[187] VVA & Wik Consult (2020). Study on Monitoring Progress in National Initiatives on Digitising Industry. Country report: Hungary. SMART 2018/0002. Available at: https://digital-strategy.ec.europa.eu/en/events/workshop-monitoring-progress-national-initiatives-digitising-industry-support-digital.

[188] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[189] European Commission (2017). Blueprint for sectoral cooperation on skills. Responding to skills mismatches on sectoral level. A key action of the New Skills Agenda for Europe. Available at: https://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=7969.

[190] European Commission (2021). DESI 2021: Hungary. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-hungary#:~:text=Hungary%20ranks%2021st%20in%20DESI%202017.%20Hungary%20performs,skills%2C%20but%20stands%20still%20slightly%20below%20the%20average.

The National Association of Employers and Manufacturers has recommended that the Hungarian government develop a vocational training model for a knowledge-based, innovative economy. According to the Association, particular attention should be paid to developing basic skills, preparing for vocational training, developing motor skills, and socialising for work.[191] In this context, the Hungarian NDS includes digital skills among its priority areas. The NDS addresses the development of digital competences, according to the Digital Competence Framework (DigComp),[192] increasing the number and qualification of IT professionals and engineers and the support for structural changes in education and vocational training.[193,194]

In response to the COVID-19 pandemic, vocational education institutions have adopted digital education technologies. Digital education is conducted in the KRETA system, which is a platform developed for online education in Hungary. Importantly, in the future, this platform will also provide access to companies participating in training to share digital curriculum content. Digitalisation levels are included in the list of occupations subject to vocational education. Nevertheless, it is important that in dual education programmes emphasis is put on learning digital skills as part of company-based training instead of school-based education.

To address skills shortages, cooperation between automotive companies and educational institutions is common. However, it tends to focus on tertiary education. For example, about two-thirds of HIPA survey participants stated that they participate in dual education programmes with tertiary education institutions. However, these programmes produce a small number of graduates (approx. 400 in the 2018-2019 academic year). Meanwhile, expectations for vocational education are growing, and more intensive cooperation will be needed in the future. Technical universities have shown positive results in preparing students for work in the automotive industry. Their programmes also prepare more graduates than tertiary level programmes (approximately 1,100). Moreover, large companies are more active in collaborating with educational institutions, while SMEs have limited resources to support training activities.[195] For examples of programmes in the automotive industry that aim to respond to industry needs for combining digital and sector competencies, see the box below.

[191] A Proposal From The National Confederation Of Employers And Industrialists (2019) A strategy for training for a knowledge-based, innovative society. Available at:https://mgyosz.hu/hirlevel/20190530_szakkepzes_strategia.pdf.

[192] European Commission (n.d.). The Digital Competence Framework. EU Science Hub. Available at: https://joint-research-centre.ec.europa.eu/digcomp/digital-competence-framework_en.

[193] Ministry of Innovation and Technology, Ministry of Interior (2020) National Digitisation Strategy. Available at: https://2015-2019.kormany.hu/download/f/58/d1000/NDS.pdf

[194] European Commission (2021). DESI 2021: Hungary. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-hungary#:~:text=Hungary%20ranks%2021st%20in%20DESI%202017.%20Hungary%20performs,skills%2C%20but%20stands%20still%20slightly%20below%20the%20average.

[195] HIPA (2019). Automotive Industry Hungary 2019: Automotive CEO Survey. Hungarian Investment Promotion Agency, Budapest. Available at: https://hipa.hu/images/dokumentumok/hipa-automotive-ceo-survey-2019.pdf.

Box 1. Programme examples in the field of autonomous vehicles

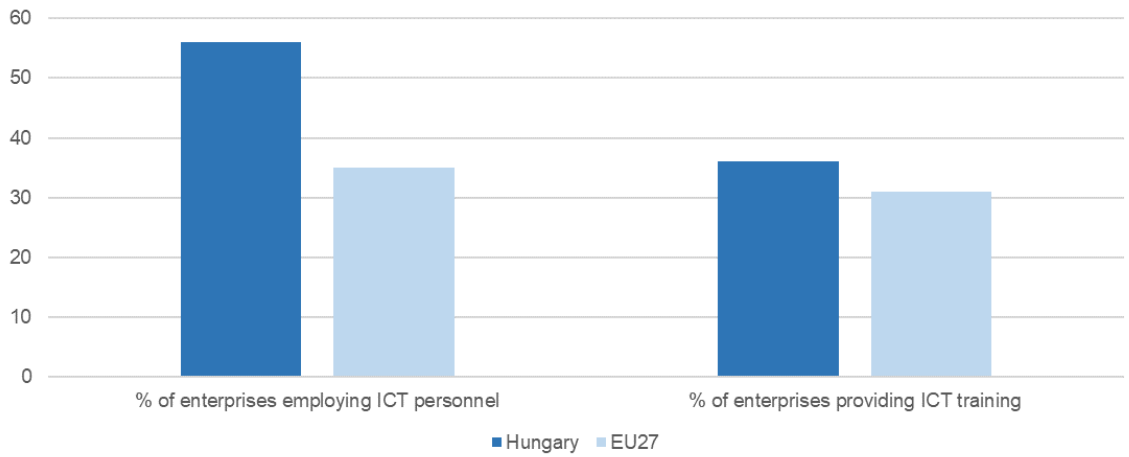
Programmes in autonomous vehicle control engineering and programming

As a response to the increasing relevance of autonomous vehicles, two master-level programmes have been launched in Budapest in Autonomous Vehicle Control Engineering (MSc) and Autonomous Vehicle Programming (MSc).[196] Both programmes are provided in English and are developed in collaboration with industrial partners.

The engineering programme aims to provide graduates with knowledge of vehicle technology, control theory, intelligent systems, and ICT. Graduates will be able to partake in the design, development, and manufacture of autonomous vehicles, simulate networks, test, and validate processes, and work in a complex environment with sensor data.[197]

However, taking a specific look at the automotive industry, Hungary shows an impressive performance in attracting employees with digital skills to the industry. More than half (56%) of Hungarian automotive enterprises employ ICT specialists (the EU average is 35%). Furthermore, slightly more Hungarian automotive enterprises provide their staff with ICT training (36%) than in the EU (31%) (see Figure 12 below).

Figure 12. Employment of ICT personnel and ICT training, automotive industry, Hungary and EU27, 2020



Source: own elaboration based on data from Eurostat: Tables ISOC_SKE_ITSPEN2 and ISOC_SKE_ITTN2, NACE sectors C29-30.

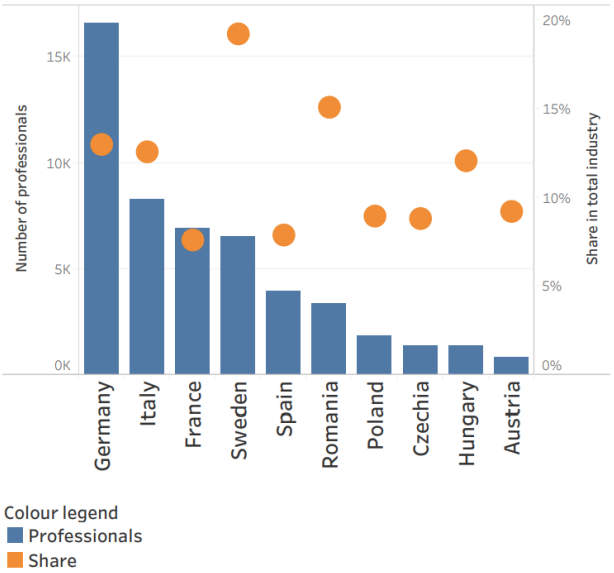
Advanced manufacturing skills and digital skills are becoming increasingly relevant in the automotive industry. Skills related to robotics, IoT, and cloud computing are among some of the most in-demand in the European automotive industry. Based on LinkedIn data, among the top 10 automotive industries in the EU, Hungary has a high proportion of individuals with advanced manufacturing skills, while in absolute numbers, it ranks ninth (see Figure 13). The country also exhibits a high growth rate, ranking fourth after Austria,

[196] HIPA (2021). Automotive Industry in Hungary. Available at: https://hipa.hu/main#publications.

[197] Budapest University of Technology and Economics (n.d.). Autonomous Vehicle Control engineering Master (MSc). Available at: https://transportation.bme.hu/msc-programmes/applicants/autonomous-vehicle-control-engineering-master-msc/.

Poland, and Romania, in the number of individuals with these skills between 2018 and 2019.[198]

Figure 13. Professionals with skills in advanced manufacturing, automotive industry, TOP10 EU countries, 2019



Source: European Commission (2020) 'Advanced Technologies for Industry – Sectoral Watch: Technological trends in the automotive industry' and Technopolis Group analysis based on LinkedIn.

3.1.3.3. Economic factors

In the DESI 'connectivity' dimension, Hungary ranks 12th out of all EU countries, its highest performance in any DESI dimension. Broadband speed and uptake are both above the EU average, however, their growth has stagnated over the past few years. Meanwhile, connectivity speeds have improved, especially in 1 Gbps take-up, which is 13.2% (the EU average is only 1.3%). Network (VHCN) coverage is below the EU average (49% versus 59% in the EU), while rural VHCN exceeds the EU average (36% versus 28% in the EU).[199] However, in 2021, only 80.6% of all businesses had broadband internet access. This is well below the EU average, where 93.8% of businesses have broadband internet. In this indicator, Hungary ranks 27th among EU countries.[200] Based on conclusions from stakeholder interviews, lack of broadband coverage can create challenges for digital technology uptake, for example, one interviewee notes that their company chose not to adopt cloud-based services due to insufficient digital infrastructure in their area.[201]

Public financial support schemes are important for automotive SMEs to pursue digitalisation. Many SMEs face insufficient economies of scale for investment in digital technologies to be feasible. Similarly, they may consider investing in digital transformation

[198] European Commission (2020). Advanced Technologies for Industry – Sectoral Watch: Technological trends in the automotive industry. Available at: https://ati.ec.europa.eu/sites/default/files/2020-08/Sectoral%20Report%20Automotive.pdf.

[199] European Commission (2021). DESI 2021: Hungary. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-hungary#:~:text=Hungary%20ranks%2021st%20in%20DESI%202017.%20Hungary%20performs,skills%2C%20but%20stands%20still%20slightly%20below%20the%20average.

[200] European Commission (2021). Digital Scoreboard. Key indicators: broadband take up and coverage. Enterprises with a fixed broadband connection. Available at: https://digital-agenda-data.eu/datasets/digital_agenda_scoreboard_key_indicators/visualizations.

[201] Findings from interviews with an SME and a large company operating in the automotive industry in Hungary.

to be too risky.[202] To remain competitive, the Hungarian automotive industry needs to pursue functional upgrading and innovation. While the government has implemented multiple initiatives to support this endeavour (see Section 3.1.3.1), Hungary still faces challenges in terms of skills shortages and limited innovation capacity.[203] Meanwhile, most Hungarian automotive companies have a multinational background, yet many of them are increasingly establishing R&D business units and engineering services in Hungary.[204]

According to the European and Regional Innovation Scoreboard, Hungary ranks as an 'emerging innovator',[205,206] while the Digital Intelligence Index ranks Hungary 57th out of 90 economies in the 'state of innovation' dimension.[207] The European and Regional Innovation Scoreboard states that Hungary's strengths are related to innovation sales impact, digitalisation, and collaborative innovation linkages. In the Digital Intelligence Index, Hungary performs best in value capture and creation and R&D. However, Hungary scores low in the high share of non-innovators with potential to innovate, climate-change-related indicators, financing and talent availability, and business practices.[208,209]

In 2019, the Hungarian automotive business enterprise expenditure on R&D was EUR 213.10 million on R&D, EUR 21.8 per inhabitant or 0.15% of GDP. When compared to countries with large automotive industries, Hungary has lower expenditure as a proportion of GDP than Germany (0.81%) and Czechia (0.23%). At the same time, Hungary has higher business expenditure on R&D in the automotive industry than Slovakia (0.11% of GDP), Italy (0.09%) and Spain (0.04%) (see Figure 14).[210]

[202] Source: Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[203] European Commission (2020). Country Report Hungary 2020. COMMISSION STAFF WORKING DOCUMENT. Available at: https://ec.europa.eu/info/sites/default/files/2020-european_semester_country-report-hungary_en.pdf.

[204] HIPA (2019). Automotive Industry Hungary 2019: Automotive CEO Survey. Hungarian Investment Promotion Agency, Budapest. Available at: https://hipa.hu/images/dokumentumok/hipa-automotive-ceo-survey-2019.pdf.

[205] Available rankings in descending order: 'innovation leader', 'strong innovator', 'moderate innovator' and 'emerging innovator'.

[206] European Commission (2022). European and Regional Innovation Scoreboard 2021. Available at: https://ec.europa.eu/research-and-innovation/en/statistics/performance-indicators/european-innovation-scoreboard/eis.

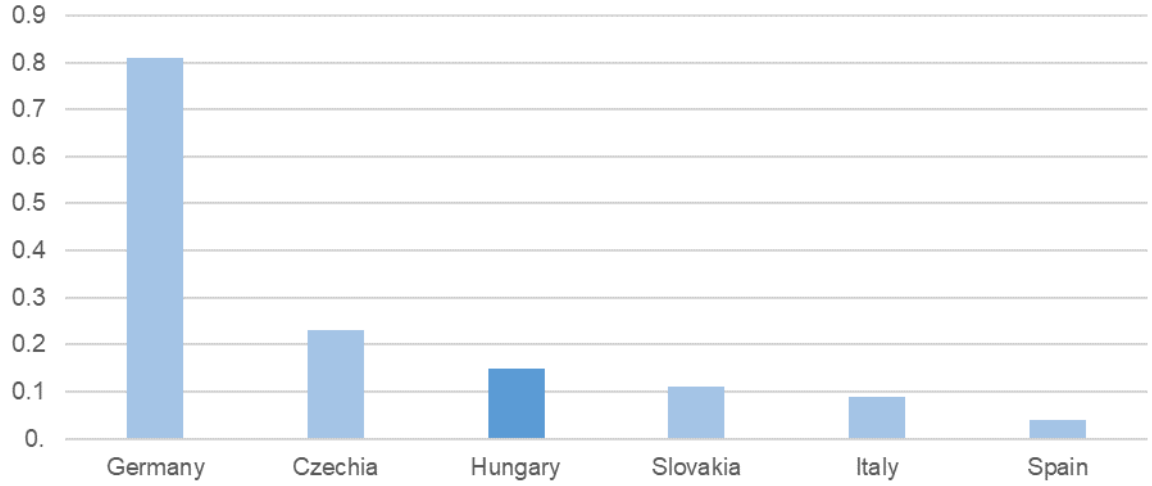
[207] Tufts University (2021). Digital Intelligence Dashboard: Hungary. Available at: https://digitalintelligence.fletcher.tufts.edu/countrydashboards.

[208] European Commission (2022). European Innovation Scoreboard 2021. Country report: Hungary. Available at: https://ec.europa.eu/info/research-and-innovation/statistics/performance-indicators/european-innovation-scoreboard_en.

[209] Tufts University (2021). Digital Intelligence Dashboard: Hungary. Available at: https://digitalintelligence.fletcher.tufts.edu/countrydashboards.

[210] Eurostat (2019, 2020). Table RD_E_BERDINDR2.

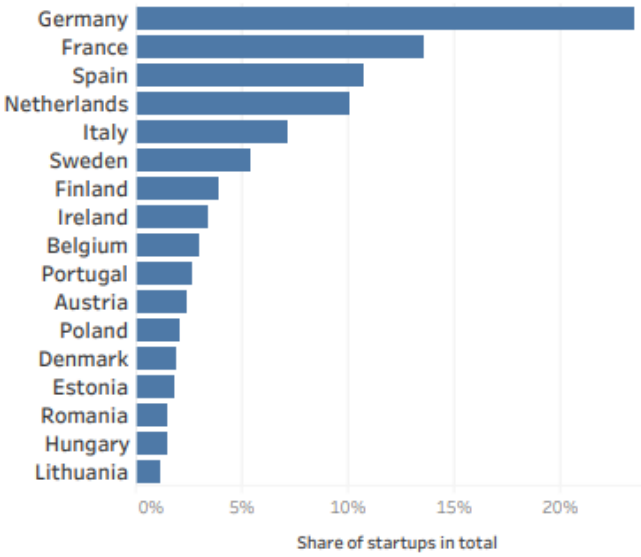
Figure 14. Business enterprise expenditure on R&D, % of GDP, automotive industry, selected countries, 2019



Source: own elaboration based on Eurostat (2019): Table RD_E_BERDINDR2, NACE sectors C29-30.
Notes: presented in descending order.

Regarding start-up activity, despite the automotive industry playing a major economic role in Hungary, automotive start-ups constitute a small share of total start-ups. Hungary ranks behind many other economies with less dominant automotive sectors in start-up creation between 2009 and 2019 (see Figure 15).[211]

Figure 15. Start-up creation in the automotive industry, EU27, 2009-2019



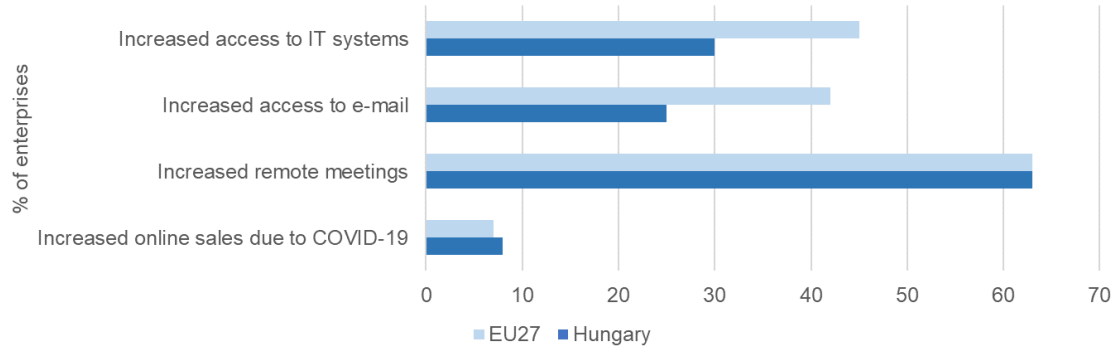
Source: European Commission (2020) 'Advanced Technologies for Industry – Sectoral Watch: Technological trends in the automotive industry' and Technopolis Group analysis based on Crunchbase and Dealroom data.

[211] European Commission (2020). Advanced Technologies for Industry – Sectoral Watch: Technological trends in the automotive industry. Available at: https://ati.ec.europa.eu/sites/default/files/2020-08/Sectoral%20Report%20Automotive.pdf.

3.1.3.4. External shocks

Many Hungarian automotive industry companies have increased their remote meetings (63%), remote access to e-mail (25%) and IT systems (30%) as a response to COVID-19. However, the increase in remote access to e-mail and IT systems due to COVID-19 is even higher in the EU on average. The same proportion of EU and Hungarian automotive enterprises increased the number of remote meetings. Few automotive sector enterprises increased online sales due to COVID-19 (8% in Hungary and 7% in the EU) (see Figure 16).[212] Stakeholders note that the COVID-19 pandemic contributed to the introduction of online work and digital education. However, they also note that the impact was limited on the development of manufacturing technologies.[213]

Figure 16. COVID-19 impact on ICT usage (selected indicators), automotive industry, Hungary and EU27, 2021



Source: own elaboration based on Eurostat: tables ISOC_E_CVD, NACE sectors C29-30.

The automotive industry was going through rapid change and faced a high degree of uncertainty even before the COVID-19 crisis.[214,215] The shocks related to the pandemic and the Russian invasion of Ukraine have further exacerbated the situation. According to conclusions from a panel discussion organised as part of this study,[216] significant gaps in digitalisation can be observed between large multinationals that implement best practices and SMEs that have a low level of digitalisation. These gaps widened further due to the COVID-19 pandemic and the Russian invasion of Ukraine as small businesses faced challenges brought by external shocks, such as a lack of core inputs.

3.1.4. Main digitalisation strengths and challenges

Hungary is specialised in midstream production activities within the supply chain.[217] Throughout COVID-19 and because of the Russian invasion of Ukraine, the automotive

[212] Eurostat (2021). Tables ISOC_E_CVD, NACE sectors C29-30.

[213] Findings from interviews conducted with an SME and a large company operating in the automotive industry in Hungary.

[214] HIPA (2019). Automotive Industry Hungary 2019: Automotive CEO Survey. Hungarian Investment Promotion Agency, Budapest. Available at: https://hipa.hu/images/dokumentumok/hipa-automotive-ceo-survey-2019.pdf.

[215] HIPA (2019). Automotive Industry Hungary 2019: Automotive CEO Survey. Hungarian Investment Promotion Agency, Budapest. Available at: https://hipa.hu/images/dokumentumok/hipa-automotive-ceo-survey-2019.pdf.

[216] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[217] European Commission (2020). Country Report Hungary 2020. COMMISSION STAFF WORKING DOCUMENT. Available at: https://ec.europa.eu/info/sites/default/files/2020-european_semester_country-report-hungary_en.pdf.

industry has experienced a series of supply chain shocks.[218,219] These disruptions add to already high uncertainty caused by digital transformation, tightening environmental standards, and changes in consumer expectations faced by the automotive industry.[220,221] In this context, it is important for the automotive industry to adapt through digital transformation to increase its efficiency and competitiveness.[222]

The Hungarian automotive industry is characterised by the presence of large multinational companies, such as Audi, Mercedes/Daimler, Suzuki, and BMW, which can help drive digitalisation in their supply chains.[223] Consequently, in some areas, Hungary shows an impressive performance in digitalisation uptake. For example, the uptake of robotics and e-commerce in the Hungarian automotive industry is higher than on average in the EU.[224] It also performs well in attracting employees with digital and advanced manufacturing skills, with a higher percentage of enterprises employing ICT personnel than on average in the EU.[225,226]

However, the uptake of many other technologies (ERP, CRM, cloud computing, big data, 3D printing, IoT, AI) and the overall level of digital intensity fall below the EU average.[227] A total of 83% of Hungarian automotive enterprises have 'low' or 'very low' digital intensity, while the EU average is 76%.[228] The low uptake of many technologies can be explained by multiple factors, including the high proportion of SMEs, structural challenges related to mid-tier production activities, and lack of awareness of available support instruments.

Large companies primarily drive digitalisation in the Hungarian automotive industry. Many smaller enterprises still struggle to reach a basic level of digital intensity, in part due to a lack of economies of scale. From a structural perspective, many automotive companies in Hungary are mid-tier suppliers, selling primarily in B2B markets. As a result, full Industry 4.0 implementation is particularly difficult as Hungarian companies have limited impact on end-products and the ability to implement 'manufacturing as a service' concepts. Furthermore, when OEMs significantly alter their business models, it has cascading impacts on the whole supply chain. Thirdly, the Hungarian automotive industry is vulnerable to demand and supply chain shocks. Therefore, mid-tier suppliers face a high

[218] Hungarian Central Statistical Office. Available at: https://www.ksh.hu/docs/hun/xftp/idoszaki/mone/20213/index.html.

[219] Index (2022). Hiánycikk lett a korom, bajban az autóipar. Available at: https://index.hu/gazdasag/2022/03/17/haboru-ukrajna-oroszorszag-hianycikk-korom-gumi-gyartas-auto/.

[220] HIPA (2019). Automotive Industry Hungary 2019: Automotive CEO Survey. Hungarian Investment Promotion Agency, Budapest. Available at: https://hipa.hu/images/dokumentumok/hipa-automotive-ceo-survey-2019.pdf.

[221] Ferincz, A., Baksa, M., Kárpáti, Z., & Taródy, D. (2021). Autóipar a gyártáson túl: Stratégiai dilemmák és trendek az iparág belátható jövőjében.

[222] European Commission (2020). Country Report Hungary 2020. COMMISSION STAFF WORKING DOCUMENT. Available at: https://ec.europa.eu/info/sites/default/files/2020-european_semester_country-report-hungary_en.pdf.

[223] HIPA (2019). Automotive Industry Hungary 2019: Automotive CEO Survey. Hungarian Investment Promotion Agency, Budapest. Available at: https://hipa.hu/images/dokumentumok/hipa-automotive-ceo-survey-2019.pdf.

[224] Hungarian Central Statistical Office. Available at: https://www.ksh.hu/docs/hun/xftp/idoszaki/ikt/2020/02/index.html.

[225] European Commission (2020). Advanced Technologies for Industry – Sectoral Watch: Technological trends in the automotive industry. Available at: https://ati.ec.europa.eu/sites/default/files/2020-08/Sectoral%20Report%20Automotive.pdf.

[226] Eurostat (2020). Tables ISOC_SKE_ITSPEN2 and ISOC_SKE_ITTN2, NACE sectors C29-30.

[227] Eurostat (2020/2021). Tables: EISOC_EC_ESELN2, ISOC_CIWEB, ISOC_CISMT, ISOC_EB_IIP, ISOC_CICCE_USE, ISOC_EB_BD, ISOC_EB_P3D, ISOC_EB_IOT, ISOC_EB_AI, NACE sectors C29-30.

[228] Eurostat (2021). Tables isoc_e_dii, NACE sectors C29-30.

degree of uncertainty about their future business operations and may deprioritise digitalisation in favour of focusing on maintaining competitiveness and profitability.[229]

Many EU-funded initiatives support digitalisation efforts and supply opportunities for automotive industry enterprises. Many of these initiatives are specifically targeted at SMEs.[230] At the same time, enterprises may lack awareness of the available support instruments and how to capitalise on them, or they see digitalisation more as a cost than a value-adding activity.[231] Hungarian SMEs do not pursue digitalisation because of the perception of digital transformation as too risky. Furthermore, while many SMEs are aware of the need to digitalise, it is often unclear how digital technologies can be applied in their business and some may lack managerial leadership in doing so. Finally, stakeholders who can support automotive companies with expertise, such as researchers, academics, and consultants, usually work with OEMs, instead of SMEs.[232]

3.2. Retail in Poland

This section presents the results of the gap analysis for the retail industry in Poland. It first provides an overview of the industry's economic performance before proceeding with the overview of the state of play of digitalisation. It then presents key factors that impact the Polish retail industry's level of digitalisation before concluding with an overview of the industry's strengths and weaknesses.

3.2.1. State of play overview

In 2020, COVID-19 brought about the first economic contraction of 2.2% in Poland in almost three decades. However, Poland's diversified economic structure led to milder consequences than in the EU on average. In 2021, Poland's economy was on the path to a strong recovery with a GDP growth of 5.9%.[233,234]

According to the European Spring Economic Forecast, the economy has continued to grow in 2022 despite the effects of the Russian invasion of Ukraine. In early 2022, growth was apparent in both industrial production and retail. Despite apprehension that inf lation and economic uncertainty will lower demand, it will be partially counteracted by the influx of refugees from Ukraine. Rising inflation is a concern and will persist throughout 2022 due to a surge in energy and food prices, although increasing labour costs and supply chain disruptions also contribute to the problem.[235]

[229] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[230] VVA & Wik Consult (2020). Study on Monitoring Progress in National Initiatives on Digitising Industry. Available at: https://digital-strategy.ec.europa.eu/en/events/workshop-monitoring-progress-national-initiatives-digitising-industry-support-digital.

[231] VVA & Wik Consult (2020). Study on Monitoring Progress in National Initiatives on Digitising Industry. Country report: Hungary. SMART 2018/0002. Available at: https://digital-strategy.ec.europa.eu/en/events/workshop-monitoring-progress-national-initiatives-digitising-industry-support-digital.

[232] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[233] European Commission (2022). Analysis of the recovery and resilience plan of Poland. Available at: https://ec.europa.eu/info/system/files/swd_2022_161_2_en.pdf.

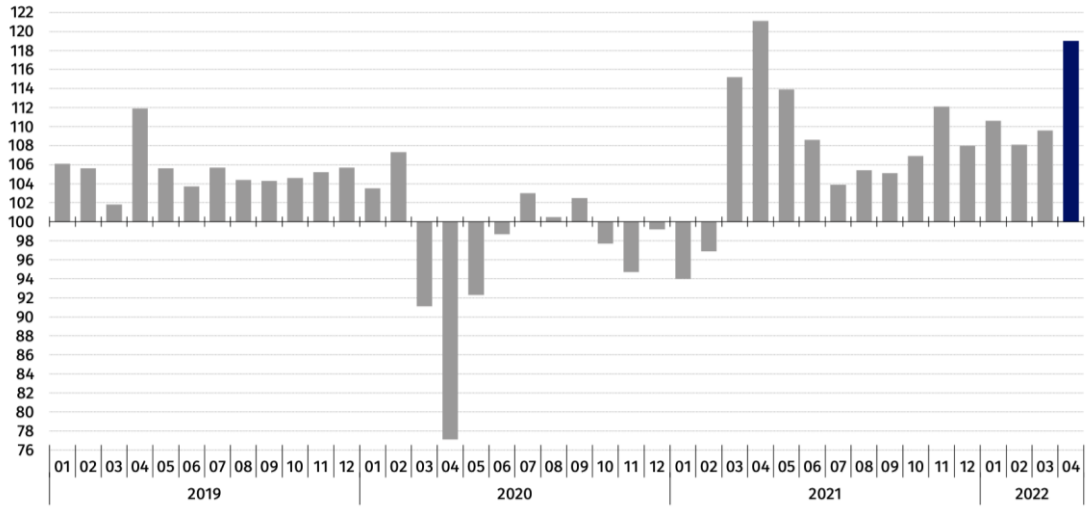
[234] European Commission (2022). Spring 2022 Economic Forecast: Russian invasion tests EU economic resilience. Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3070.

[235] European Commission (2022). Spring 2022 Economic Forecast: Russian invasion tests EU economic resilience. Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3070.

In 2019, the number of enterprises in the Polish retail industry (except for motor vehicles and motorcycles) reached 286,795, of which almost 99.92% were SMEs. In fact, every fifth SME (22.4%) in Poland operates in retail.[236] The production value in 2021 was EUR 39,832.5 million, and value added reached EUR 22,571.8 million. Industry turnover was EUR 142,819.2 million in 2019 and dropped to EUR 141,177.4 million in 2020. Similarly, a decrease in the number of persons employed was also observed from 2019 to 2020: from 1,283,333 to 1,254,599.[237] As of June 2021, the Polish retail industry consisted of 98,017 shops in total.[238]

While all sectors were affected by the COVID-19 crisis, the Polish retail market was particularly hard-hit due to both social distancing measures[239] and changes in consumer demand, such as the drop in demand for non-essential items.[240] The initial shock led to a year-on-year drop in retail sales of 11.8% in April 2020.[241] Retail sales did not fully recover until 2021.[242]

Figure 17. Retail sales of goods (constant prices) - analogous period of the previous year = 100, Poland, 2019-2022



Source: Główny Urząd Statystyczny (2022).

More than one-fourth of retail trade businesses in Poland sell either 'other goods in specialised stores' (27%) or have 'non-specialised stores'. 'Retail trade not in stores, stalls or markets' constitutes 18% of enterprises, and 'retail sale via stalls and markets'

[236] Polska Agencja Rozwoju Przedsiębiorczości (2021). Status report the sector of small and medium-sized enterprises in Poland, page 107. Available at: https://www.parp.gov.pl/component/publications/publication/raport-o-stanie-sektora-malych-i-srednich-przedsiebiorstw-w-polsce-2021.

[237] Eurostat (2019). Table SBS_SC_DT_R2.

[238] NielsenIQ (2021). Retail market 2021. Structure, numbers of facilities, trends. Results, quantity and structure research trade in June 2021 according to NielsenIQ. Available at: https://foodfakty.pl/rynek-detaliczny-2021-struktura-liczebnosc-placowek-trendy-wyniki-badania-liczebnosci-i-struktury-handlu-w-czerwcu-2021-wg-nielseniq

[239] Politico (2020). Europe's coronavirus lockdown measures compared. Available at: https://www.politico.eu/article/europes-coronavirus-lockdown-measures-compared/.

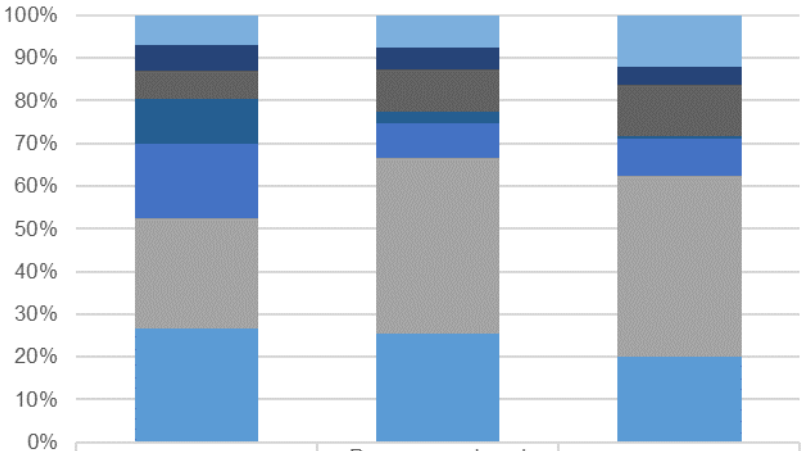
[240] OECD (2020). COVID-19 and the retail sector: impact and policy responses. Available at: https://read.oecd-ilibrary.org/view/?ref=134_134473-kuqn636n26&title=COVID-19-and-the-retail-sector-impact-and-policy-responses.

[241] European Commission (2022). Analysis of the recovery and resilience plan of Poland. Available at: https://ec.europa.eu/info/system/files/swd_2022_161_2_en.pdf.

[242] Główny Urząd Statystyczny (2022). Dynamika sprzedaży detalicznej w kwietniu 2022 r. Available at: https://stat.gov.pl/obszary-tematyczne/ceny-handel/handel/dynamika-sprzedazy-detalicznej-w-kwietniu-2022-roku,14,89.html.

constitutes 10%. Categories of 'other household equipment in specialised stores', 'food, beverage and tobacco specialised stores' are relevant for 7% and 6% of retail enterprises, respectively. A total of 7% of enterprises fall under other categories.[243] For a breakdown based on the number of enterprises, employees, and turnover, see Figure 18. A breakdown of stores by category is available below.

Figure 18. Retail industry company, employment, and turnover distribution breakdown (%) by sub-sectors, Poland



	Enterprises (2019)	Persons employed (2020)	Turnover (2020)
Other (cultural and recreational goods, information and communication equipment, automotive fuel)	7%	8%	12%
Food, beverages and tobacco in specialised stores	6%	5%	4%
Other household equipment in specialised stores	7%	10%	12%
Via stalls and markets	10%	3%	1%
Not in stores, stalls or markets	18%	8%	9%
Non-specialised stores	26%	41%	43%
Other goods in specialised stores	27%	26%	20%

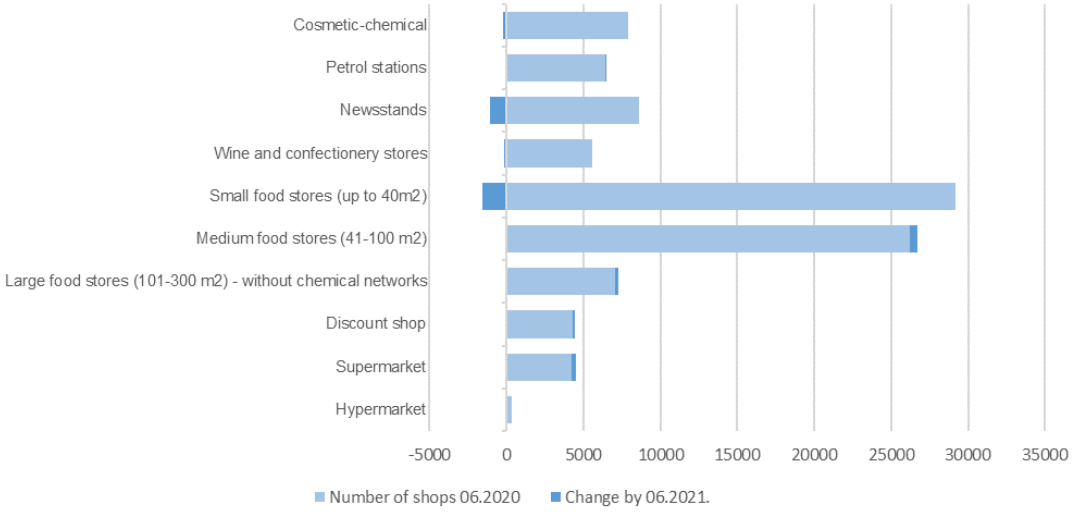
Source: own elaboration based on Eurostat: Table SBS_SC_DT_R2.
Notes: data for 2020, except for the number of enterprises where latest available data for 2019 was used.

According to the NielsenIQ Shopper Trends 2021 report, the number of newsstands, small grocery, and cosmetic-chemical stores in Poland continued to decrease in 2021. However, the rate of decline has been lower than in previous years. This trend has been present for several years and cannot be fully explained by the pandemic-related restrictions. However, from June 2020 until June 2021, there were categories where the number of stores increased, such as supermarkets and medium and large food stores, which points to trade consolidation. Moreover, there is significant competition among market participants, partly because Polish shoppers tend to 'shop around' for the best offer as opposed to remaining loyal to a single brand. Finally, demand-side pressures exist for the retail store networks to adapt to population size.[244] The number of shops in Poland by category is indicated in the figure below.

[243] Eurostat (2019). Table SBS_SC_DT_R2.

[244] NielsenIQ (2021). Retail market 2021. Structure, numbers of facilities, trends. Results, quantity and structure research trade in June 2021 according to NielsenIQ. Available at: https://foodfakty.pl/rynek-detaliczny-2021-struktura-liczebnosc-placowek-trendy-wyniki-badania-liczebnosci-i-struktury-handlu-w-czerwcu-2021-wg-nielseniq.

Figure 19. Number of shops in Poland by category, 2020-2021



Source: own elaboration based on NielsenIQ research (2021)

Notes: Light blue indicates the number of shops in 2020, dark blue indicates the change in the number shops until June 2022, combined they indicate the total number of shops in June 2022.

The industry is characterised by a wide range of different retailers, from small standalone stores to international chains that are facing different market trends:

- Large stores (over 300 m2) showed moderate growth in the first half of 2021. Supermarkets and discount stores were the strongest performers, and, in the case of discount stores, this growth trend has been sustained for multiple years and aligns with similar trends elsewhere in Europe.

- Small stores (less than 300 m2) showed consolidation, with more stores closed than opened. Poland is the leader in Europe in terms of the proportion of sales attributable to small stores. Newsstands have seen a downward trend for several years and had difficulty adapting to the pandemic.[245]

Finally, as mentioned above, the COVID-19 pandemic has significantly affected the retail sector. Only 14% of retailers managed to shift their business model online. Meanwhile, almost a third (30%) of companies reduced the working hours of their employees. A majority (78%) of retail CEOs do not foresee headcount growth for at least five years.[246]

The Polish retail industry is made up of a high proportion of SMEs. Small market players are facing increasing competition and a trend towards trade consolidation. Furthermore, the retail market is vulnerable to COVID-19-related stocks, such as social distancing measures and changes in consumer demand. These characteristics underline the need for the Polish retail industry, especially its smaller companies, to increase competitiveness and resilience.

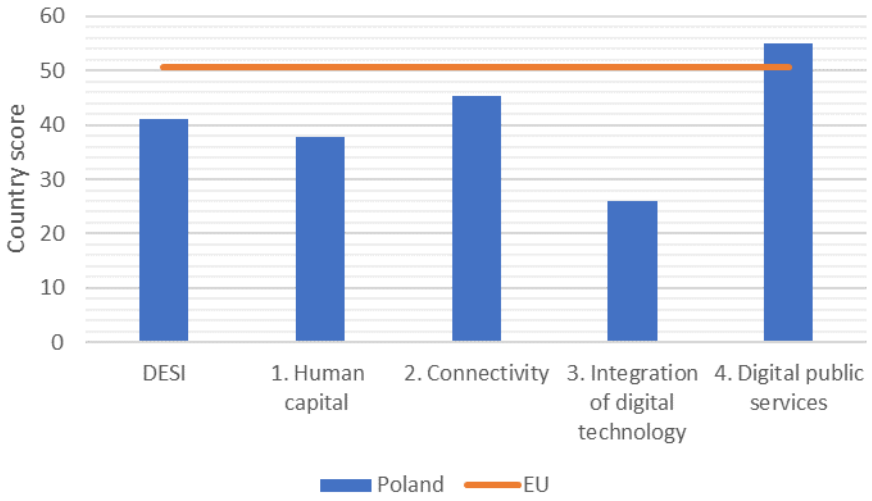
[245] NielsenIQ (2021). Retail market 2021. Structure, numbers of facilities, trends. Results, quantity and structure research trade in June 2021 according to NielsenIQ. Available at: https://foodfakty.pl/rynek-detaliczny-2021-struktura-liczebnosc-placowek-trendy-wyniki-badania-liczebnosci-i-struktury-handlu-w-czerwcu-2021-wg-nielseniq.

[246] SCF News – Retailnet.pl (2022). Handel czeka dalsza cyfryzacja i optymalizacja procesów. Available at: https://retailnet.pl/2022/02/18/95081-raport-parp-handel-czeka-dalsza-cyfryzacja-i-optymalizacja-procesow/.

3.2.2. Digitalisation in the industry

According to DESI 2021, Poland ranks 24th out of 27 EU Member States, scoring below average in most dimensions. The country ranks 24th in the 'human capital' dimension, where it scores below average in most indicators. Despite having promoted the use of e-government, Poland's use of 'digital public services' remains limited, ranking 22nd in this dimension. In the 'connectivity' and 'integration of digital technology' dimensions, Poland ranks 21st and 24th, respectively (see Figure 20).[247]

Figure 20. DESI relative performance by dimension, Poland, 2021



Source: own elaboration based on European Commission (2021). DESI 2021: Poland.

Elaborating on the 'integration of digital technologies' dimension, slightly more than half (52%) of SMEs in Poland have at least a basic level of digital intensity (the EU average is 60%). Engagement in e-commerce is limited, with 13% of SMEs selling online and 5% conducting cross-border sales to other EU countries. Less than one-third (29%) of enterprises share information electronically, and only 14% actively use social media. In terms of advanced technologies, 15% of Polish enterprises use cloud solutions, and 18% implement AI in their operations, while big data is not commonly used yet.[248]

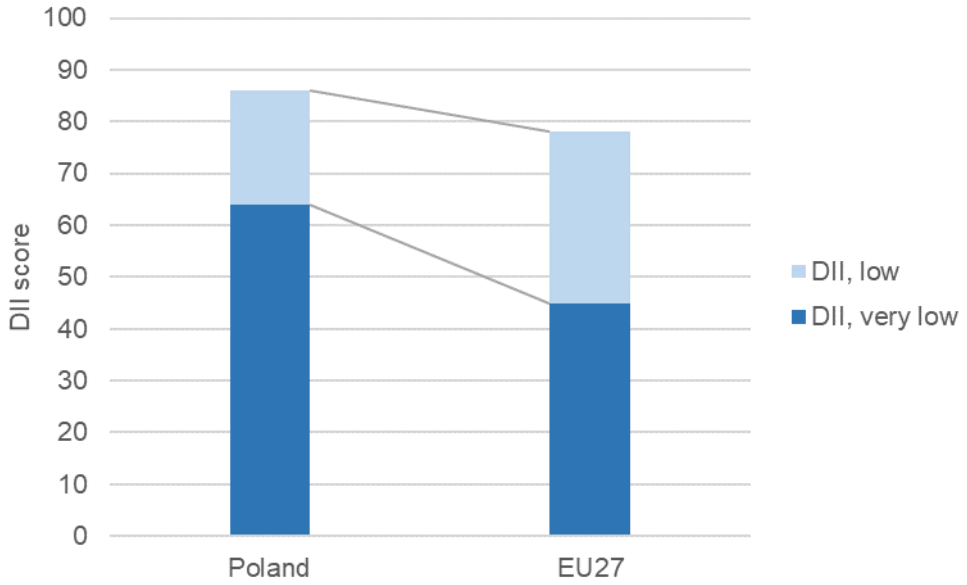
The Polish retail industry also shows a low level of digitalisation. According to the DII for 2021, Poland has a high percentage of retail enterprises with a 'very low' level of digital intensity (64%) in comparison to the EU average of 45%. By contrast, 22% of Polish retail enterprises have a 'low' score on the DII, while the European average stands at 33% for the retail industry (see Figure 21). Combined, 86% of Polish retailers show a 'low' or 'very low' level of digital intensity, which is 8% higher than the EU average.[249]

[247] European Commission (2021). DESI 2021: Poland. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-poland.

[248] European Commission (2021). DESI 2021: Poland. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-poland.

[249] Eurostat (2021). Tables isoc_e_dii, NACE sector G47.

Figure 21. Very low and low DII score comparison, retail industry, Poland and EU27, 2021



Source: own elaboration based on data from Eurostat: Tables isoc_e_dii, NACE sector G47.

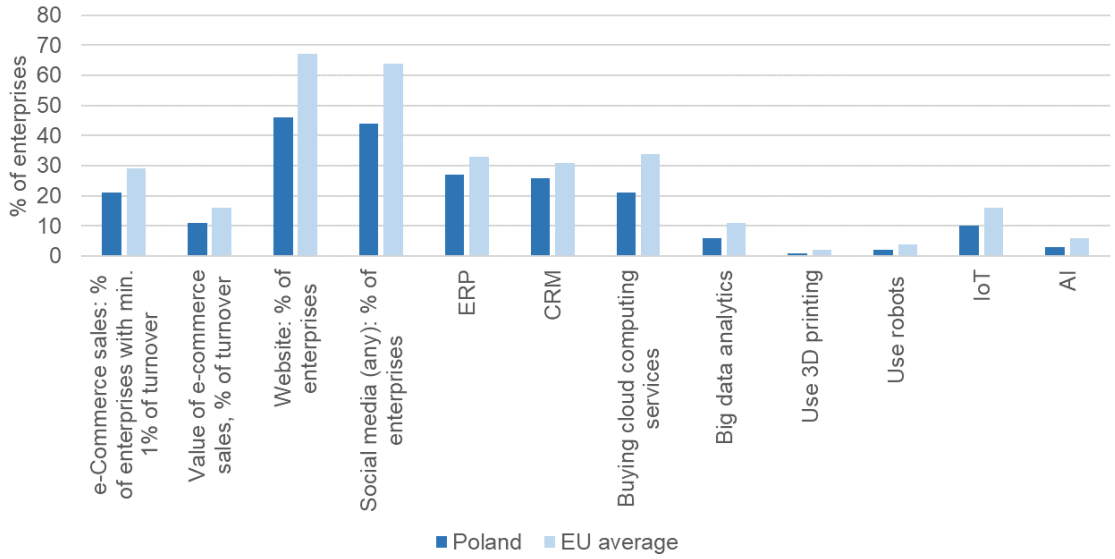
According to RetailNet, most experts agree that the adoption of digital technologies and upskilling activities are necessary to keep the market developing. However, only 10% of enterprises are prioritising investment in new IT solutions that would help them grow their business, and just 8% are planning to automate some of their processes. Most Polish retail companies focus their development strategies on the introduction of new services or products (32%) or increasing their margins (33%), which may be due to the economic consequences of the pandemic.[250]

The latest data from Eurostat show that Polish retail companies fall behlow EU average when it comes to adopting digital technologies. For example, 67% of European retail enterprises have a website in comparison to 46% of Polish companies. Similarly, 64% of European enterprises have a social media account, compared to 44% in Poland. The highest levels of uptake in Poland are observable for websites (46% of enterprises), social media (44%), ERP (27%) and CRM (26%) systems. Around one in five enterprises buy cloud services (21%) and have e-commerce sales (21%). The least used digital technologies in the Polish retail industry are 3D printing (1%), robotics (2%), and AI (3%). However, the use of these technologies in the retail industry is low across Europe, as illustrated in the graph below.[251]

[250] SCF News – Retailnet.pl (2022). Handel czeka dalsza cyfryzacja i optymalizacja procesów. Available at: https://retailnet.pl/2022/02/18/95081-raport-parp-handel-czeka-dalsza-cyfryzacja-i-optymalizacja-procesow/.

[251] Eurostat (2020, 2021). Tables EISOC_EC_ESELN2, ISOC_CIWEB, ISOC_CISMT, ISOC_EB_IIP, ISOC_CICCE_USE, ISOC_EB_BD, ISOC_EB_P3D, ISOC_EB_IOT, ISOC_EB_AI, NACE sector G47.

Figure 22. Uptake of digital technologies, retail industry, Poland and EU27



Source: own elaboration based on Eurostat: Tables EISOC_EC_ESELN2, ISOC_CIWEB, ISOC_CISMT, ISOC_EB_IIP, ISOC_CICCE_USE, ISOC_EB_BD, ISOC_EB_P3D, ISOC_EB_IOT, ISOC_EB_AI, NACE sector G47.

Polish retail SMEs increasingly use digital marketing. With social media platforms such as Facebook or Instagram, even small companies can advertise their products, target their customer groups, and make use of influencers and other schemes to boost their sales. This is supported by an abundance of tools, information, and courses on digital marketing that can be accessed at a low price.[252]

The approach to implementing e-commerce varies by business size. While e-commerce is especially important in the retail industry, only one in five Polish retail companies are selling online (21% versus 29% in the EU on average), and the proportion of e-commerce sales of turnover is low (11% in Poland, 16% in the EU) (see Figure 22).[253] According to EcommerceDB, the major e-commerce players in Poland are large retail companies that transitioned to omnichannel sales (building on top of their physical stores and growing a web-based audience). This corresponds to trends in larger retail markets, such as China, where business scale allows companies to offer more competitive prices.[254] Meanwhile, small stores may prefer to use external service providers, such as intermediary marketplaces, due to cost considerations. Fulfilment services can help enterprises that cannot afford to rent a large office space or maintain their own infrastructure. In addition, 55% of Polish e-commerce shipping services are currently provided by InPost, which guarantees that goods are received within 48 hours. InPost played a significant role in the uptake of e-commerce during the COVID-19 pandemic.[255] Meanwhile, small chains may benefit most from external support in implementing their own solutions, as they have more complex value chains and operations than small stores that use the services of external providers.[256]

[252] Comarch, badanie Przyszłośc Zakupów (2018). Available at: https://www.wiadomoscihandlowe.pl/artykul/handel-detaliczny-szybko-sie-cyfryzuje-i-wdraza-nowe-technologie-badanie.

[253] Eurostat (2021). Tables EISOC_EC_ESELN2, ISOC_EC_EVALN2, NACE sector G47.

[254] ecommerceDB (n.d.). The eCommerce market in Poland. Available at: https://ecommercedb.com/en/markets/pl/all.

[255] ecommerceDB (n.d.). The eCommerce market in Poland. Available at: https://ecommercedb.com/en/markets/pl/all.

[256] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

Wine and confectionery stores and small and medium food stores, which are not part of retail chains, are the least digitalised segments of the Polish retail market. Many of these stores are still relying on simple tools, such as Excel spreadsheets and raw data provided by a cash registry system. These stores may lack resources to invest in advanced tools and equipment and risk being outcompeted by other market players. For example, between June 2020 and June 2021, the number of small food stores decreased by 5.5%, while wine and confectionery stores saw a 3% decrease.[257]

Overall, while many large retailers have adopted digital technologies, smaller retailers are struggling to reach a basic level of digitalisation. Given the importance of SMEs to the Polish retail market, as well as trends towards trade consolidation, it is crucial to boost digital technology adoption for retail SMEs to maintain their competitiveness and increase their resilience towards external shocks.

3.2.3. Key factors influencing digitalisation in the industry

3.2.3.1. Policy factors

According to the 2021 Digital Intelligence Index's[258] 'state of institutions' dimension, Poland ranks below the average for Europe and Central Asia and high-income country group medians. However, Poland shows strong performance in the ICT regulatory environment (ranked 19th out of 90 economies), transparency (30th) and effectiveness of institutions (34th). Its lowest relative performance can be observed in government facilitation of ICT (53rd), the legal environment for business (59th) and bureaucracy (73rd).[259] Poland also ranks highest out of the EEA countries included in the OECD's DSTRI.[260] This indicates that Poland's regulatory environment poses significant barriers to digital trade (see Annex 5).[261]

Multiple governmental institutions and organisations are involved in supporting SME digitalisation and driving innovation in Poland, including Centrum Projektów Polska Cyfrowa ('Digital Poland' Centre of Projects), Digital Poland Foundation, Future Industry Platform Foundation and GovTech Centre. However, Poland lacks specialised instruments dedicated to supporting retail industry digitalisation. For example, in the DIH/EDIH network, no hubs specifically specialise in retail despite the industry's economic importance. As a result, retail enterprises need to adapt their plans to fit non-industry-specific existing instruments.

Several initiatives aimed at strengthening the overall digitalisation of industry exist in Poland. For example, the Foundation Future Industry Platform was established in 2019, and its objective is to support competitive growth through digital transformation. It

[257] NielsenIQ (2021). Retail market 2021. Structure, numbers of facilities, trends. Results, quantity and structure research trade in June 2021 according to NielsenIQ. Available at: https://foodfakty.pl/rynek-detaliczny-2021-struktura-liczebnosc-placowek-trendy-wyniki-badania-liczebnosci-i-struktury-handlu-w-czerwcu-2021-wg-nielseniq.

[258] The Digital Intelligence index is composed of two scoreboards: the digital evolution scoreboard compares the digital maturity and historical growth trajectory of countries, the digital trust scoreboard, which measures the trustworthiness of the digital ecosystem, the level and types of friction in digital experiences, the depth of engagement among Internet users, and the level of trust expressed by citizens.

[259] Tufts University (2021). Digital Intelligence Dashboard: Poland. Available at: https://digitalintelligence.fletcher.tufts.edu/countrydashboards.

[260] The DSTRI is a composite indicator that takes a value between '0' and '1'. It measures how open the regulatory environment is for digital trade. '0' indicates an open regulatory environment for digitally enabled trade, '0' indicates a completely closed regime.

[261] OECD (2021). Digital Services Trade Restrictiveness Index Simulator. Available at: https://sim.oecd.org/Default.ashx?lang=En&ds=DGSTRI&d1c=eu&cs=eu.

promotes digital transformation in processes, products, and business models, including using automation, AI, ICT, and communication between machines. Key technologies covered by the platform include IoT, cybersecurity, robotics and automation, big data and data analytics, 3D printing and AI.[262]

Similarly, Polish Industry 4.0 and the DIH network aim to create a library of solutions and a knowledge transfer programme, especially focusing on SMEs. DIHs aim to support the creation of new business models according to Industry 4.0. This initiative is well recognised among industry stakeholders, who perceive it as highly useful. It allows for the concentration of competencies and tools relevant for digital transformation in one place.[263] Furthermore, in the first call to support the EDIH network, the European Commission approved funding for 11 EDIHs in Poland.[264]

Start in Poland (SIP) is the largest start-up support programme in Central and Eastern Europe. SIP aims to create favourable conditions for start-ups to locate their business in Poland. It also helps to accelerate the development of an ecosystem that supports start-ups, knowledge sharing and cooperation between companies, and the attraction of talent to Poland.[265]

Paper to Digital Poland aims to promote the development of e-government and the digitalisation of the economy. The programme involves nine work streams: digital public services, e-reporting, distributed register, e-transport and e-flow of goods, cashless transactions, e-invoice and e-receipt, e-education, AI and IoT.[266]

Multiple recent legislative changes are relevant to digitalisation in the retail industry, from payment methods to support for digitalising enterprises, for example:

- The latest COVID-19-related policy allows retailers to implement free credit card terminals to support contactless payments and increase PIN-less transactions.
- The use of validated e-signatures in B2B wholesale orders, which allows B2B channels to become faster and more efficient.[267]

[262] VVA & Wik Consult (2020). Study on Monitoring Progress in National Initiatives on Digitising Industry. Country report: Poland. SMART 2018/0002. Available at: https://digital-strategy.ec.europa.eu/en/events/workshop-monitoring-progress-national-initiatives-digitising-industry-support-digital.

[263] VVA & Wik Consult (2020). Study on Monitoring Progress in National Initiatives on Digitising Industry. Country report: Poland. SMART 2018/0002. Available at: https://digital-strategy.ec.europa.eu/en/events/workshop-monitoring-progress-national-initiatives-digitising-industry-support-digital.

[264] DG CNECT A4 - Digital Transformation of Industrial Ecosystems (2022). Presentation 'Digitalisation of Businesses and the network of European Digital Innovation Hubs (EDIH)' during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[265] VVA & Wik Consult (2020). Study on Monitoring Progress in National Initiatives on Digitising Industry. Country report: Poland. SMART 2018/0002. Available at: https://digital-strategy.ec.europa.eu/en/events/workshop-monitoring-progress-national-initiatives-digitising-industry-support-digital.

[266] VVA & Wik Consult (2020). Study on Monitoring Progress in National Initiatives on Digitising Industry. Country report: Poland. SMART 2018/0002. Available at: https://digital-strategy.ec.europa.eu/en/events/workshop-monitoring-progress-national-initiatives-digitising-industry-support-digital.

[267] Otto-Duszczyk P. (2022). Cyfrowa transformacja w handlu nabrała rozpędu. Available at: https://serwisy.gazetaprawna.pl/nowe-technologie/artykuly/8403694,cyfrowa-transformacja-w-handlu-nabrala-rozpedu.html.

- A new policy has been introduced that allows agricultural entities to partake in retail trade.[268]

- New regulations also give tax benefits to companies that implement robotics, which is relevant for, warehouses,[269] and increased automation and digitalisation of retail companies.[270]

- The Polish government provides grants for SME digitalisation, regardless of where on the value chain digitalisation takes place.[271]

Looking at the EU-level programmes, Poland's Recovery and Resilience Plan (RRP PL) will be financed by EUR 23.9 billion in grants and EUR 11.5 billion in loans. It will aim to foster digitalisation, address climate change, improve health care and strengthen judicial independence. To support digital objectives, the plan will allocate 21.3% of its funding which exceeds the minimum required by the RRF Regulation. Support for the digital transition will focus on access to broadband infrastructure, improvement of digital skills and education, e-services, and cybersecurity.[272,273] Around EUR 1.2 billion will be linked to promoting the digitalisation of business, including SMEs, including support in the adoption of digital solutions, and promoting cooperation between R&D institutes and enterprises.[274] In terms of sectoral coverage, the RRP PL focuses on agrifood, creative industries, aviation and telecommunications.[275] However, similarly to national programmes, the RRP PL does not include measures linked specifically to retail industry digitalisation.

Poland's Smart Specialisation Strategy prioritises a healthy society, bio-economy comprising agrifood, forestry and environment, innovative technologies and industrial processes, sustainable energy and natural resources, and waste management.[276] This strategy is integrated into the Strategy for Responsible Development that aims to support reindustrialisation and innovative companies.[277] However, none of the regional smart specialisations is dedicated directly to retail entities.[278]

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[268] Oficjalna strona Prezydenta Rzeczypospolitej Polskiej (2022). Ustawa uwalniająca rolniczy handel detaliczny podpisana przez Prezydenta RP. Available at: https://www.prezydent.pl/aktualnosci/wydarzenia/ustawa-uwalniajaca-rolniczy-handel-detaliczny-podpisana-przez-prezydenta-rp,47624.

[269] Editorial office of the Tax Portal (2022). Ulga na robotyzację. Polski Ład wspiera innowacje. Available at: https://www.podatki.gov.pl/wyjasnienia/ulga-na-robotyzacje-polski-lad-wspiera-innowacje/.

[270] EBKF (n.d.). Ulga na cyfryzację i automatyzację przedsiębiorstw. Available at: https://www.ebkf.eu/artykuly/ulga-na-cyfryzacje-i-automatyzacje-przedsiebiorstw.

[271] PARP (2021). Wsparcie MSP w obszarze cyfryzacji - Bony na cyfryzację. Available at: https://www.parp.gov.pl/component/grants/grants/wsparcie-msp-w-obszarze-cyfryzacji-bony-na-cyfryzacje.

[272] European Commission (2022). Laying the Foundations for Recovery: Poland. Available at: https://ec.europa.eu/info/sites/default/files/recoveryandresilience_poland-factsheet_en.pdf.

[273] European Commission (2022). Questions and answers on Poland's recovery and resilience plan. Available at: https://ec.europa.eu/commission/presscorner/detail/en/qanda_22_3376.

[274] Deloitte (2021). The contribution of National Recovery and Resilience Plans to achieving Europe's Digital Decade ambition. Available at: https://www.vodafone.com/sites/default/files/2021-06/deloitte-llp-europe-digital-decade-rrf-gap-analysis.pdf.

[275] OECD (2022). Financing SMEs and Entrepreneurs 2022: An OECD Scoreboard, OECD Publishing, Paris. Available at: https://doi.org/10.1787/e9073a0f-en.

[276] European Commission (n.d.). Smart Specialisation Platform. Available at: https://s3platform.jrc.ec.europa.eu.

[277] VVA & Wik Consult (2020). Study on Monitoring Progress in National Initiatives on Digitising Industry. Country report: Poland. SMART 2018/0002. Available at: https://digital-strategy.ec.europa.eu/en/events/workshop-monitoring-progress-national-initiatives-digitising-industry-support-digital.

[278] KIS (n.d.). Regionalne Inteligentne Specjalizacje. Available at: https://smart.gov.pl/pl/jak-inteligentne-specjalizacje-realizowane-sa-w-regionach.

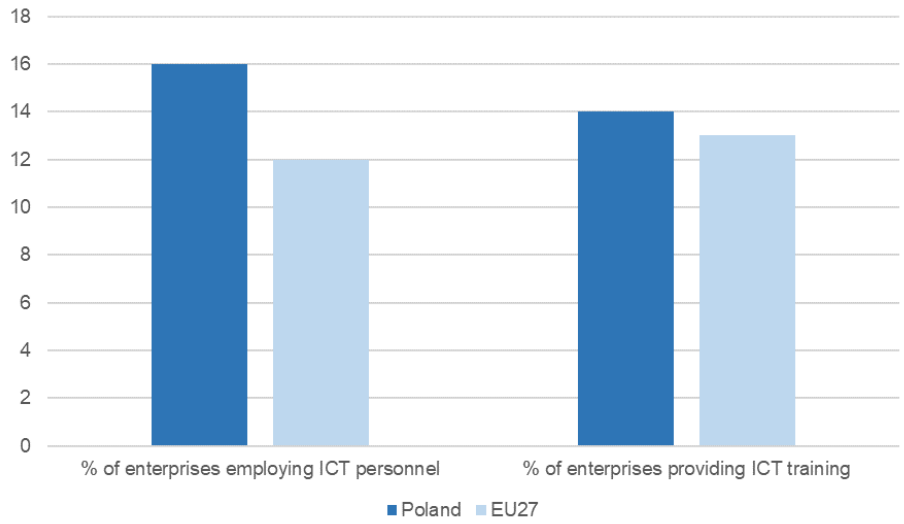
In short, Poland has taken steps to support digital technology adoption in the retail sector, for example, by providing tax benefits or making contactless payments easier. However, many of the initiatives aimed at boosting digitalisation are either sector agnostic or focus on traditional industrial sectors, such as manufacturing. As a result, Poland lacks retail-specific instruments for digitalisation. In turn, the demand for support by Polish retailers is limited as well due to a lack of awareness on available initiatives.[279] Given the retail industry's economic importance and the high proportion of SMEs that are facing competition from larger companies, it is critical to raise awareness about available support mechanisms.

3.2.3.2. Social factors

According to DESI 2021, Poland ranks 24th out of 27 EU countries in the 'human capital' dimension. Only 44% of people aged 16 to 74 have basic digital skills, while the EU average is 56%. One in five individuals (21%) has advanced digital skills. Moreover, ICT specialists constitute a lower share of the total workforce than, on average, in the EU. ICT graduates make up only 3.8% of all graduates.[280]

In the retail industry, 16 % of enterprises employ ICT personnel, and 14% provide ICT training to their employees. While this exceeds the EU average in the retail industry, it still is quite low (see Figure 23). Furthermore, the retail industry is dealing with an ageing workforce[281] that could potentially make it difficult to upgrade their digital skills in the future.[282]

Figure 23. Employment of ICT personnel and ICT training, retail industry, Poland and EU27, 2020



Source: own elaboration based on data from Eurostat: Tables ISOC_SKE_ITSPEN2 and ISOC_SKE_ITTN2, NACE sector G47.

[279] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[280] European Commission (2021). DESI 2021: Poland. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-poland.

[281] dlahandlu.pl (2022). Who is a statistical supermarket employee? Over 700,000 people work in this industry. Available at: https://www.dlahandlu.pl/detal-hurt/wiadomosci/kim-jest-statystyczny-pracownik-supermarketu-w-tej-branzy-pracuje-ponad-700-tys-osob,88450.html.

[282] Eurostat (2020). Tables ISOC_SKE_ITSPEN2 and ISOC_SKE_ITTN2, NACE sector G47.

According to RetailNet, only 12% of retail enterprises state that they are planning to invest in employee training and development in the coming years. In this context, insufficient skills could become a major barrier to SME digitalisation efforts.[283]

The retail sector is also experiencing major shifts in consumer behaviour. Consumers are increasingly shopping and engaging with businesses online. According to a McKinsey survey, the digital adoption rate[284] in Poland was 84% before the COVID-19 crisis and rose to 96% during the pandemic.[285] Consumers are increasingly expecting to pay for goods and services and obtain offers from retailers through their mobile phones. The dynamic development of e-commerce, e-services and m-commerce are likely to gain further momentum due to the dramatic increase in the number of potential users because of the pandemic.

Furthermore, digital product and service innovations (for example, NFTs, virtual boutiques, and digital clothing to be worn by avatars in the metaverse) are becoming increasingly common.[286] While big retailers are using these innovations abundantly, they are often expensive and require knowledge far beyond that available to SMEs.

3.2.3.3. Economic factors

Factors such as wage increases, higher inflation, and favourable loan conditions have an impact on digitalisation in the retail industry. Enterprises are encouraged to invest in digitalisation, automation and robotisation to increase their production capacity as part of the recovery from COVID-19. Combined with the improved financial situation of enterprises during the economic rebound, retailers may also have better access to financial resources to invest in digital transformation. Nevertheless, a high EUR/PLN exchange rate may make investing in digital solutions supplied by foreign providers more expensive.

In terms of 'connectivity', Poland ranks 21st in the EU, according to DESI 2021. FVHC network and FFTP coverage has increased since 2019. However, FTTP coverage in rural areas remains relatively low at 24.1%, although it also saw an increase since 2019. Fixed broadband coverage in Poland stands at 68%, relative to 62% in 2019. The EU average for fixed broadband coverage of at least 100Mbps in 2020 was 34%. Poland slightly exceeded the EU average with a coverage rate of 37%. Meanwhile, mobile broadband uptake in Europe is significantly higher than in Poland (71% versus 58%).[287]

According to both the European and Regional Innovation Scoreboard and the Digital Intelligence Index, Poland has room to improve its innovation performance. The Innovation Scoreboard categorises Poland as an 'emerging innovator', which is the lowest available

[283] SCF News – Retailnet.pl (2022). Handel czeka dalsza cyfryzacja i optymalizacja procesów. Available at: https://retailnet.pl/2022/02/18/95081-raport-parp-handel-czeka-dalsza-cyfryzacja-i-optymalizacja-procesow/

[284] Use of at least one digital channel in any industry by consumers, survey of 20,000 European consumers.

[285] McKinsey (2020). Europe's digital migration during COVID-19: Getting past the broad trends and averages the broad trends and averages.

[286] CR Fashionbook (2022). Check out Gucci Vault's new metaverse shop partnered with 10KTF. Available at: https://crfashionbook.com/check-out-gucci-vaults-new-metaverse-shop-partnered-with-10ktf/.

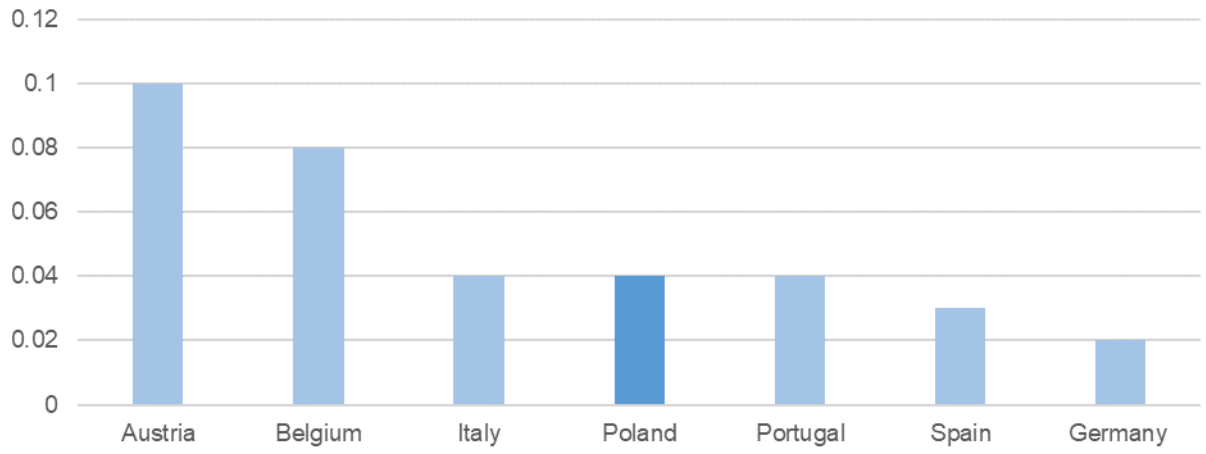
[287] European Commission (2021). DESI 2021: Poland. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-poland.

ranking.[288, 289, 290] Poland's relative strengths in innovation lay in digitalisation, intellectual assets, use of IT, start-up capacity, value creation and value capture. However, Poland has a high share of 'non-innovators' and it scores low on climate-change-related indicators, availability of financing, business practices and talent availability.[291, 292]

According to the 2022 European Semester Country Report for Poland, its R&D intensity in 2020 was 1.39% of GDP, while the EU average reached 2.32%. The ten-year compound growth rate of R&D reached an impressive 6.88%. At the same time, business enterprise expenditure on R&D between 2010 and 2020 grew even faster (16.4% compound growth rate), although it remained below the EU average at 0.87% of GDP (the EU average was 1.53%).[293]

Business enterprise expenditure on R&D in the wholesale and retail trade and repair of motor vehicles and motorcycles amounted to EUR 235.94 million in 2019, or 0.04% of GDP. When compared to other European countries, which have many major retailers[294], Poland's business enterprise expenditure on R&D as a proportion of GDP is comparable to Italy and Portugal (0.04%), as illustrated in Figure 24 below.[295]

Figure 24. Business enterprise expenditure on R&D, % of GDP, wholesale and retail trade and repair of motor vehicles and motorcycles, selected countries, 2019



Source: own elaboration based on Eurostat (2019): table RD_E_BERDINDR2.
Notes: presented in descending order.

[288] Available rankings in descending order: 'innovation leader', 'strong innovator', 'moderate innovator' and 'emerging innovator'.

[289] European Commission (2022). European and Regional Innovation Scoreboard 2021. Available at: https://ec.europa.eu/research-and-innovation/en/statistics/performance-indicators/european-innovation-scoreboard/eis.

[290] Tufts University (2021). Digital Intelligence Dashboard: Poland. Available at: https://digitalintelligence.fletcher.tufts.edu/countrydashboards.

[291] European Commission (2022). European Innovation Scoreboard 2021. Country report: Poland. Available at: https://ec.europa.eu/info/research-and-innovation/statistics/performance-indicators/european-innovation-scoreboard_en.

[292] Tufts University (2021). Digital Intelligence Dashboard: Poland. Available at: https://digitalintelligence.fletcher.tufts.edu/countrydashboards.

[293] European Commission (2022). European Semester Country Report: Poland. Available at: https://ec.europa.eu/info/system/files/2022-european-semester-country-report-poland_en.pdf.

[294] Based on Retail Index of major retailers in Europe. Available at: https://www.retail-index.com/HomeSearch/CalculateNumberofRetailerspercountrysector.aspx.

[295] Eurostat (2019, 2020). Table RD_E_BERDINDR2.

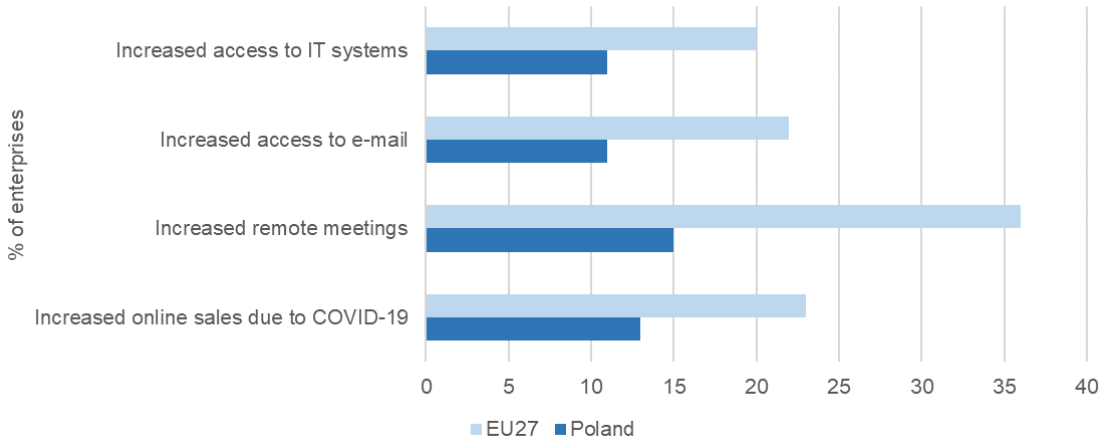
Improved economic conditions can provide retail enterprises with an opportunity to invest in digitalisation. However, the lack of dedicated instruments to support digitalisation uptake in the retail industry can make it harder for enterprises to take advantage of this opportunity and contribute to the low awareness of retail enterprises on support opportunities.

3.2.3.4. External shocks

According to RetailNet, the COVID-19 pandemic had a significant impact on how companies are managed. Just over one in five companies (21%) had additional trainings for their labour force to support the handling of new (often digitally supported tasks). Even fewer companies (14%) have shifted to a completely digital business model during the pandemic. [296]

According to Eurostat data, only 13% of companies in the retail industry increased online sales in response to COVID-19, which is lower than the European average for the same NACE sector (23%). Similarly, only 15% of Polish retail companies increased remote meetings (versus 36% in the EU), and 11% increased remote access to e-mail and IT systems (see Figure 25).[297]

Figure 25. COVID-19 impact on ICT usage (selected indicators), retail industry, Poland and EU27, 2021



Source: own elaboration based on Eurostat: Tables ISOC_E_CVD, NACE sector G47.

The pandemic has created challenges for the retail market as firms try to adapt to new customers' needs. Traditional retailers are incorporating new digital solutions into their business activities. For example, the Polish convenience store chain Żabka has introduced the self-service Żabka store and Żabka Nano, a shop-in-shop type of store. Omnichannel retailing and quick-commerce are becoming popular. As a result, more stores offering express delivery of grocery products have opened (for example, Glovo, Bolt, Wolt, Lisek, Żabka Jush). Subscription models traditionally associated with newspapers and magazines are now used for cars, clothes and even grocery products.[298]

[296] SCF News – Retailnet.pl (2022). Handel czeka dalsza cyfryzacja i optymalizacja procesów. Available at: https://retailnet.pl/2022/02/18/95081-raport-parp-handel-czeka-dalsza-cyfryzacja-i-optymalizacja-procesow/.

[297] Eurostat (2021). Tables ISOC_E_CVD, NACE sector G47.

[298] NielsenIQ (2021). Retail market 2021. Structure, numbers of facilities, trends. Results, quantity and structure research trade in June 2021 according to NielsenIQ. Available at: https://foodfakty.pl/rynek-detaliczny-2021-struktura-liczebnosc-placowek-trendy-wyniki-badania-liczebnosci-i-struktury-handlu-w-czerwcu-2021-wg-nielseniq.

Many Polish retail companies have successfully adopted digital technologies to cope with pandemic-related challenges. However, the uptake of online sales or provision of remote access to employees remains below the EU average. This may be due to the large proportion of small retailers that characterises the Polish retail market, which have slower rates of digital technology adoption.[299]

3.2.4. Main digitalisation strengths and challenges

While Poland is the leader in sales attributable to small stores, the number of small retailers has been falling in several categories.[300] Furthermore, the Polish retail market was particularly hard-hit by the pandemic due to both social distancing measures[301] and changes in consumer demand.[302] Given the importance of SMEs to the Polish retail market, it is crucial to boost digital technology adoption for retail SMEs to maintain their competitiveness and increase their resilience to external shocks, such as the pandemic.

Most (86%) Polish retailers show a 'low' or 'very low' level of digital intensity, which is 8% higher than the EU average.[303] Digitalisation is mainly driven by large companies, while smaller enterprises find it difficult to keep up. For example, rapidly changing consumer expectations are benefiting those who have adopted e-commerce and digital channels for interacting with consumers, while those that are slow to digitalise may lose out on consumers who have started using digital solutions during the pandemic.[304] In Poland, only 13% of companies in the retail industry increased online sales in response to COVID-19, which is lower than the European average (23%).[305] Similarly, digital product and service innovations are utilised mainly by big retailers, while SMEs lack the skills and resources to take advantage of them.[306] This could make it even harder for small enterprises to maintain competitiveness in an ecosystem where market consolidation has been ongoing for several years.[307]

Nevertheless, the wide availability of tools, such as intermediary marketplaces, digital marketing services, and fulfilment services, can support the adoption of e-commerce through the outsourcing of some processes. These particularly can support small stores with simple value chains that would consider implementing their own solutions too expensive. Meanwhile, small chains with slightly more complex value chains may benefit the most from external support in their digitalisation journey.[308]

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[299] NielsenIQ Shopper Trends 2021 report.

[300] NielsenIQ (2021). Retail market 2021. Structure, numbers of facilities, trends. Results, quantity and structure research trade in June 2021 according to NielsenIQ. Available at: https://foodfakty.pl/rynek-detaliczny-2021-struktura-liczebnosc-placowek-trendy-wyniki-badania-liczebnosci-i-struktury-handlu-w-czerwcu-2021-wg-nielseniq.

[301] Politico (2020). Europe's coronavirus lockdown measures compared. Available at: https://www.politico.eu/article/europes-coronavirus-lockdown-measures-compared/.

[302] OECD (2020). COVID-19 and the retail sector: impact and policy responses. Available at: https://read.oecd-ilibrary.org/view/?ref=134_134473-kuqn636n26&title=COVID-19-and-the-retail-sector-impact-and-policy-responses.

[303] Eurostat (2021). Tables isoc_e_dii, NACE sector G47.

[304] McKinsey (2020). Europe's digital migration during COVID-19: Getting past the broad trends and averages the broad trends and averages.

[305] Eurostat (2021). Tables ISOC_E_CVD, NACE sector G47.

[306] CR Fashionbook (2022). Check out Gucci Vault's new metaverse shop partnered with 10KTF. Available at: https://crfashionbook.com/check-out-gucci-vaults-new-metaverse-shop-partnered-with-10ktf/.

[307] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[308] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

Poland has undertaken several steps to support digital technology adoption in the retail sector, for example, by providing tax benefits and financing for digitalisation and making contactless payments easier. However, many of the initiatives aimed at boosting digitalisation are either sector agnostic or focus on traditional industrial sectors, such as manufacturing, and Poland lacks retail-specific instruments for digitalisation. As a result, retail enterprises need to adapt their plans to fit non-industry-specific existing instruments. For example, retail industry enterprises may have to apply to programmes that have been designed to fit mainly manufacturing businesses, as opposed to service-oriented companies. This factor may also impact the level of awareness that retail SMEs have about digitalisation opportunities, as there is a lack of demand for available support. The EDIH/ DIH network could play a particularly important role in demonstrating the benefit that retail SMEs can have from partaking in available support initiatives.[309]

3.3. Textile in Portugal

The section presents the results of the gap analysis for the textile industry in Portugal. It first provides an overview of the industry's economic performance before proceeding with the overview of the state of play of the digitalisation of Portugal's textile industry. It then presents key factors that impact the Portuguese textile industry's digitalisation before concluding with an overview of the industry's strengths and weaknesses.

3.3.1. State of play overview

According to the latest Post Programme Surveillance Report for Portugal, in 2021, the national economy has continued to recover from the pandemic-induced contraction that occurred in 2020. GDP increased by 4.9% in 2021, roughly in line with expectations, and regained slightly more than half of the ground lost in 2020. Growth is expected to remain robust in 2022, though the outlook for global demand has weakened as commodity markets and global supply chains have been disrupted by the war in Ukraine. Given Portugal's low exposure to the war zone, the direct impact on GDP and employment is expected to be limited.[310] Despite this, the global impact of the war on commodity prices, global supply chains, and business sentiment is expected to offset some of the country's growth momentum. GDP is expected to rise 5.8% in 2022 and 2.7% in 2023, according to the European Commission's 2022 Spring Forecast (see Figure 26).[311,312]

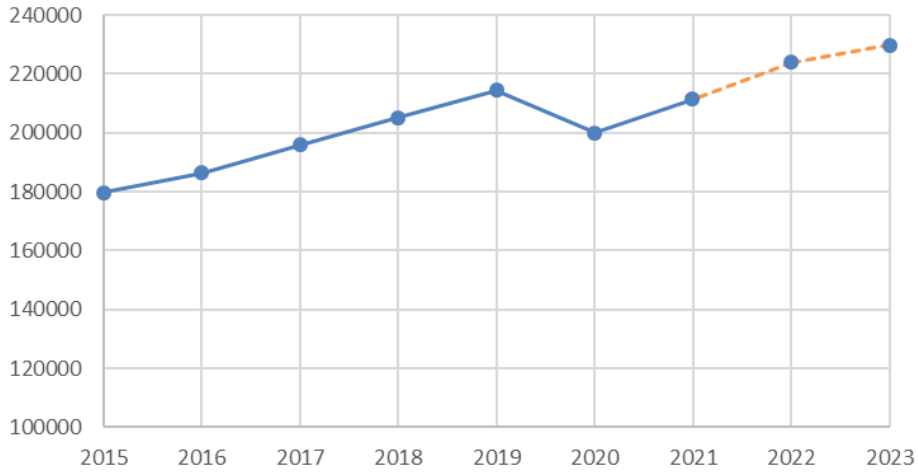
[309] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[310] European Commission (2021). Post-Programme Surveillance Report – Portugal, Spring 2022. Available at: https://ec.europa.eu/info/publications/economic-and-financial-affairs-publications_en.

[311] European Commission (2022). Spring 2022 European Economic Forecast. Available at: https://ec.europa.eu/info/system/files/economy-finance/ip173_en.pdf .

[312] European Commission (2021). Post-Programme Surveillance Report – Portugal, Spring 2022. Available at: https://ec.europa.eu/info/publications/economic-and-financial-affairs-publications_en.

Figure 26. GDP growth, EUR million, 2015-2023



Source: Banco de Portugal.
Notes: the orange line indicates projection.

According to 2020 figures from Banco de Portugal,[313] the Portuguese textile ecosystem[314] is represented by more than 8,700 companies, most (99.2%) are SMEs. Together they employ around 170,500 people and generate a turnover exceeding EUR 9,072 million. The industry contributes around EUR 3,089 million in value-added. This represents 3.6% of the total Portuguese workforce and a contribution of 4.5% to the national GDP. The textile industry is thus one of the most important industries in the Portuguese economy.[315] It has an advantage in leveraging its relatively low-cost skilled labour, which supports the production of footwear, manufacture of fabrics and tanning activities. Portugal is also an important producer of acrylic.[316]

The textile industry ecosystem is composed of multiple sectors and sub-sectors, including the textile, clothing, footwear manufacturing, manufacturing of man-made fibres and tanning and dressing of leather/dressing and dyeing of fur, and leather, breaking the textile ecosystem down into sectors and sub-sectors:

- The textile sector (NACE C13) accounts for 23.5% of all ecosystem companies and 25.8% of the labour force. Out of a total of 2,052 textile companies, 2,029 are SMEs (98.9%), and they employ 33,267 people out of the 43,998 working in the textile sector (75.6%). In 2020, textile sector activity produced a total of EUR 3,449 million, generating EUR 3,402 million in turnover with EUR 1,103 million in value-added.

- The clothing industry sector (NACE C14) represents 51.1% of textile ecosystem companies and 46.6% of the workforce. Out of a total of 4,465 companies in this subsector, 4,465 are SMEs (99.6%), and they employ 73,389 people out of the 79,504 working in the clothing subsector (92.3%). The clothing industry's

[313] Banco de Portugal (n.d.) Quadros do Sector. Available at: https://www.bportugal.pt/QS/qsweb/Dashboards.

[314] For the purposes of this study, the 'textile ecosystem' also includes clothing, leather, and footwear. See Annex 1. Industries, sectors, and sub-sectors included in the study

[315] ATP (n.d.). Statistics. Available at: https://atp.pt/en/statistics/description/.

[316] European Commission (2021). Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Data on the EU textile ecosystem and its competitiveness: final report, Publications Office, 2021. Available at: https://data.europa.eu/doi/10.2873/23948b.

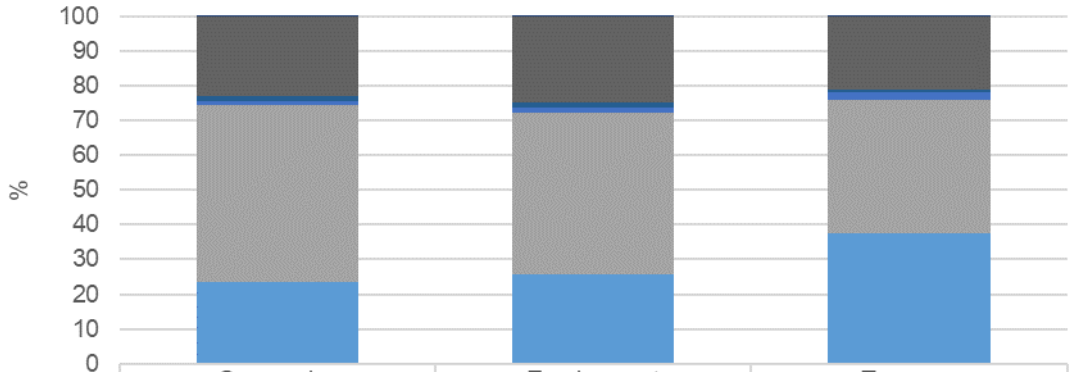
production volume reached EUR 3,561 million in 2020, generating a EUR 3,480 million turnover and EUR 1,245 million in value-added.

- Footwear manufacturing (NACE C1520) accounts for 23.3% of textile ecosystem companies and 22.7% of employment. Out of a total of 1,982 subsector companies, 1,973 are SMEs (99.5%), and they represent 36,698 jobs out of the 41,864 footwear subsector jobs (87.7%). Manufacture of footwear reached a production value of EUR 1,918 million in 2020, with a turnover of EUR 1,879 million and EUR 636 million in value-added.

- Together, the manufacturing of man-made fibres (NACE C206), manufacture of luggage (NACE C1512) and tanning and dressing of leather/dressing and dyeing of fur (NACE C1511) represent the remaining 2.7% of the textile ecosystem (240 companies) and 2.9%, or 5,117, of the jobs in the industry. These three subsectors represent EUR 322 million in production, EUR 312 million in turnover and EUR 104 million in value-added.[317]

For a breakdown of the textile industry into NACE sectors/sub-sectors based on the number of companies, employment, and turnover, see Figure 27.

Figure 27. Textile industry company, employment, and turnover breakdown (%) by NACE, Portugal



	Companies	Employment	Turnover
C206	0	0	0
C1530	23	25	21
C1512	2	2	1
C1511	1	1	2
C14	51	47	38
C13	24	26	38

Source: own elaboration based on data from Banco de Portugal.

Despite a lack of official national figures for 2021, the Textile and Clothing Association of Portugal (ATP) has stated that Portuguese textile and clothing exports (NACE C13 and C14) reached a record EUR 5,419 million in 2021, up 16.5% from 2020. Exports of knitted garments and home textiles contributed to this impressive growth. Knitted garments constituted EUR 2,336 million in exports, up to EUR 193 million (+9%) from the previous year, while exports in home textiles were EUR 763 million, up EUR 112 million (+17%). At the same time, woven garments have failed to recover from the pandemic's effects thus

[317] Banco de Portugal (n.d.). Quadros do Sector. Available at: https://www.bportugal.pt/QS/qsweb/Dashboards.

far, with exports of EUR 796 million in 2021, down EUR 189 million from the previous year (-19%).[318]

In footwear manufacturing, data from the latest status report of the Portuguese Footwear Association (APICCAPS)[319] show that after the pandemic-related downturn, the Portuguese footwear industry (NACE 1520) is experiencing a strong recovery. Its performance in foreign markets in the last quarter of 2021 was the best recorded to date. In 2021, Portugal exported footwear worth EUR 1,676 million to 162 countries on five continents. In the past decade, exports have grown by 29%.[320]

In some product segments, such as safety footwear (growth of 16% to EUR 29 million), waterproof footwear (up by 56% to EUR 56 million) and textile footwear (growth of 36% to EUR 75 million), the sector reached record highs in terms of exports.[321]

In short, Portuguese textile companies' overall assessment of the current state of business is favourable. Their concerns are centred on the supply of production factors, the price and availability of raw materials, the energy and fuel price volatility, transportation and logistics costs, labour shortages to meet strong demand and inflationary trends.[322] Technology will be critical in addressing supply chain disruption, improving analytics, and introducing new ways to engage with customers.[323,324]

3.3.2. Digitalisation in the industry

Portugal ranks 16th of 27 in the EU in its overall DESI performance. It shows relatively weaker performance in the 'human capital' and 'integration of digital technologies' dimensions, ranking 18th and 17th, respectively. Portugal ranks higher in the 'connectivity' (15th) and 'digital public services' (14th) dimensions.[325] For a comparison of Portugal's DESI dimension scores with the EU average, see Figure 28.

[318] SAPO (2022). Ano 2021 foi "o melhor de sempre" das exportações de têxteis e vestuário – ATP. Available at: https://www.sapo.pt/noticias/economia/ano-2021-foi-o-melhor-de-sempre-das_6203eb5b256adf5f0b7d6ff6

[319] Portuguese Shoes APICCAPS (2022). Análise trimestral de conjuntura à indústria de calçado. Available at: https://www.apiccaps.pt/library/media_uploads/conjuntura2022-1t.pdf.

[320] Portuguese Shoes APICCAPS (2021). Facts & Numbers 2021. Available at: https://www.apiccaps.pt/library/media_uploads/facts-numbers-2021.pdf.

[321] Portuguese Shoes APICCAPS (2021). Facts & Numbers 2021. Available at: https://www.apiccaps.pt/library/media_uploads/facts-numbers-2021.pdf.

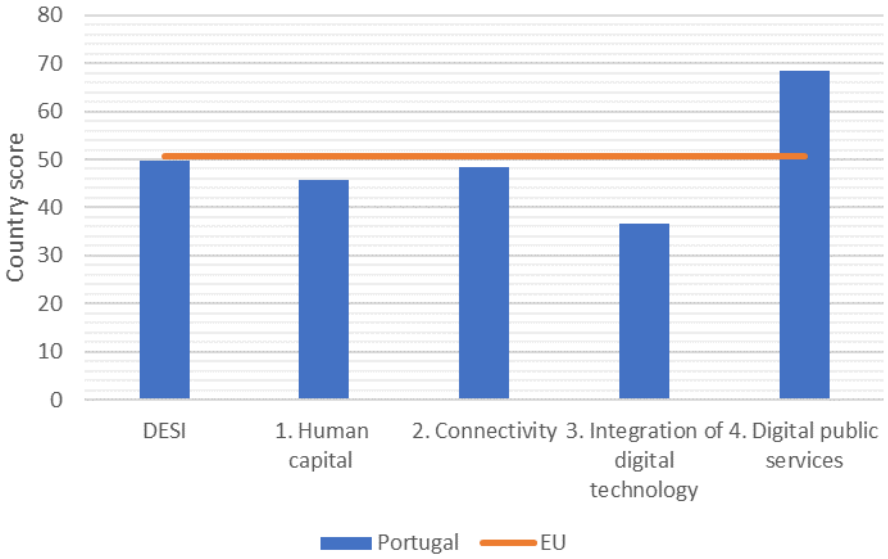
[322] Portuguese Shoes APICCAPS (2021). Facts & Numbers 2021. Available at: https://www.apiccaps.pt/library/media_uploads/facts-numbers-2021.pdf.

[323] European Commission (2020). Advanced Technologies for Industry – Sectoral Watch. Technological trends in the textiles industry. Available at: https://ati.ec.europa.eu/reports/sectoral-watch/technological-trends-textiles-industry.

[324] Euratex (2020). Facts & key figures of the European textile and clothing industry. Available at: https://euratex.eu/wp-content/uploads/EURATEX-Facts-Key-Figures-2020-LO.pdf.

[325] European Commission (2021). DESI 2021: Portugal. Available at: https://digital-strategy.ec.europa.eu/en/library/digital-economy-and-society-index-desi-2021.

Figure 28. DESI relative performance by dimension, Portugal, 2021



Source: own elaboration based on European Commission (2021). DESI 2021: Portugal.

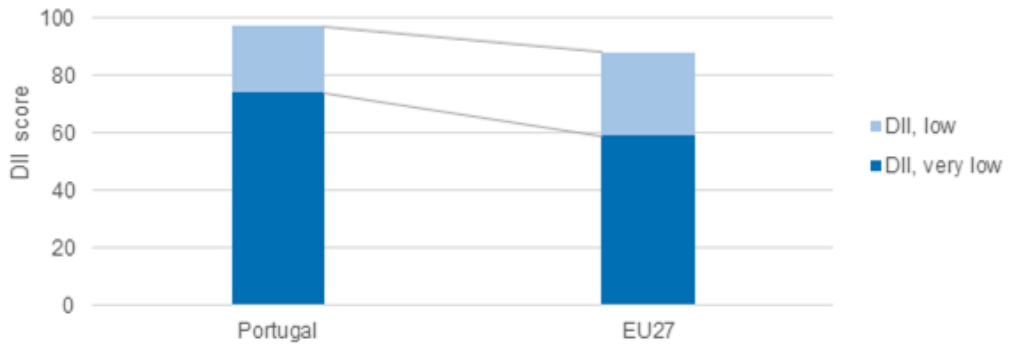
As mentioned above, Portugal performs slightly below the EU average in the 'integration of digital technology' dimension. Just over half of its enterprises (51%) exhibit at least basic digital intensity, which remains below the EU average of around 60%. By contrast, Portugal shows good results in using ICT for environmental sustainability, online commerce (19% of SMEs as opposed to the EU average of 17%), and the use of AI (31% versus only 25% in the EU). Cloud services are used by 21% of enterprises, while 11% use big data. E-invoicing uptake is significantly below the EU average of 27% at 17%.[326]

Looking at the Portuguese textile industry, 74% of enterprises score 'very low' in the DII, while 23% exhibit a 'low' digital intensity level (see Figure 29). The proportion of textile enterprises with a 'very low' DII score exceeds the EU average of 59%. Slightly more European enterprises (29%) show a 'low' level of digital intensity. Therefore, the total proportion of Portuguese textile ecosystem enterprises classified with 'low' or 'very low' in digital intensity amounts to 97%, compared to the EU average of 88%.[327]

[326] European Commission (2021). DESI 2021: Portugal. Available at: https://digital-strategy.ec.europa.eu/en/library/digital-economy-and-society-index-desi-2021.

[327] Eurostat (2021). Tables isoc_e_dii, NACE sectors C13-15.

Figure 29. Very low and low DII score comparison, textile industry, Portugal and EU27, 2021



Source: own elaboration based on data from Eurostat: Tables isoc_e_dii, NACE sectors C13-15.

In 2019, CITEVE conducted a study to assess the digital maturity of 39 textile and clothing companies. The study found that only 18.4% of the companies surveyed were already implementing 'one or more Industry 4.0 projects', while 13.2% were planning on starting their first project within six months. Half of the studied companies (47.4%) were still collecting information and evaluating scenarios. The remaining 21% had not started the process or thought Industry 4.0 did not apply to them.[328]

Another study performed in 2020 under the Interreg Sudoe DigiTVC project [329] surveyed 66 textile and clothing companies from Portugal, France, and Spain. The study found that in Portugal, only 45% of the companies reported that their top management is aware of the opportunities offered by digital technologies. At the same time, 85% saw a link between company development and progress made in digital technology adoption. Meanwhile, 40% of surveyed companies reported that their staff is open to change, 55% stated that they have mixed feelings, and only 5% noted that their staff are resistant to change. Finally, 60% of respondents reported that their company's digital transformation is ongoing (5% planned to start it within a year, 30% within three years).

In the textile industry, several state-of-the-art technologies are increasingly being adopted by innovative companies. These include the digitalisation of fabrics, 3D digital design and development, computer vision and AI for quality inspection, digital printing of fabrics, data analytics in the production process, AR/VR to support remote operations and blockchain for product and data traceability.[330]

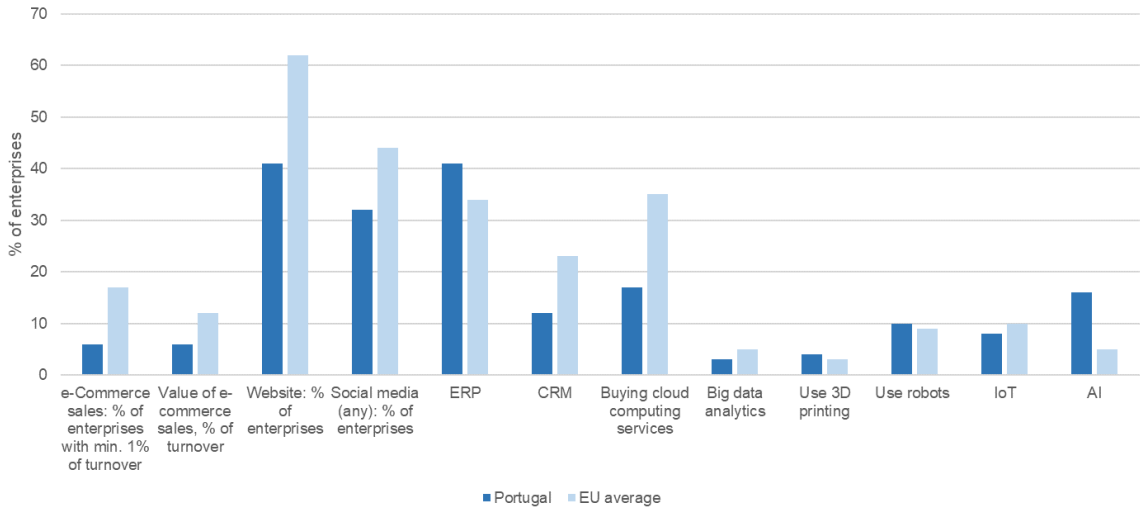
The latest data from Eurostat for NACE sectors 13-15 show that, despite Portuguese textile industry enterprises lagging behind the EU average in several digital technology uptake indicators, the adoption of some innovative technologies is becoming increasingly common. For example, the country shows strong performance in the use of AI. Approximately three times as many Portuguese textile industry enterprises use AI when compared to the EU average. Moreover, the use of 3D printing in Portugal slightly exceeds the EU average (4% of enterprises in Portugal versus 3% in the EU). Similarly, ERP has been implemented in 41% of Portuguese textile companies as opposed to 34% in the EU. Finally, the use of robotics in Portugal (10%) slightly exceeds the EU average of 9%.

[328] Interreg SUDOE (2020). Digital maturity diagnosis Quantitative analysis. Available at: https://digitvc.eu/wp-content/uploads/2021/04/GT1-activity-1-2-Quantitative-Analyzes-Final-version.pdf.

[329] Cluster Textile (n.d.). Knit-Force. Available at: https://www.clustertextil.pt/knit-force.

[330] European Commission (2020). Advanced Technologies for Industry – Sectoral Watch. Technological trends in the textiles industry. Available at: https://ati.ec.europa.eu/reports/sectoral-watch/technological-trends-textiles-industry.

Figure 30. Uptake of digital technologies, textile industry, Portugal and EU27



Source: own elaboration based on Eurostat: Tables EISOC_EC_ESELN2, ISOC_CIWEB, ISOC_CISMT, ISOC_EB_IIP, ISOC_CICCE_USE, ISOC_EB_BD, ISOC_EB_P3D, ISOC_EB_IOT, ISOC_EB_AI, NACE sectors C13-15.

Notes: data from 2021, except big data analytics, 3D printing, use of robots and IoT, where 2020 was the latest available year. 'e-Commerce' refers to the proportion of enterprises where e-Commerce sales exceed 1% of turnover.

Meanwhile, the Interreg Sudoe DigiTVC project survey showed that of Portuguese textile industry respondents, 25% prioritise digitalising production, 20% tools for design and innovation, 20% e-commerce, 15% CRM and 10% logistics. One-tenth of respondents stated that they do not have any priorities, while 55% of companies surveyed stated that they have a digital transformation roadmap in place. In terms of specific technology adoption, the study found:

- High rates of adoption for supply chain management (SCM) systems (50%), product life cycle management (PLM) systems (55%), CRM systems (55%), digital tools to support relationships with suppliers (75% partially, 10% fully digital process).

- In terms of levels of production automation, 40% of respondents considered it to be 'high' or 'very high' in their organisation, 40% stated that it was medium, while 20% considered it 'low'. Larger companies performed better in this indicator, reaching 50% of 'high' automation against only 30% for very small enterprises (VSEs). Only 35% of the surveyed companies have invested in warehouse automation.

- Barcode was by far the most popular automatic identification technique (65% adoption) indicated by respondents, with QR code being adopted by 10% of respondents and 25% adopting other methods.

- A total of 45% of companies collected real-time data and used data analytics tools (50% of large companies, only 10% of VSEs). 85% of respondents stated that business data is available freely in the company with no silos.

- Only 5% of respondents indicated that their company does not have a website, and the majority that does have it, does not update it regularly. Most (80%) respondents have a social media presence, although only half are using social media frequently.

- A total of 71% of B2C companies have adopted an e-commerce platform, while only 20% of B2B companies have done the same.[331]

According to EC Flash Eurobarometer 486, Portuguese SMEs rank uncertainty about future digital standards, lack of financial resources and IT security as the top three barriers to digitalisation. Skills and legal/ regulatory compliance are major obstacles to digitalisation as well. In addition, a significant percentage of enterprises referred to 'other issues' not mentioned in the survey.[332] These results are in line with the conclusions from stakeholder interviews, where bureaucracy associated with applying for public funding and the uncertainty of the reimbursements timeline were mentioned. Moreover, interviewees also noted that project and change management skills are also critical.

While the Portuguese textile industry shows good results in the adoption of certain technologies, such as AI, the overall level of digital intensity is 'low' or 'very low' in most enterprises. This is likely linked to several factors, including the large proportion of SMEs in the industry, who find the digitalisation journey more challenging than large enterprises, as well as existing barriers to digitalisation in Portugal. Moreover, it is important to look at digitalisation in the industry holistically as most textile SMEs are integrated in complex supply chains. In this context, lack of standardisation will also be a key issue to address in the future.[333]

3.3.3. Key factors influencing digitalisation in the industry

3.3.3.1. Policy factors

In the 2021 Digital Intelligence Index[334] 'state of institutions' dimension, Portugal ranks below the high-income country group median and above the European and Central Asian median. Portugal shows particularly good performance in the ICT regulatory environment (ranking 15th out of 90 economies), transparency (26th) and effectiveness of institutions (28th) clusters. Portugal ranks the lowest in the legal environment for businesses (38th), government facilitation of ICT (38th) and bureaucracy (60th).[335] Meanwhile, in the OECD DSTRI,[336] Portugal's score is lower than the EEA average, indicating a favourable regulatory environment for digital trade (see Annex 5).[337]

Multiple European-level policy changes will profoundly affect digitalisation in the textile industry. In 2021 and 2022, several new regulations and directives have been introduced to define rules around marketing and labelling, due diligence, and traceability and sustainability reporting in the textile industry. They all have a significant impact on

[331] Cluster Textile (n.d.). Knit-Force. Available at: https://www.clustertextil.pt/knit-force.

[332] Flash Eurobarometer 486 (2020) Portugal. Available at: https://europa.eu/eurobarometer/api/deliverable/download/file?deliverableId=73491.

[333] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[334] The Digital Intelligence index is composed of two scoreboards: the digital evolution scoreboard compares the digital maturity and historical growth trajectory of countries, the digital trust scoreboard, which measures the trustworthiness of the digital ecosystem, the level and types of friction in digital experiences, the depth of engagement among Internet users, and the level of trust expressed by citizens.

[335] Tufts University (2021). Digital Intelligence Dashboard: Portugal. Available at: https://digitalintelligence.fletcher.tufts.edu/countrydashboards.

[336] The DSTRI is a composite indicator that takes a value between '0' and '1'. It measures how open the regulatory environment is for digital trade. '0' indicates an open regulatory environment for digitally enabled trade, '0' indicates a completely closed regime.

[337] OECD (2021). Digital Services Trade Restrictiveness Index Simulator. Available at: https://sim.oecd.org/Default.ashx?lang=En&ds=DGSTRI&d1c=eu&cs=eu.

companies' modus operandi and require considerable advances in process digitalisation and data sharing along the supply chain. Despite regional and country differences, laws relating to product traceability and advanced consumer information have demanding requirements regarding data exchange along the supply chain. And they can only be addressed through process digitalisation and automation.

For example, the European Green Deal[338] and the Strategy for Sustainable and Circular Textiles[339] in the EU are examples of regulations that relate to sustainability and will significantly affect supplies in the textile ecosystem. Via the Circular Economy Action Plan (CEAP) in 2020,[340] the European Commission announced a legislative proposal to require environmental claims to be substantiated using Product & Organisation Environmental Footprint methods. It demands, among other requirements, the introduction of a digital product passport to provide clear information on the environmental characteristics of a textile product.

Furthermore, several EU regulations and directives have been proposed, such as the EU Corporate Sustainability Due Diligence Directive Proposal,[341] the EU Corporate Sustainability Reporting Directive Proposal[342] and the EU Ecodesign Requirements for Sustainable Products Regulation Proposal,[343] which will have significant implications for the textile industry. As companies will have to adapt rapidly to changes in the regulatory environment, some of them, especially smaller companies, will need additional resources and support to do so.[344]

On a national level, in 2020, Portugal approved the 'National Action Plan for Digital Transition' prioritising digital inclusion, education and training, digital transformation of businesses, public administration, and digitalisation of education. The action plan promotes enterprise digitalisation through entrepreneurship and start-up ecosystems, digital transformation of companies and SMEs, and knowledge transfer. It is linked with the main programmes for business digital transition (Indústria 4.0 and Advantage 4.0) and follows three main action points:

- Generalise Industry 4.0 to encourage companies, technology suppliers, and institutions to share knowledge and experience.

[338] European Commission (n.d.). European Green Deal. Available at: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en.

[339] European Commission (2022). 141 final. Communication from the Commission to the European Parliament, the Council, the European Economic And Social Committee And The Committee Of The Regions Eu Strategy for Sustainable and Circular Textiles, Brussels. Available at: https://ec.europa.eu/environment/publications/textiles-strategy_en.

[340] European Commission (2020). Circular Economy Action Plan. Available at: https://ec.europa.eu/environment/pdf/circular-economy/new_circular_economy_action_plan.pdf.

[341] European Commission (2022). Proposal for a Directive on corporate sustainability due diligence and annex. Available at: https://ec.europa.eu/info/publications/proposal-directive-corporate-sustainable-due-diligence-and-annex_en.

[342] European Commission (2021). 189 final, Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2013/34/EU, Directive 2004/109/EC, Directive 2006/43/EC and Regulation (EU) No 537/2014, as regards corporate sustainability reporting, Brussels 21.4.2021. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021PC0189&from=EN.

[343] Related documents available at: https://ec.europa.eu/environment/publications/proposal-ecodesign-sustainable-products-regulation_en.

[344] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

- Empower Industry 4.0 by adapting human capital skills to the reality of Industry 4.0 through an academic offer in digital skills and the requalification of the existing workforce.

- Assimilate Industry 4.0 by focusing on solutions and technologies that facilitate access to technical skills and funding.[345]

Moreover, Portugal is dedicated to the development of advanced technologies, as evidenced by several strategies under the national initiative on digital competencies INCoDe.2030,[346] such as the 2030 Artificial Intelligence Portugal Strategy and the 2030 Advanced Computing Portugal Strategy. In addition, as part of INCoDe.2030, Portugal is developing an open data strategy that will outline specific initiatives to promote data reuse and sharing.

Portugal's Recovery and Resilience Plan (RRP PT) supports the digitalisation of enterprises in several ways. Component 16 Empresas 4.0 of RRP PT supports the digitalisation of businesses with measures amounting to EUR 592 million. The plan includes support for the development of a test beds network, digital commerce, coaching to support businesses in the adoption of advanced technologies, support for start-ups in developing and adopting new digital technologies, DIHs and platforms and actions for dematerialisation of invoices and cybersecurity. Other measures under component five 'investment and innovation', will strengthen and empower the national scientific and technological system and improve business-academia linkages. Within the textile industry, a certain focus is also put on identifying common problems and potential solutions by bringing together industry stakeholders and ICT providers.[347]

Box 2. Examples of RRP PT-linked initiatives in the textile ecosystem

Promoting sustainable solutions in the Portuguese footwear sector

Within the RRP PT component five, the Portuguese footwear sector will receive support for the next three years, through the Footwear and Fashion Cluster, led by APICCAPS and the Portuguese Technological Footwear Centre (CTCP), to become an international pioneer in the development of sustainable solutions. The sector intends to 'strengthen Portuguese exports based on a highly competitive national productive ground, centred on knowledge and innovation'.

FAIST project

With a budget of close to EUR 60 million, the FAIST project, currently under RRP PT evaluation, aims to improve:

- specialisation in the footwear sector for new product categories;

- supply capacity by increasing capacity to manufacture medium and big orders by improving assembly process efficiency;

[345] Diário da República (2020). Resolução do Conselho de Ministros n.º 30/2020. Available at: https://files.dre.pt/1s/2020/04/07800/0000600032.pdf.

[346] Portugal INCoDe (n.d.). An integrated public policy initiative to enhance digital competences. Available at: https://www.incode2030.gov.pt/en/initiative.

[347] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

- innovation throughout the footwear production chain;
- local production of equipment and advanced technologies to replace imports, thus creating skills and capacities required for the installation of production units with high levels of automation and robotics locally.[348]

TextP@ct consortium

TextP@ct is a textile and clothing sector consortium composed of 40 entities, including SMEs, large companies, IT and advanced manufacturing companies, academia, R&D centres. It is led by CITEVE and has submitted a proposal of EUR 58 million aiming at the main digitalisation challenges of the textile and clothing companies, where robotics and automation, supply-chain integration, smart manufacturing, data analytics and digital skills are top priorities.

In line with the RRP PT, Portugal is creating a national network of DIHs, which includes the Digi4fashion hub operating in the textile ecosystem. Their purpose is to support the digital transformation of enterprises, especially SMEs and the public sector. The DIHs will aim to guarantee regional, sectoral, and territorial coverage, digital technology specialisation and complementarity. The network will work with tech and R&D centres, laboratories, competitiveness clusters and enterprises. Each DIH will found an accelerator to foster the entrepreneurial ecosystem around its sectors. Furthermore, in 2022, three EDIHs were selected by the European Commission in the first call, while Portugal plans to fund six additional EDIHs.[349]

Portuguese textile industry enterprises are facing increasing regulatory pressure related to environmental and ethical standards that will require them to pursue data analytics and digitalisation in their supply chains. In this context, the policies and initiatives to support industry digitalisation will be especially important in helping prepare the textile industry for these new requirements.

3.3.3.2. Social factors

Negative demographic trends and rising skills shortages in Portugal highlight the importance of upskilling and reskilling its workforce. According to DESI 2021, Portugal ranks 18th out of the 27 EU countries in the 'human capital' dimension. The level of basic digital skills remains at 52%, which is lower than the EU average of 56%. However, the country has seen a significant increase in the proportion of ICT specialists (approximately 4% of the workforce). Only 2.3% of all graduates are ICT graduates, which is much lower than the EU average of 3.9%. However, a significant increase in the proportion of ICT graduates has been observed since 2019, when the proportion in Portugal was only 1.9%.[350]

Concerning the digital skills of the labour force, Portugal created multiple interconnected programmes to upskill and reskill employees and entrepreneurs with digital competencies, including in SMEs. These include:

[348] Portuguese Shoes APICCAPS (2021). Facts & Numbers 2021. Available at: https://www.apiccaps.pt/library/media_uploads/facts-numbers-2021.pdf.

[349] DG CNECT A4 - Digital Transformation of Industrial Ecosystems (2022). Presentation 'Digitalisation of Businesses and the network of European Digital Innovation Hubs (EDIH)' during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[350] European Commission (2022). Portugal in the Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-portugal.

- The Emprego+Digital program, which began in 2020 and trains employees in manufacturing, commerce, services, tourism, and agriculture. The programme will cover 200,000 employees by the third quarter of 2025, with a total investment of EUR 94 million.

- The national programme Jovem+Digital, launched in 2020 to help young unemployed people aged 18 to 35 gain digital skills. It establishes ten vocational training paths in high employability areas. It provides six-month intensive programming courses at a university or polytechnic, as well as three months of work-based learning in a company.

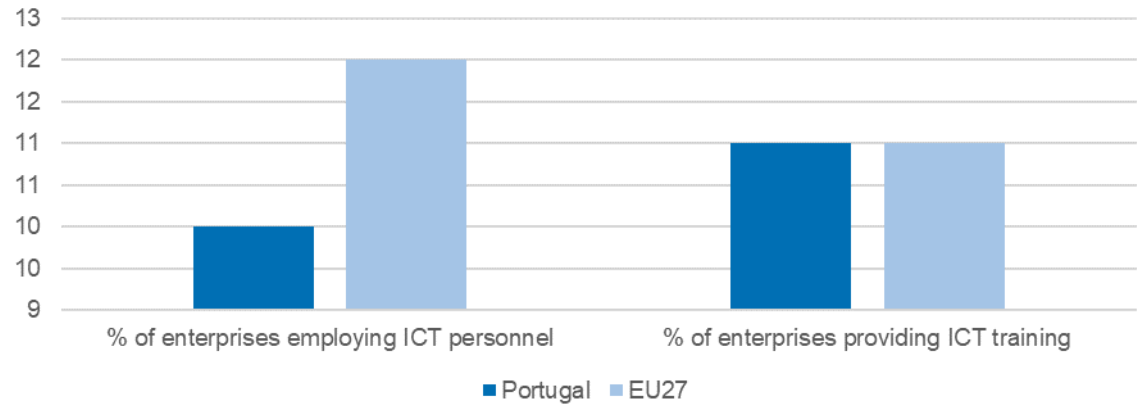
- The Eu Sou Digital (I'm Digital) program, which began in July 2021, aims to train over one million adults in basic digital skills by 2023, utilising a national network of young volunteers and training centres located throughout Portugal.

- The INCoDe.2030 national initiative on digital competencies, with broader goals and greater alignment with the National Action Plan for Digital Transition.[351]

Based on the results of the Interreg Sudoe DigiTVC project survey, 70% of Portuguese textile industry respondents report the level of their staff's digital skills to be 'medium', and 30% report it as being 'low'. More than half (60%) have recently provided training on digital tools for their staff. However, the proportion is significantly lower among VSEs (10%) when compared to larger companies (75%).[352]

The findings of this survey compliment the data from Eurostat, which show that the European textile industry in general performs poorly in attracting professionals with ICT skills. Across Europe, only 12% of enterprises in the industry employ people with such skills, while this figure is slightly lower for Portugal (10%). Furthermore, only 11% of enterprises in Portugal reported providing ICT training to their staff, which is equivalent to the EU average (see Figure 31).

Figure 31. Employment of ICT personnel and ICT training, textile industry, Portugal and EU27, 2020



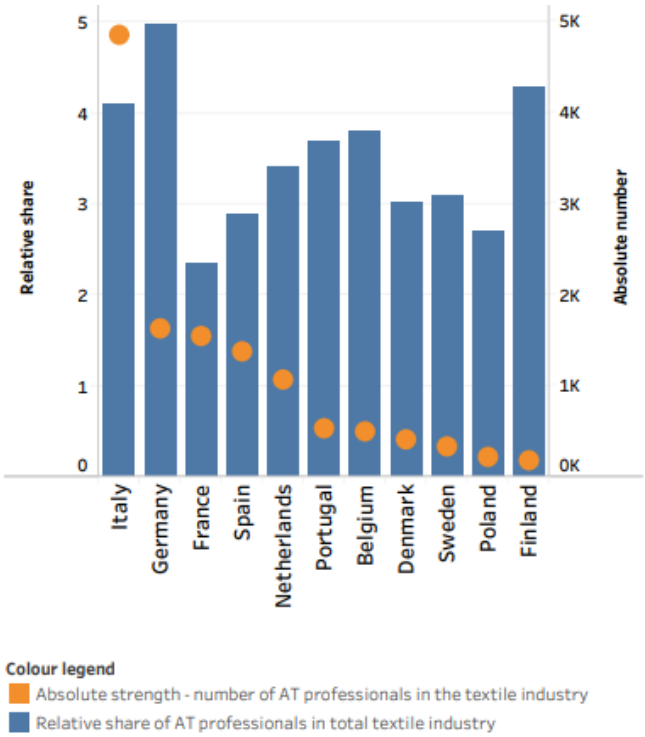
Source: own elaboration based on data from Eurostat: Tables ISOC_SKE_ITSPEN2 and ISOC_SKE_ITTN2, NACE sectors C13-15.

[351] European Commission (2022). Portugal in the Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-portugal.

[352] Cluster Textile (n.d.). Knit-Force. Available at: https://www.clustertextil.pt/knit-force.

However, according to the Technopolis Group analysis of LinkedIn data, Portugal has a relatively high share of professionals with skills in advanced technologies, yet it still trails behind such countries as Italy, Germany, and Finland. Meanwhile, the absolute number of these professionals is relatively low, ranking below Italy, Germany, France, Spain, and the Netherlands.[353] These trends suggest that action needs to be taken to ensure that the Portuguese textile industry has a workforce with the right skills mix to meet the demands of the future.

Figure 32. Professionals on LinkedIn employed in the textile industry with skills in advanced technologies, top EU27 countries



Source: European Commission (2020) 'Advanced Technologies for Industry – Sectoral Watch. Technological trends in the textiles industry' and Technopolis Group analysis based on LinkedIn data.

The textile industry needs to be responsive to changes in consumer habits and expectations. One such change is an increasing interest in product customisation accelerated by advances in technology. This trend, together with a need for waste reduction, is transforming the textile industry from a supply-push to a demand-pull model, where small-batch or even unitary orders are placed. Apart from significantly changing the business model, this trend also has major implications for digitalisation. It can only be achieved when the complete workflow, from customer to order and to manufacturing plant, is totally digital. [354]

Some of the larger companies have already started investing in digital tools that enable the digitalisation of the whole design process and the production of realistic digital samples. This process allows the client to customise the product and place the order without a physical product or samples being manufactured. However, it requires the use

[353] European Commission (2020). Advanced Technologies for Industry – Sectoral Watch. Technological trends in the textiles industry. Available at: https://ati.ec.europa.eu/reports/sectoral-watch/technological-trends-textiles-industry.

[354] European Commission (2020). Advanced Technologies for Industry – Sectoral Watch. Technological trends in the textiles industry. Available at: https://ati.ec.europa.eu/reports/sectoral-watch/technological-trends-textiles-industry.

of advanced technologies requiring technical skills from product designers that many companies currently do not possess, especially SMEs.

Textile companies will need to adapt to rapidly changing consumer habits and expectations. Adapting to new consumer trends will require companies to adopt new technologies and ways of engaging with their customers. However, this transformation will require companies to have the right competencies, including digital and advanced manufacturing skills. If the existing skills gaps are not addressed, they can become a barrier to digital transformation, especially for SMEs.[355, 356]

3.3.3.3. Economic factors

The national connectivity infrastructure in Portugal is not considered a major barrier to digitalisation. According to DESI 2021, Portugal ranks 15th in the 'connectivity' dimension. The country's coverage of at least 100 Mbps fixed broadband take-up reaches 63% compared to an EU average of 34%, and 87% in VHCN broadband (against an EU average of 59%). Total and rural fibre to the premises (FTTP) coverage continues to increase. Overall fixed broadband take-up reached 79% in 2020, slightly over the EU average (77%). However, despite its almost 100% mobile 4G coverage, Portugal scores below the EU average in mobile broadband take-up.[357]

According to the European Innovation Scoreboard 2021, Portugal is a 'moderate innovator'.[358,359] Since 2014, Portugal's relative performance in the EU has increased, except in 2021, when it decreased sharply. Portugal shows strong performance in ensuring attractive research systems, digitalisation, and the use of IT. On the one hand, relatively weaker performance can be observed in business process innovation and climate change-related indicators.[360] On the other hand, the Digital Intelligence Index, which also measures innovation, indicates that Portugal's relative strengths are in value creation (ranked 27th out of 90 economies), business practices (28th) and R&D (28th). Out of the 'innovation' dimension indicator clusters, Portugal has the lowest rank in value capture (52nd), start-up capacity (57th) and financing (63rd).[361]

Portugal's spending on R&D in 2020 constituted 1.62% of GDP, while the EU average was 2.32%. From 2010 until 2020, the compound annual growth rate of R&D spending reached 0.52%. Business enterprise expenditure on R&D was 0.92% of GDP (EU average 1.53%), with a compound annual growth rate of 2.71%.[362] Business enterprise expenditure on R&D

[355] EIB (2022). Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022.

[356] EIB (2022). Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey. Available at: https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022.

[357] European Commission (2022). Portugal in the Digital Economy and Society Index. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-portugal.

[358] Available rankings in descending order: 'innovation leader', 'strong innovator', 'moderate innovator' and 'emerging innovator'.

[359] European Commission (2022). European and Regional Innovation Scoreboard 2021. Available at: https://ec.europa.eu/research-and-innovation/en/statistics/performance-indicators/european-innovation-scoreboard/eis.

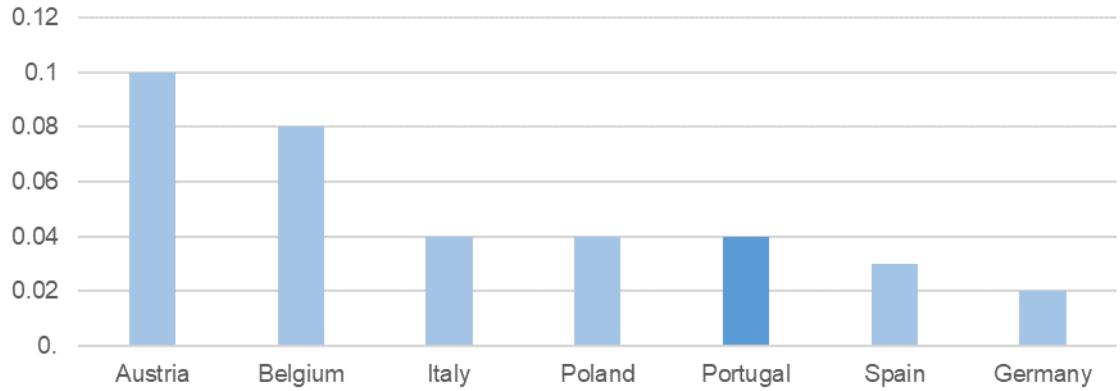
[360] European Commission (2022). European Innovation Scoreboard 2021. Country report: Portugal. Available at: https://ec.europa.eu/info/research-and-innovation/statistics/performance-indicators/european-innovation-scoreboard_en.

[361] Tufts University (2021). Digital Intelligence Dashboard: Portugal. Available at: https://digitalintelligence.fletcher.tufts.edu/countrydashboards.

[362] European Commission (2022). European Semester Country Report: Portugal. Available at: https://ec.europa.eu/info/system/files/2022-european-semester-country-report-portugal_en.pdf.

in the textile industry in 2020 was EUR 47.04 million or EUR 4.6 per inhabitant, up from EUR 41.19 million or EUR 4 per inhabitant in 2019. When compared to other countries with important textile industries in Europe, business enterprise expenditure on R&D is comparable to that in Italy and Poland (0.04% of GDP). Meanwhile, Austria and Belgium spend more than Portugal, while Spain and Germany have lower expenditures (see Figure 33).[363]

Figure 33. Business enterprise expenditure on R&D, % of GDP, textile industry, selected countries, 2019



Source: own elaboration based on Eurostat (2019): Table RD_E_BERDINDR2, NACE sectors C13-15.
Notes: presented in descending order.

According to the study 'Advanced Technologies for Industry – Sectoral Watch, Technological trends in the textiles industry', Germany, France, Italy, Spain, and the Netherlands, have the highest numbers of venture capital-backed firms. Portugal places 9th in total investment captured. Foreign investment from outside the EU has shown growth since 2013 across many textile industries – Portugal is among the countries that have experienced the largest increases. Meanwhile, Portugal, Estonia, and Sweden saw the greatest intra-EU28 investment growth between 2013 and 2017.[364] However, when it comes to public funding for digitalisation, interviewed stakeholders consider the process bureaucratic. Stakeholders also note that there is uncertainty associated with the timeline of reimbursements.

Among major textile industries, Portugal ranks after Finland, France, Sweden, and Germany in the share of start-ups. Venture capital investment in textile industry start-ups was the highest in Finland, Sweden, and Germany, followed by Portugal and Spain. In the European textile industry, start-ups innovate in advanced materials (21%), sustainability (14%) and e-textiles and wearable electronics (11%). However, the highest proportion of start-ups (29%) operates in the digital field, offering, for example, online services, e-commerce software, virtual fitting, and size recommendations.[365]

The Portuguese textile industry does not face significant digital infrastructure-related barriers to digitalisation and has an active innovation ecosystem. However, when it comes to obtaining public funding, textile industry enterprises face barriers related to bureaucracy and a lack of clarity on reimbursement conditions.

[363] Eurostat (2019, 2020). Table RD_E_BERDINDR2.

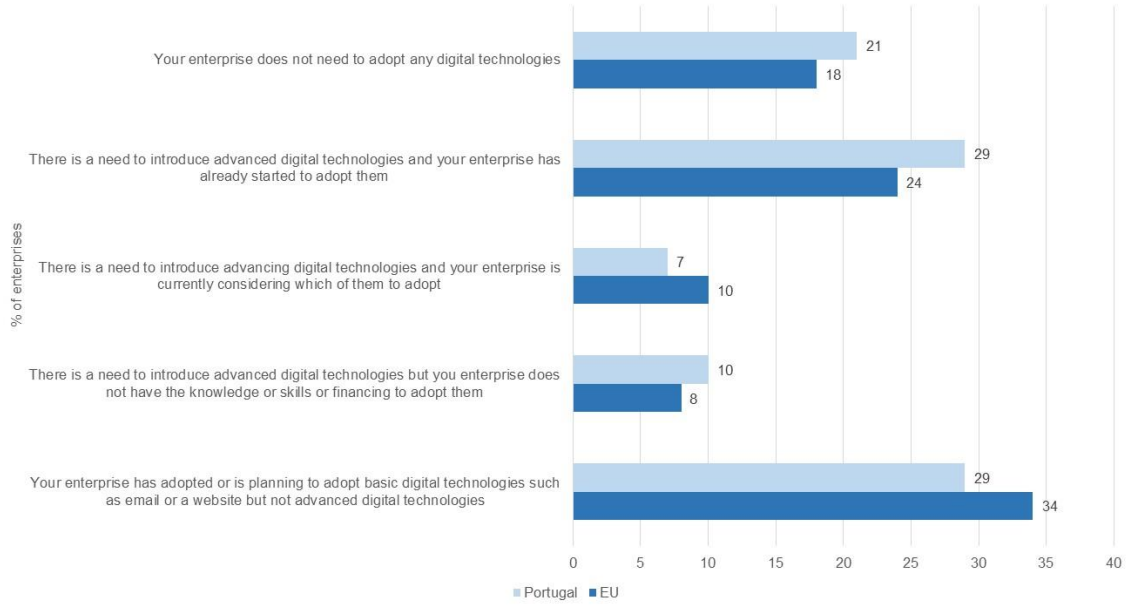
[364] European Commission (2020). Advanced Technologies for Industry – Sectoral Watch. Technological trends in the textiles industry. Available at: https://ati.ec.europa.eu/reports/sectoral-watch/technological-trends-textiles-industry.

[365] European Commission (2020). Advanced Technologies for Industry – Sectoral Watch. Technological trends in the textiles industry. Available at: https://ati.ec.europa.eu/reports/sectoral-watch/technological-trends-textiles-industry.

3.3.3.4. External shocks

Flash Eurobarometer 486, which was run from late February to late April 2020, during the initial phase of the pandemic, provides some information on the state of digitalisation of SMEs in the EU27. Based on data from 500 Portuguese enterprises, 29% of respondents had adopted or were planning to adopt basic digital technologies such as email or a website (EU average 34%). About one-tenth of Portuguese enterprises believed there was a need to introduce advanced technologies, but their enterprise did not have the knowledge or skills or financing to adopt them (EU 8%). In addition, 7% recognised the need and were considering which technology to adopt (10% in the EU), and 29% stated that they were already adopting advanced technologies (24% in the EU). Around one in five Portuguese enterprises stated that they did not need to adopt any digital technologies.

Figure 34. Portuguese enterprises approach to digitalisation, 2020



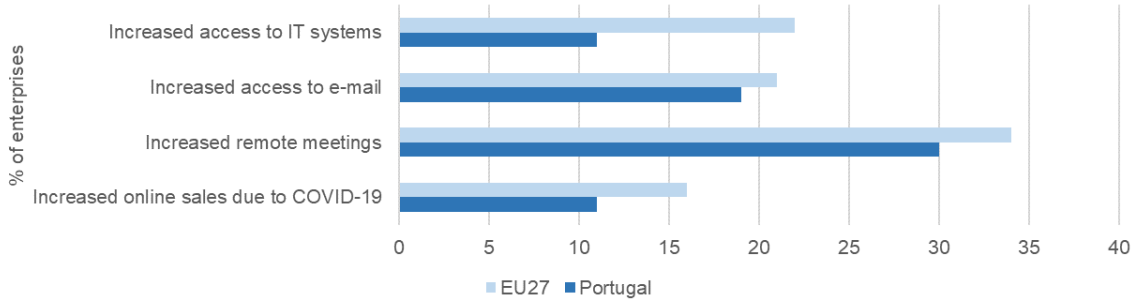
Source: own elaboration based on European Commission (2020). Flash Eurobarometer 486.

Due to social distancing, communication within and between firms, as well as with consumers in the textile industry, transitioned to digital channels. While data on the impact of COVID-19 on Portuguese textile ecosystem companies is scarce, figures from Eurostat on ICT usage indicate that the pandemic encouraged the adoption of digital tools for supporting new sales channels (11% increase in companies selling online). Similarly, companies increased the use of collaborative tools for maintaining contact with customers, partners and suppliers (30% increase in video-conferencing tools adoption) and tools for supporting remote working for employees (19% increase in remote access to email service and 11% increase in remote access to internal information system).[366] While the pandemic saw some textile companies adapt rapidly, some companies have also put their digitalisation efforts on hold to focus on challenges brought by external shocks, such as the current rise of input prices.[367]

[366] Eurostat (2021). Tables ISOC_E_CVD, NACE sectors C13-15

[367] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

Figure 35. COVID-19 impact on ICT usage (selected indicators), textile industry, Portugal and EU27, 2021



Source: own elaboration based on Eurostat: Tables ISOC_E_CVD, NACE sectors C13-15.

Portuguese companies also adopted new technologies, such as 3D computer-aided design systems, realistic rendering of digital fabrics and avatars for fitting and movement simulation, 3D printing, IoT, AI and computer vision, and the use of AR/VR. Many of these technologies have been adopted by a few large companies. Yet, only a few technologies have specific applications and/or do not require additional R&D. Nevertheless, they have the potential to become increasingly important in the textile ecosystem in the future.

For several years the textile industry has been undergoing a significant digital transformation because of increased consumer demand for personalised products, the connectivity of textile manufacturing devices via IoT applications, and increased automation of production and logistics processes. Technological advancements have resulted in new business models and opportunities for textile companies. Despite limited data, there is some evidence that the COVID-19 pandemic pushed Portuguese companies, including in the textile industry, to increase their level of digitalisation. However, the data suggests that those adoption rates were lower in Portugal than in Europe on average, indicating the possibility for further improvement.

3.3.4. Main digitalisation strengths and challenges

The industry represents a complete value chain for textile products that can withstand supply chain disruptions, including ones related to the COVID-19 crisis.[368] However, changes in the regulatory environment and consumer expectations, such as stricter environmental and ethical standards, will change the industry landscape in the upcoming years. Technology will be critical in addressing supply chain disruption, improving analytics, and introducing new ways to engage with customers.[369,370]

While the Portuguese textile industry shows good results in the adoption of certain technologies, such as AI, the overall level of digital intensity is low or very low in the vast majority of enterprises.[371] The proportion of Portuguese textile ecosystem enterprises with

[368] European Commission (2021). Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Data on the EU textile ecosystem and its competitiveness: final report, Publications Office, 2021. Available at: https://data.europa.eu/doi/10.2873/23948.

[369] European Commission (2020). Advanced Technologies for Industry – Sectoral Watch. Technological trends in the textiles industry. Available at: https://ati.ec.europa.eu/reports/sectoral-watch/technological-trends-textiles-industry.

[370] Euratex (2020). Facts & key figures of the European textile and clothing industry. Available at: https://euratex.eu/wp-content/uploads/EURATEX-Facts-Key-Figures-2020-LO.pdf.

[371] Eurostat (2020/2021). Tables EISOC_EC_ESELN2, ISOC_CIWEB, ISOC_CISMT, ISOC_EB_IIP, ISOC_CICCE_USE, ISOC_EB_BD, ISOC_EB_P3D, ISOC_EB_IOT, ISOC_EB_AI, NACE sectors C13-15.

'low' or 'very low' digital intensity amounts to 97%, compared to the EU average of 88%.[372] This is likely linked to several factors, including the large proportion of SMEs in the industry, who find the digitalisation journey more challenging than large enterprises. From a structural perspective, the difficulty of automating certain industry processes (for example, sewing), especially on a small scale, also likely contributes to limited uptake.

Several ongoing trends will require rapid digitalisation and implementation of data analytics solutions in the supply chain. However, given the industry's currently low level of digital intensity, this will present significant challenges. These trends include:

- Regulatory requirements that will require extensive supply chain due diligence, which companies will need to respond to through process digitalisation and data analytics, which will present a significant challenge, especially for SMEs.
- Need to respond to environmental concerns as the textile industry is a large contributor to pollution. Industry 4.0 implementation will be critical for reducing waste and increasing efficiency.
- Rapidly changing consumer expectations which will require enterprises to provide customers with opportunities for customisation and digital channels for interaction, as well as to respond to environmental and ethical concerns.
- Commitments made by fashion brands that have publicly stated objectives related to sustainability and ethical production.
- Re-shoring and manufacturing in local or regional clusters will provide opportunities for the Portuguese textile industry but also require it to be able to adapt to international standards and requirements.

However, a shortage of competences required for digital transformation, which is compounded by an ageing workforce and a negative image of industrial jobs, makes it difficult for SMEs to adapt to the new requirements and expectations. A large proportion of SMEs in the industry finds it difficult to devote the time and resources necessary to evaluate and acquire necessary digital solutions. For example, in the context of input price increases, some enterprises have once again halted digitalisation efforts to focus on pressing concerns.[373]

To support SMEs in their digitalisation journey, Portugal has fostered a support ecosystem for textile SMEs that includes technology centres, associations, clusters, and competitiveness agencies, as well as multiple initiatives to boost digitalisation in connection to the RRP, as well as other projects. The EDIH/ DIH network can play a major role in bringing stakeholders together to address issues collectively. This is especially key since most enterprises in the textile ecosystem are part of complex value chains.[374]

[372] Eurostat (2021). Tables isoc_e_dii, NACE sectors C13-15.

[373] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[374] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

3.4. Agrifood in Lithuania

This section presents the results of the gap analysis for the agrifood industry in Lithuania. It first provides an overview of the industry's economic performance before proceeding with the overview of the industry's state of play of digitalisation. The section then presents key factors that impact the Lithuanian agrifood industry's capacity for digitalisation before concluding with an assessment of the industry's strengths and weaknesses.

3.4.1. State of play overview

As a small open economy, Lithuania is vulnerable to the turbulent external environment that is currently characterised by slowing growth in Europe, continued trade tensions, and geopolitical risks. In the domestic context, migration, an ageing population, and a shrinking workforce are the main risks threatening economic stability. Lithuania's economy grew at 5% in 2021, with growth expected to slow down to 1.7% in 2022.[375] The rate of unemployment remains steady and is forecast to increase to 7.2% in 2022, up from 7.1% in 2021. The country has seen relatively larger spikes in inflation in comparison to the other EU Member States, with inflation forecast to hit 12.5% in 2022.[376] This is due to Russia's invasion of Ukraine, which has led to a surge in energy prices and growing concerns about supply shortages, which had driven up food prices.

The agriculture and food sectors play an important role in the Lithuanian economy, creating 7.1% of Lithuania's GDP and employing over 11% of the workforce in 2019.[377] Similarly to the other four industries analysed in this report, 85% of Lithuanian agrifood companies are SMEs, mostly focusing on the key industry segments of cereals, dairy, and meat.[378] According to data from 2019, the Lithuanian agrifood industry was made up of 978 agricultural companies and 957 companies in the food processing industry, employing a total of 64,000 workers and generating a EUR 4.9 billion turnover.[379]

Agriculture is not only an important sector for Lithuania's economy; it also plays an important social role in the country, with 33% of Lithuania's population still living in rural areas in 2020.[380] The sector grew consistently from 2014 to 2019, with its gross value added increasing by 14.5% over the six-year period. In 2019, the gross value added in the agriculture, forestry and fishery sector was EUR 1,431.6 million. Grain production made up the largest share of the agricultural production output, a total of 32.9%. Milk production was second, making up 16.4% of the output, followed by livestock and poultry, which made up 15.4% of agricultural production, as illustrated in the figure below.[381]

[375] European Commission (2022). Spring 2022 Economic Forecast for Lithuania. Available at: https://ec.europa.eu/info/business-economy-euro/economic-performance-and-forecasts/economic-performance-country/lithuania/economic-forecast-lithuania_en.

[376] European Commission (2022). Spring 2022 Economic Forecast for Lithuania. Available at: https://ec.europa.eu/info/business-economy-euro/economic-performance-and-forecasts/economic-performance-country/lithuania/economic-forecast-lithuania_en.

[377] Ministry of Agriculture of the Republic of Lithuania (2020). Lithuanian Agrifood Sector. Available at: https://zum.lrv.lt/uploads/zum/documents/files/LT_versija/Naujiena/Leidiniai/Lithuanian_agrifood_sector_2020.pdf

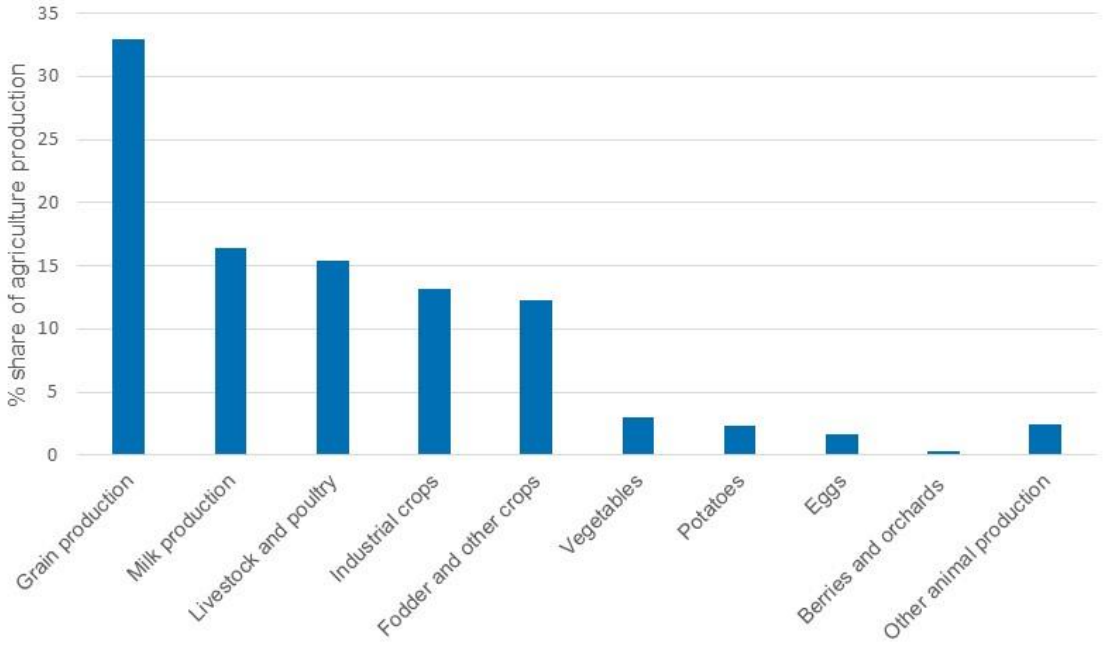
[378] Ministry of Agriculture of the Republic of Lithuania (2020). Lithuanian Agrifood Sector. Available at: https://zum.lrv.lt/uploads/zum/documents/files/LT_versija/Naujiena/Leidiniai/Lithuanian_agrifood_sector_2020.pdf

[379] Ministry of Agriculture of the Republic of Lithuania (2020). Lithuanian Agrifood Sector. Available at: https://zum.lrv.lt/uploads/zum/documents/files/LT_versija/Naujiena/Leidiniai/Lithuanian_agrifood_sector_2020.pdf

[380] More information available at: https://www.kaimotinklas.lt/uploads/documents/files/LKT%20leidinys%20Kartu%20kaita.pdf

[381] LAEI (2022). Lietuvos žemės ir maisto ūkis 2019 (Agriculture and food sector in Lithuania 2019). Available at: https://www.laei.lt/?mt=leidiniai&straipsnis=1817&metai=2020

Figure 36. Agricultural production output in Lithuania, 2019



Source: own elaboration based on data from Lietuvos žemės ir maisto ūkis 2019 (Agriculture and food sector in Lithuania 2019), available at: https://www.laei.lt/?mt=leidiniai&straipsnis=1817&metai=2020.

However, despite investments and consolidation, Lithuanian agriculture is still considered less efficient than that in other EU countries, with the average output per hectare of utilised agricultural land (across Lithuanian farms from 2012-2017) reaching only around 37% of the EU average, and land productivity indicators across Lithuanian farms of all sizes standing at a lower level than farms of equivalent sizes in the EU.[382]

Lithuania is a net exporter of agricultural products. In 2018, the export of agricultural and food products totalled EUR 4.9 billion, while imports amounted to EUR 3.9 billion.[383] In 2019, the exports of agriculture and food products contributed to 18.4% of total national exports.[384] Lithuania has the highest export intensity in the Central and Eastern Europe (CEE) region, with 51% of the final output of the crop and animal production sector as well as 47% of the food and beverages sector sent to export. In the fish and aquaculture sector, the export-to-output ratio is 0.27, which is close to the CEE average.[385]

Looking at imports in the agrifood industry, low reliance on imports of intermediate inputs is observed. In Lithuania, this indication falls below the CEE average in the fishing and aquaculture sector and a few percentage points above the average in the food and beverages manufacturing sector. The total dependence on intermediate inputs in the crop

[382] EIT Food (2020). Food Foresight on the impact of COVID-19. Available at: https://www.eitfood.eu/projects/food-foresight.

[383] Ministry of Agriculture of the Republic of Lithuania (2020). Lithuanian Agrifood Sector. Available at: https://zum.lrv.lt/uploads/zum/documents/files/LT_versija/Naujiena/Leidiniai/Lithuanian_agrifood_sector_2020.pdf.

[384] EIT Food (2022). Food Foresight: the Impact of COVID-19 in the Agrifood Sector in Central and Eastern Europe. Available at: https://www.eitfood.eu/reports/food-foresight-cee.

[385] EIT Food (2022). Food Foresight: the Impact of COVID-19 in the Agrifood Sector in Central and Eastern Europe. Available at: https://www.eitfood.eu/reports/food-foresight-cee.

and animal production sector is the second highest in the region, but it does not exceed 0.35 in total.[386]

Just like elsewhere in Europe, COVID-19 has had a significant effect on the agrifood industry. Initial responses to the public health threat led to some restrictions on in-person operations, especially in factories, although most companies were able to continue production. A total of 107 companies in the food, agriculture and fisheries sectors applied for a subsidy to mitigate the impact of COVID-19-related quarantine.[387] The pandemic also had a negative impact on the supply chains in the agrifood industry, resulting in increased commodity prices due to their limited availability and delays. Due to its proximity to Russia, Lithuania has also felt the impact of the Russian attack on Ukraine, with the European Spring Economic Forecast ranking the country fourth in its vulnerability matrix.[388] Lithuania imports 28% of its fertilisers, 48% of fossil fuels and 18% of metals and minerals from the Russian Federation.[389] As a result, prices of commodities have increased further.[390]

The COVID-19 pandemic caused mobility issues within the retail and recreational sectors due to initial lockdown restrictions. This was expected to have an indirect impact on the agrifood sector. However, although consumption levels slowed down during the pandemic, this was mainly due to the deteriorating labour market conditions. Overall, the sale of food and beverages remained relatively resilient.[391] Lithuania's agrifood industry showed resilience during the COVID-19 pandemic by successfully shortening its industrial value chain.[392] In Lithuania, all the categories of manufacturing goods besides durable goods seem largely unaffected by the pandemic. In 2020 the consumption of non-durable consumer goods as well as food products did not see a fall larger than 5% compared to last year.[393]

3.4.2. Digitalisation in the industry

Despite the undeniable importance and relevance of the agrifood sector for the Lithuanian economy, the uptake of digital technologies in this sector is still relatively low. Digital technologies have the potential to bring many benefits to the agrifood sector. They can contribute to extending shelf life, monitoring freshness, providing data on food quality, improving safety and convenience, among other things.[394] The main problem facing the industry today is the inefficient food value chain.[395] Digital technologies are not being fully

[386] EIT Food (2022). Food Foresight: the Impact of COVID-19 in the Agrifood Sector in Central and Eastern Europe. Available at: https://www.eitfood.eu/reports/food-foresight-cee.

[387] Data taken from: https://ls-osp-sdg.maps.arcgis.com/apps/dashboards/9e3c2468417b422ca13cafb76794c5d7.

[388] European Spring Economic Forecast (2022). European Economic Forecast. Available at: https://ec.europa.eu/info/system/files/economy-finance/ip173_en.pdf. A country vulnerability matrix to the Russian invasion of Ukraine available on page 35.

[389] Resource Trade Earth (2020). Information on trade flows of different commodities between countries. Available at: https://resourcetrade.earth/.

[390] IMF (2022). Commodity Price Statistics. Available at: https://data.imf.org/?sk=471DDDF8-D8A7-499A-81BA-5B332C01F8B9.

[391] EIT (2020). Food Foresight Lithuania. Available at: https://www.eitfood.eu/projects/food-foresight.

[392] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[393] EIT (2020). Food Foresight Lithuania. Available at: https://www.eitfood.eu/projects/food-foresight.

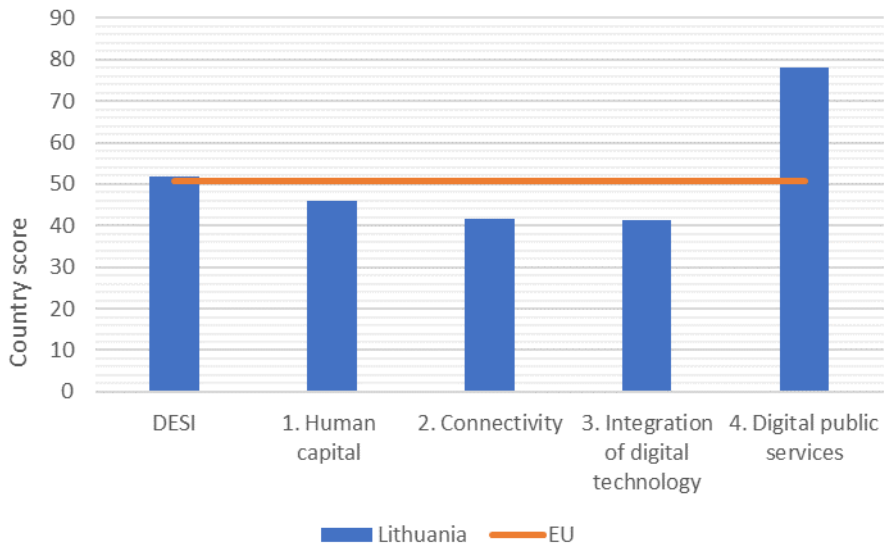
[394] Bičkauskė, Daiva, et al. (2020). Challenges of Digital Transformation in the Agri-Food Sector. Sociálno-Ekonomická RevuE.

[395] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

harnessed due to a lack of knowledge and skills, risk aversion, and lack of cost-effectiveness.

Lithuania ranks 14th in the EU according to DESI 2021. It scores above the EU average in the dimension of 'digital public services', ranking 12th in the EU. Lithuania scores 96 in the 'digital services for businesses' indicator, which is well above the EU average of 84. Among the four DESI dimensions, Lithuania scores the lowest in 'connectivity', ranking 25th in the EU. This is due to the country's low readiness for the implementation of 5G (5%) and 5G coverage (0%).

Figure 37. DESI relative performance by dimension, Lithuania, 2021



Source: own elaboration based on European Commission (2021). DESI 2021: Lithuania.

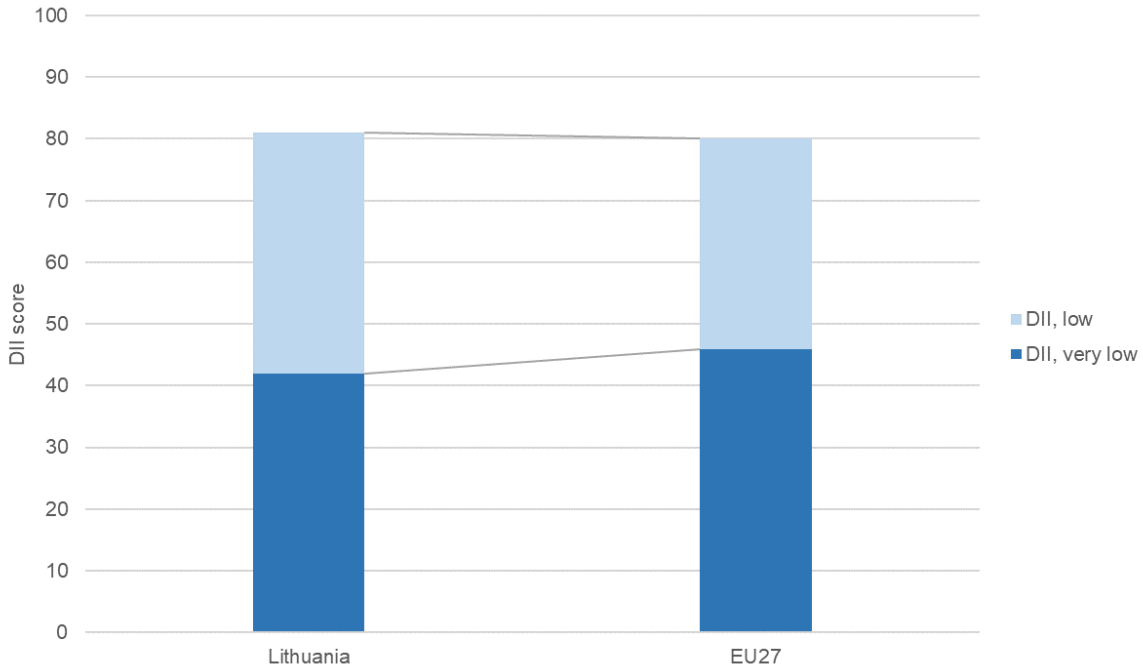
Looking at the 'integration of digital technology' dimension, Lithuanian ranks 12th and has demonstrated a steady improvement in this category over time. A total of 54% of SMEs have at least a basic level of digital intensity, 28% of SMEs sell their goods and services online, and 15% of their turnover is generated through e-commerce.[396] An analysis by Śledziewska et al.[397] suggests that Lithuanian SMEs are among the leaders of digital transformation in the EU. They operate in a supportive digital environment, benefiting from the developed digital infrastructure. Most of them make full use of various digital technologies such as websites, social media, management, and e-commerce tools.

According to the Digital Intensity Index, in Lithuania, 42% of enterprises in the accommodation, food and beverage services sector have a 'very low level' of digital intensity, which is just below the EU average of 46%. Meanwhile, 39% of Lithuanian enterprises have a 'low' level of digital intensity which is marginally higher than the EU average of 34%.

[396] DESI (2021). Country Report Lithuania. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance.

[397] Śledziewska, K.R.W. (2016). Digital Transformation of Small and Medium Enterprises in Lithuania. Available at: http://www.delab.uw.edu.pl/wp-content/uploads/2016/06/DELAB-raportLITHUANIA.pdf.

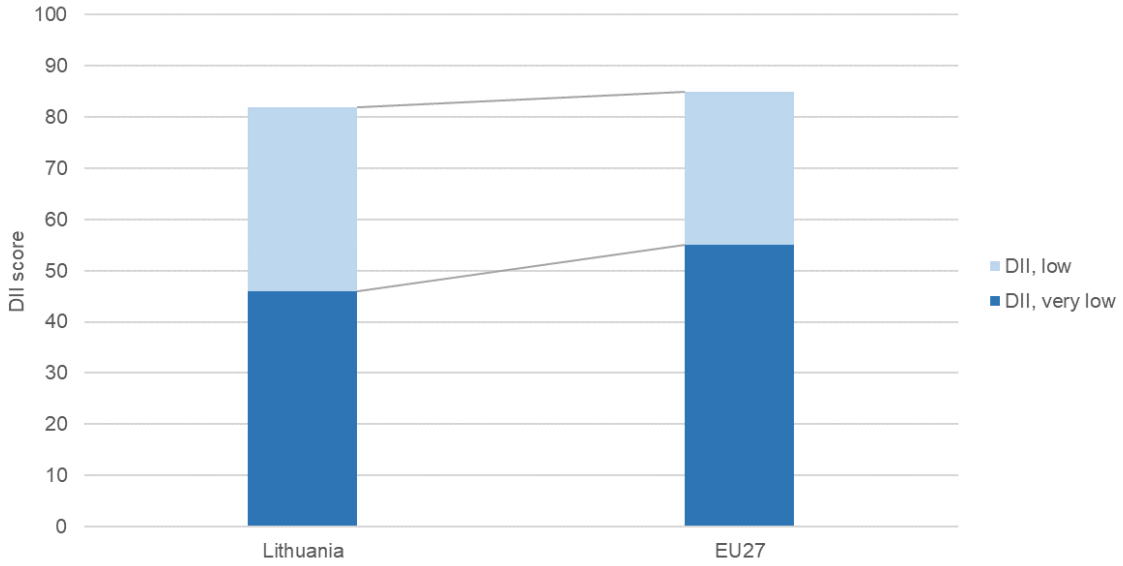
Figure 38. Very low and low DII score comparison, Lithuania and EU27, 2021 (Accommodation, food, and beverage services)



Source: own elaboration based on data from Eurostat tables isoc_e_dii, NACE sectors C155-56.

Similarly, Lithuania has a lower proportion of companies with a 'very low' digital intensity score in the manufacturing of food, beverages, and tobacco sector (46%) than the EU average (55%). In addition, 36% of Lithuanian enterprises have a 'low' DII score, which is slightly higher than the EU average of 30%, as illustrated in Figure 39 below.

Figure 39. Very low and low DII score comparison, Lithuania and EU27, 2021 (Manufacturing of food, beverages, tobacco)

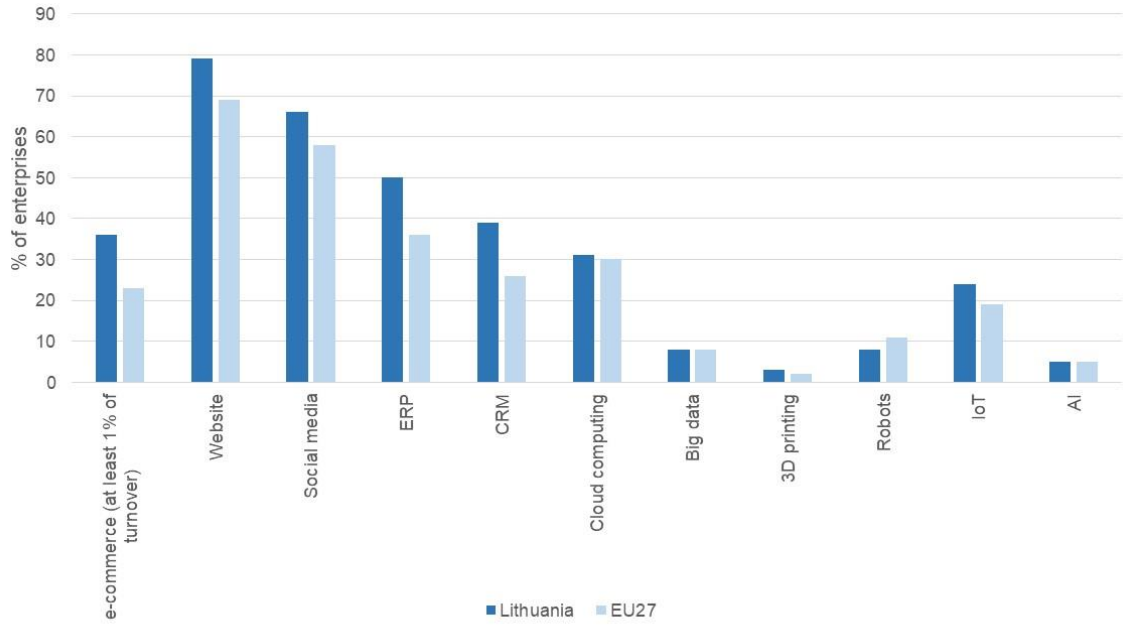


Source: own elaboration based on data from Eurostat tables isoc_e_dii, NACE sectors C10-12.

In this sector, Lithuanian enterprises outperform the EU average in the uptake of many digital technologies, with the most used being websites and social media. According to the

latest data from Eurostat, 79% of Lithuanian companies in this sector have created a website, and 66% have a social media account. These figures exceed the EU average of 69% and 58%, respectively. The technologies that are least frequently adopted by Lithuanian companies operating in the manufacturing of food, beverages, and tobacco sector are 3D printing (used by 3% of companies) and AI (5%). On average, 2% of European enterprises in this sector use 3D printing and 5% use AI.

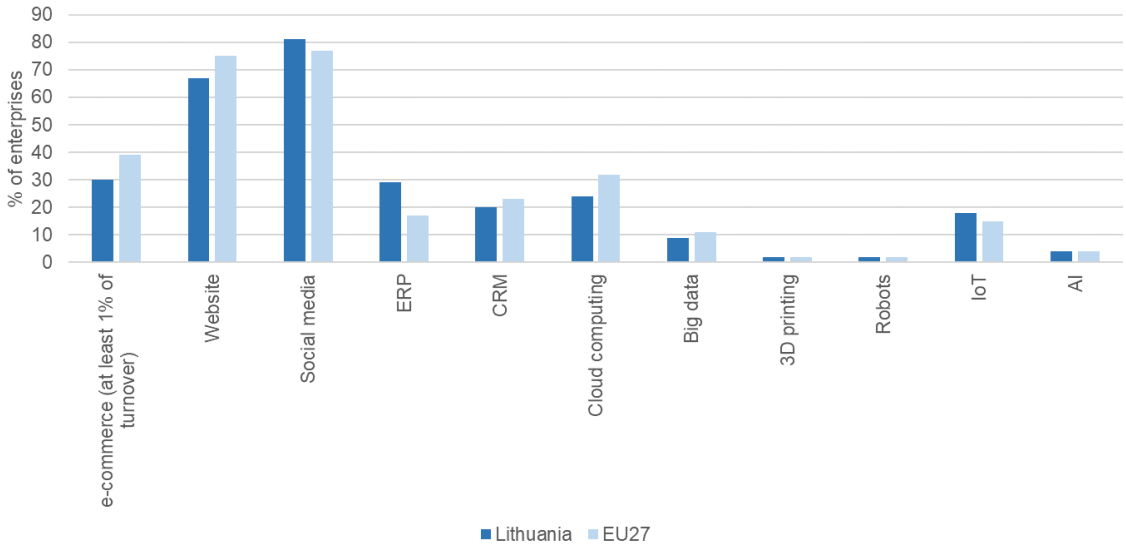
Figure 40. Uptake of digital technologies, Lithuania and EU27 (Manufacturing of food, beverages, tobacco)



Source: own elaboration based on Eurostat: EISOC_EC_ESELN2, ISOC_CIWEB, ISOC_CISMT, ISOC_EB_IIP, ISOC_CICCE_USE, ISOC_EB_BD, ISOC_EB_P3D, ISOC_EB_IOT, ISOC_EB_AI, NACE sectors C10-12.

By contrast, the accommodation, food, and beverage services sector lags behind the EU average in the uptake of some digital technologies. For example, 75% of European companies in this sector have a website as opposed to 67% of Lithuanian companies. However, Lithuanian companies still exceed the EU average in the use of social media, with 81% having an account on social media. This is slightly above the EU average of 77%. 3D printing is still among the least commonly used technologies, both in Lithuania and the EU (used by 2% of companies). Robotics also falls into the category of the least commonly used digital technologies in this sector, as it is only used by 2% of Lithuanian companies, in line with the EU average.

Figure 41. Uptake of digital technologies, Lithuania and EU27 (Accommodation, food and beverage services)



Source: own elaboration based on Eurostat: EISOC_EC_ESELN2, ISOC_CIWEB, ISOC_CISMT, ISOC_EB_IIP, ISOC_CICCE_USE, ISOC_EB_BD, ISOC_EB_P3D, ISOC_EB_IOT, ISOC_EB_AI, NACE sectors C155-56.

Despite the relatively high uptake of basic digital technologies, the Lithuanian agrifood sector is negatively impacted by fragmented value chains. Efficient agricultural management is still needed to increase the value added along the supply chain. Digital technologies are being used for this purpose, but the potential for further integration remains.[398] The use of digital technologies is common for the control and monitoring of soil and weather conditions and the prevention of various weeds, pests, and diseases. At the same time, small farmers lack resources to invest in digital technologies.[399] The next step in the integration of agricultural value chains is the introduction of AI-based management and forecasting for food production. Building collective knowledge across the agrifood value chain is key in facilitating the adoption of digital technologies by rural farmers, manufacturing, and logistic companies alike.[400]

Overall, the agrifood sector in Lithuania has strong potential for digitalisation, with companies operating in the sector adopting basic digital technologies and software. However, data suggest that limited connectivity and lack of digital skills might act as barriers to the industry's digital transformation. Small farmers are the least digitalised players in the sector. Nevertheless, the industry has a strong potential to digitalise if it takes a holistic approach to agriculture and works collaboratively to spread digitalisation along the entire value chain.

[398] Findings from an interview with a Lithuanian academic specialising in agrifood.

[399] Findings from an interview with a Lithuanian academic specialising in agrifood.

[400] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

3.4.3. Key factors influencing digitalisation in the industry

3.4.3.1. Policy factors

In the 2021 Digital Intelligence Index[401] 'state of institutions' dimension, Lithuania ranks 26th out of 90 economies analysed and is slowly advancing. Lithuania ranks particularly high in the ICT Regulatory Environment (ranking 6th), the legal environment for business (16th) and effectiveness of institutions (26th) clusters. Lithuania ranks the lowest in government facilitation of ICT (43rd) and bureaucracy (50th).[402] Meanwhile, in the OECD DSTRI,[403] Lithuania scores below the EEA average, indicating a favourable regulatory environment for digital trade (see Annex 5).[404]

Agriculture and food production (processing) have often been treated as separate sectors in Lithuania, with development initiatives and funding instruments tailored individually to each. For example, in 2019, the Lithuanian Ministry of Agriculture published a White Paper on Lithuania's rural and agricultural development, detailing key challenges, objectives, and actions to be achieved by 2030.[405] Even though the white paper talks extensively about the need for the adoption of digital technologies, it only focuses on Lithuania's agricultural sector. In addition, the Lithuanian Industry Digitisation Roadmap 2020-2030 does not include agrifood or even manufacturing of food products among the discussed industries.[406]

Nevertheless, agriculture and food production are integral elements of the agrifood supply chain. To generate high added value, it is necessary to look at these sectors holistically through the lens of an integrated value chain.[407] In addition, changing levels of productivity, regional disparities, and climate change will all transform the agrifood industry in the coming years. In turn, the traditional approach and support measures adopted by the Lithuanian government for the agrifood sectors are not sufficient.

Considering the above and recognising the issues facing the agrifood industry, stakeholders in the Lithuanian food value chain, together with academia, are increasingly collaborating with the public sector stakeholders. Currently, they are working together with the Ministry of Agriculture of the Republic of Lithuania and the Ministry of Economy and Innovation to adopt the Roadmap for the AgriFoodTech in Lithuania.[408] The roadmap is

[401] The Digital Intelligence index is composed of two scoreboards: the digital evolution scoreboard compares the digital maturity and historical growth trajectory of countries, the digital trust scoreboard, which measures the trustworthiness of the digital ecosystem, the level and types of friction in digital experiences, the depth of engagement among Internet users, and the level of trust expressed by citizens.

[402] Tufts University (2021). Digital Intelligence Dashboard: Lithuania. Available at: https://sites.tufts.edu/digitalplanet/files/2021/countrydashboards/Digital_Intelligence_Dashboard_LT.pdf.

[403] The DSTRI is a composite indicator that takes a value between '0' and '1'. It measures how open the regulatory environment is for digital trade. '0' indicates an open regulatory environment for digitally enabled trade, '0' indicates a completely closed regime.

[404] OECD (2021). Digital Services Trade Restrictiveness Index Simulator. Available at: https://sim.oecd.org/Default.ashx?lang=En&ds=DGSTRI&d1c=eu&cs=eu.

[405] Lietuvos Respublikos žemės ūkio ministerija (2019). BALTOJI KNYGA. Available at: https://zum.lrv.lt/uploads/zum/documents/files/LT_versija/Veiklos_sritys/Bendroji_zemes_ukio_politika/Baltoji_knyga_2019.pdf

[406] Lithuanian Innovation centre (2020). Lithuanian Industry Digitisation Roadmap 2020-2030. Available at: https://eimin.lrv.lt/uploads/eimin/documents/files/Lithuanian%20Industry%20Digitisation%20Roadmap%202020-2030%20UPDATED%20EN%20(1).pdf.

[407] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[408] Further information at: https://cvpp.eviesiejipirkimai.lt/Notice/Details/2022-608422.

expected to be approved by the end of 2022. More information about the roadmap is available in the box below.

Box 3. AgriFoodTech roadmap in Lithuania

Draft AgriFoodTech roadmap in Lithuania

The AgriFoodTech Roadmap is a long-term development strategy for the agrifood sector, with the strategic objective of increasing the added value and global competitiveness of Lithuania's agrifood sector through the application of climate-friendly practices and new digital technologies. It is based on the principle of mutual public-private commitments and sets the ambitious goal of improving Lithuania's EU ranking in the value added by the agriculture, food, and fisheries sectors to 11th place. The target is for Lithuania to export 60% of its agricultural production by 2030.[409]

Some of the initiatives foreseen under the roadmap include:

- Creation of a sustainable and resilient food value chain in Lithuania through the use of digital technologies to ensure traceability and quality at all stages of production, processing, and distribution.
- Strengthening inter-institutional cooperation, clustering, and involvement of research institutions to test and deploy new technologies.
- Given the importance of data exchange and capacity building in the sector, the draft roadmap foresees the development of an AgriFood tech platform, which would encourage experimentation and testing of digital technology applications.

In addition, Lithuania's government adopted several other initiatives that indirectly foster the digitalisation of the agrifood sector. For example, the Ministry of Transport and Communications launched a 5G Sandbox project in 2022.[410] The goal of the initiative is to promote innovation and the application of 5G technologies in various sectors, including agriculture, seaports, railways, and smart cities, among others.

Lithuania is currently in the process of revising its Smart Specialisation Strategy (S3).[411] The draft strategy foresees the development of health technologies and biotechnology, including safe food and sustainable resources; development of new production processes, materials, and technologies; and strengthening the application of information and communication technologies, such as AI, big and distributed data, IoT, and cyber security, among others. Similarly to the 2014-2020 financing period, the strengthening of agricultural innovations and food technologies remains a strategic priority.[412]

At the same time, some of Lithuania's main policy initiatives omit the agrifood industry or do not focus on its digitalisation. For example, the 2021-2030 National Progress

[409] Further information at: https://cvpp.eviesiejipirkimai.lt/Notice/Details/2022-608422.

[410] Lietuvos Respublikos susisiekimo ministerija (2022). Lietuvos revoliucinės 5G ekosistemos startuoliams – 24,5 mln. eurų parama, bendradarbiauti siūlosi JK verslininkai ir mokslo bendruomenė. Available at: https://sumin.lrv.lt/lt/naujienos/lietuvos-revoliucines-5g-ekosistemos-startuoliams-24-5-mln-euru-parama-bendradarbiauti-siulosi-jk-verslininkai-ir-mokslo-bendruomene

[411] Mano vyriausybė (2022). MTI taryba pritarė sumaniosios specializacijos prioritetams ir misijų temoms – žingsniui link efektyvesnio verslo ir mokslo bendradarbiavimo sprendžiant visuomenės iššūkius. Available at: https://lrv.lt/lt/naujienos/mti-taryba-pritare-sumaniosios-specializacijos-prioritetams-ir-misiju-temoms-zingsniui-link-efektyvesnio-verslo-ir-mokslo-bendradarbiavimo-sprendziant-visuomenes-issukius

[412] Smart Specialisation Platform (n.d.) Lithuania. Available at: https://s3platform.jrc.ec.europa.eu/region-page-test/-/regions/LT.

Programme[413] does not mention the agrifood industry. Similarly, Lithuania's Agriculture and Rural Development 2023-2027 strategic plan,[414] which is still pending approval by the Commission, does not have a special programme for digitalisation. Digitalisation is only mentioned as an additional enabler for value-added products.

Stakeholders also point to missing support schemes for smaller farmers and agrifood cooperatives.[415] Agrifood cooperatives are important ecosystem participants as they provide support to small farmers in the form of digital services. This allows even the smallest of farms to benefit from digitalisation. Instead of needing to invest in digital technologies, they can rent them from a cooperative. Evidence points to Lithuanian agrifood cooperatives being among the least digitalised in the EU.[416]

The Lithuanian Industry Digitisation Roadmap 2020-2030 lays down ambitious goals and an action plan for industry digitalisation, including becoming an industry leader for digitalisation in the CEE region. The roadmap identifies the most pertinent technologies for the Lithuanian industry and outlines the vision for industry digitisation by 2030. Whilst the plan does not explicitly mention agrifood or even manufacturing of food products, it is an important strategic document that signals a political commitment to industry digitalisation.[417]

Looking at Lithuania's participation in EU-level programmes, the country is committed to accelerating the pace of digitalisation in its Recovery and Resilience Plan (RRP LT).[418] A total of EUR 700.6 million (31.5% of the total funding available under the RRP LT) is allocated to measures supporting the digital transition. Over half of these funds are dedicated to digital public services and infrastructure. However, the target digitalisation measures to do not foresee digitalisation of the agrifood sector.[419] Despite several discussions and proposals from companies in the industry, the agrifood industry was omitted from RRP LT.[420] The plan recognises the importance of the digitalisation of Lithuanian farms to meet the green transition targets but only envisions specific measures for the cleaning up and restoration of Lithuania's wetlands.[421]

Lithuania is also strengthening the capacity of the agrifood industry in the adoption of digital technologies through Digital Innovation Hubs. The AgriFood Lithuania DIH was established with the goal of becoming the leading non-governmental facilitator of the Lithuanian agrifood innovation ecosystem.[422] AgriFood Lithuania is coordinating national

[413] Lietuvos Slaugos Specialistų Organizacij (2021). 2021-2030 m. nacionalinis pažangos planas. Available at: https://www.lsso.lt/post/2021-2030-m-nacionalinis-pa%C5%BEangos-planas.

[414] Lietuvos Respublikos žemės ūkio ministerija (n.d.). Lietuvos žemės ūkio ir kaimo plėtros 2023-2027 m. strateginis planas. Available at: https://zum.lrv.lt/lt/lietuvos-zemes-ukio-ir-kaimo-pletros-2023-2027-m-strateginis-planas-1.

[415] Findings from an interview with a Lithuanian academic specialising in agrifood.

[416] Jorge-Vázquez, Javier & Chivite Cebolla, Mª Peana & Salinas-Ramos, Francisco. (2021). The Digitalization of the European Agri-Food Cooperative Sector. Determining Factors to Embrace Information and Communication Technologies. Agriculture. 11. 514. 10.3390/agriculture11060514.

[417] Lithuanian Innovation centre (2020). Lithuanian Industry Digitisation Roadmap 2020-2030. Available at: https://eimin.lrv.lt/uploads/eimin/documents/files/Lithuanian%20Industry%20Digitisation%20Roadmap%202020-2030%20UPDATED%20EN%20(1).pdf.

[418] European Commission (n.d.) Lithuania's recovery and resilience plan. Available at: https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility/lithuanias-recovery-and-resilience-plan_en.

[419] DESI (2021). Country Report Lithuania. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance.

[420] AgriFood Lithuania's own research.

[421] FinMin (n.d.). Ekonomikos Gaivinimo Ir Atsparumo Didinimo Planas „Naujos Kartos Lietuva". Available at: https://finmin.lrv.lt/uploads/finmin/documents/files/Naujos%20kartos%20Lietuva%20planas.pdf.

[422] AgriFood Lithuania (n.d.). Mes esame „AgriFood Lithuania DIH"! Available at: https://www.agrifood.lt/apie-mus/.

research activities collaborating with business and public stakeholders, as well as enabling cross-border cooperation. The hub is a participant in various EU-funded programmes, including EIT Food, ECCP, SmartAgriHubs, SS4AF networks and EC-funded cross-broader projects.[423] The hub is also part of the consortium, which was approved as one of the three EDIHs in Lithuania.[424]

Nevertheless, the Lithuanian agrifood industry could perform better in absorbing EU funds. The implementation of the Agricultural European Innovation Partnerships (EIP-AGRI) still lags behind.[425] In 2014-2019, there were only five EIP-AGRI (Operational Groups) projects implemented in Lithuania (out of 25 expected). The implemented projects include soil management (2), dairy production and farming techniques (2) and one project aimed at setting up an Innovation Support Service.[426]

3.4.3.2. Social factors

Two main social factors affect the agrifood industry's digitalisation in Lithuania – human capital and changing consumer behaviour. As mentioned above, Lithuania ranks 17th in the 'human capital' dimension of DESI 2021. A total of 56% of the population has at least basic digital skills, and 58% have at least basic software skills, with both values matching the EU average. However, Lithuania falls below the EU average in the availability of ICT specialists, which constitute only 3.3% of employed individuals aged 15-74. In addition, a significant gap between the uptake of digital skills in urban and rural areas exists, which in 2019 stood at 20%, making it one of the highest in the EU.[427] Despite government initiatives to advance digitalisation in the country, relatively few companies (only 14%) provide ICT training.[428]

Taking a sector-specific look at the proportion of workers with specialist ICT skills, 16% of Lithuanian enterprises in the manufacturing of food, beverages and tobacco sector employ ICT personnel. This suggests that the sector is failing to attract employees with specialist knowledge of digital technologies. This problem is further exacerbated by a lack of training in ICT, with only 16% of Lithuanian enterprises offering such opportunities to their staff.

[423] More information at: https://www.agrifood.lt/projektai/.

[424] DG CNECT A4 - Digital Transformation of Industrial Ecosystems (2022). Presentation 'Digitalisation of Businesses and the network of European Digital Innovation Hubs (EDIH)' during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

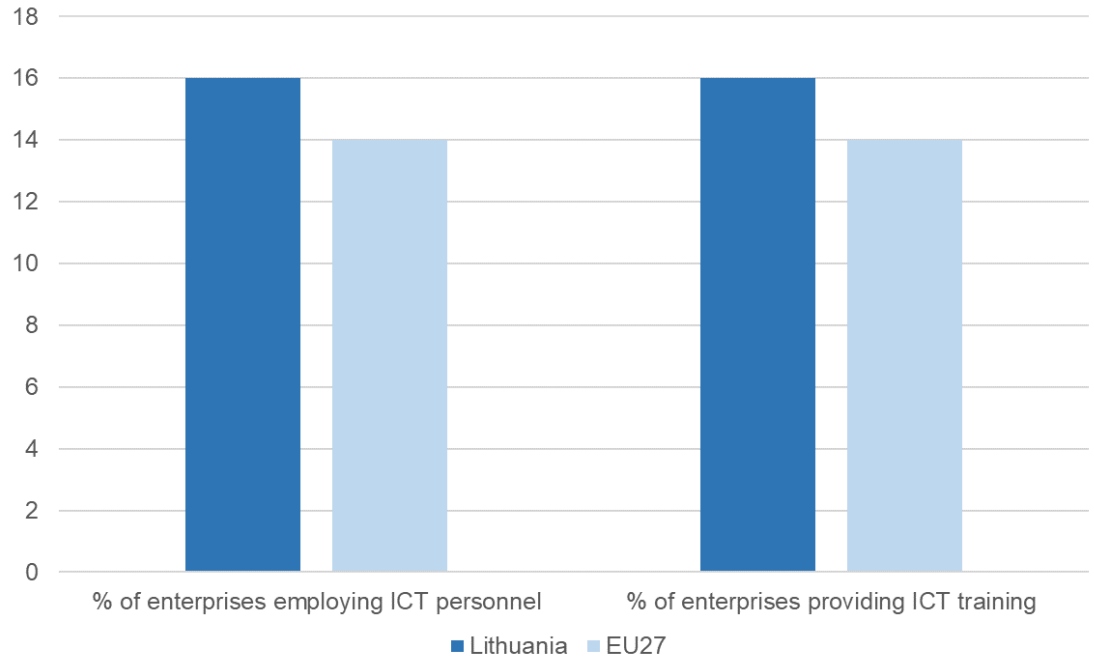
[425] EIP-AGRI. (n.d.) Lithuania. Available at https://ec.europa.eu/eip/agriculture/en/geographical-area/lithuania.

[426] SWD (2020). 395 final, Commission recommendations for Lithuania's CAP strategic plan, Brussels, 18.12.2020. Available at: https://zur.lt/wp-content/uploads/2021/01/29_EN_LT_document_travail_service_part1_v3-1.pdf.

[427] Eurostat (2019). Tables [isoc_sk_dskl_i]. Available at: https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do.

[428] DESI (2021). Country Report Lithuania. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance.

Figure 42. Employment of ICT personnel and ICT training, Lithuania and EU27, 2020 (Manufacturing of food, beverages, tobacco)



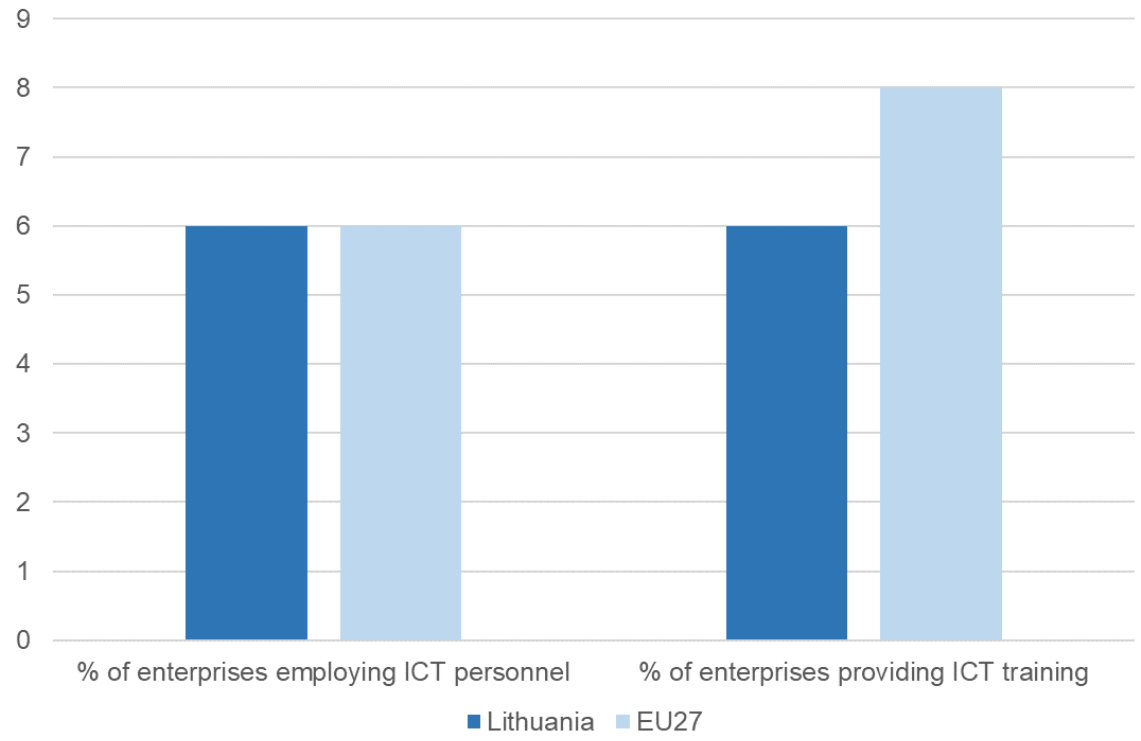
Source: own elaboration based on data from Eurostat: Tables ISOC_SKE_ITSPEN2 and ISOC_SKE_ITTN2, NACE sectors C10-12.

When considering the accommodation, food and beverage services sector, the situation regarding ICT personnel is worse, as illustrated in Figure 43 below. Only 6% of Lithuanian enterprises employ ICT personnel, which is equivalent to the EU average. Meanwhile, 6% of enterprises in the country provide ICT training, which falls slightly below the EU average of 8%. This issue is further reflected by the fact that in the period 2014-2019, the total number of people participating in trainings funded under the Rural Development Programme (RDP) 2014-2020 stood at 14,300 (7% of the total farming population).[429] This adds to the reported shortage of skills in rural areas, especially in digital and financial literacy.[430]

[429] European Commission. Recommendation for a Council recommendation on the 2019 National Reform Programme of Lithuania and delivering a Council opinion on the 2019 Stability Programme of Lithuania. COM/2019/515 final. CSR 2

[430] SWD (2020). 395 final, Commission recommendations for Lithuania's CAP strategic plan, Brussels, 18.12.2020. Available at: https://zur.lt/wp-content/uploads/2021/01/29_EN_LT_document_travail_service_part1_v3-1.pdf.

Figure 43. Employment of ICT personnel and ICT training, Lithuania and EU27, 2020 (Accommodation, food, and beverage services)



Source: own elaboration based on data from Eurostat: Tables ISOC_SKE_ITSPEN2 and ISOC_SKE_ITTN2, NACE sectors C155-56.

Lithuania is seeing a gradual decrease in the number of graduates in the agrifood industry, pointing to the fact that the sector is not seen as a desirable career option. In 2020, out of 31,800 students in higher education, only 410 were pursuing a degree in Agricultural Science. The number has decreased by 504 students since 2018.[431]

The ageing workforce is another social challenge for the agrifood industry. According to 2018 statistics, 47% of Lithuanian farmers were older than 40 years old. Despite the Ministry of Agriculture of the Republic of Lithuania's strategies and support mechanisms for young farmers,[432] as of 1 January 2020, only 17,201 of registered farmers in Lithuania were under the age of 40, a decrease compared to 2010. Nevertheless, in 2020 there was an increase in the amount of land cultivated by young farmers, and the economic size of their farms increased by 47.5%.[433] The evidence thus points to the fact that young people are developing a more sophisticated way of farming and are making better use of the resources they have.[434]

Changing consumer behaviour, especially after the COVID-19 pandemic, is driving more consumers to look for agricultural products online. According to DESI 2021, 65% of all

[431] Lietuvos oficialiosios statistikos rengėjai (2021). Lietuvos švietimas, kultūra ir sportas. Available at: https://osp.stat.gov.lt/lietuvos-svietimas-kultura-ir-sportas-2021/aukstasis-mokslas.

[432] Lietuvos Respublikos žemės ūkio ministerija (n.d.). Lietuvos kaimo plėtros 2014–2020 m. programa. Available at: https://zum.lrv.lt/lt/veiklos-sritys/lietuvos-kaimo-pletros-2014-2020-m-programa.

[433] Data taken from: https://www.kaimotinklas.lt/uploads/documents/files/LKT%20leidinys%20Kartu%20kaita.pdf.

[434] Lietuvos kaimo tinklas (2020). Kartų kaita Lietuvos kaime. Available at: https://www.kaimotinklas.lt/uploads/documents/files/LKT%20leidinys%20Kartu%20kaita.pdf.

Lithuanian households subscribe to fixed internet access.[435] This acted as an incentive for some farmers were encouraged to open online shops and change their marketing approach to working with the consumer directly due to the COVID-19 pandemic.[436]

3.4.3.3. Economic factors

Lithuania ranks 25th among EU countries in the 'connectivity' dimension of DESI 2021, with an overall score of 41.7.[437] The majority (71%) of Lithuanian households are covered by fast broadband (NGA). However, a digital divide in the country exists, as only 29.6% of households in rural areas have fast broadband (NGA) access. Take-up of at least 100 mbps fixed broadband stands at 31% of households, which is below the EU average of 34%. Similarly, in its recommendations for Lithuania's CAP strategic plan, the European Commission highlighted contributing to the EU Green Deal target on broadband and addressing rural/urban gaps in broadband coverage as priority areas for Lithuania's agricultural development.[438]

Lithuania is among the EU countries without any 5G mobile broadband coverage but with 100% coverage of 4G. Lithuania is planning to address the lack of 5G coverage and limited broadband uptake as part of achieving EU 2025 targets through implementing the RAIN3 project.[439] This project foresees building approximately 30 communication towers, laying down 1,210 km of fibre-optic cables, and the development of a passive optical network (PON) infrastructure in areas where the market cannot provide this infrastructure.[440] In addition, as mentioned in Section 3.4.3.1, Lithuania has adopted several policy initiatives aimed at implementing 5G.

The Lithuanian agrifood industry is adversely affected by its fragmented approach to innovation. The agricultural knowledge and innovation system (AKIS)[441] experiences a lack of coordination between actors and insufficient focus on farmers' needs. According to the EIT country profile for Lithuania, the country has yet to harness the potential of clusters operating in this sector.[442] Similarly, the Interreg Europe's Action Plan for Lithuania identifies the need for stronger cooperation between businesses, social partners, and the government as one of the weaknesses of the sector.[443]

In addition, Lithuania allocated only 2.3% of CAP funds in the programming period 2014-2020 to measures linked to information, knowledge, and innovation, which was below the

[435] DESI (2021). Country Report Lithuania. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance.

[436] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[437] DESI (2021). Country Report Lithuania. Available at: https://digital-strategy.ec.europa.eu/en/policies/countries-digitisation-performance.

[438] SWD (2020). 395 final, Commission recommendations for Lithuania's CAP strategic plan, Brussels, 18.12.2020. Available at: https://zur.lt/wp-content/uploads/2021/01/29_EN_LT_document_travail_service_part1_v3-1.pdf.

[439] Plačiajuostis internetas (2022). PROJEKTAI. Available at: https://www.placiajuostis.lt/lt/projektai.

[440] Plačiajuostis internetas (2022). Plačiajuosčio ryšio infrastruktūros plėtra kaimo vietovėse. Available at: https://www.placiajuostis.lt/lt/placiajuoscio-rysio-infrastrukturos-pletra-kaimo-vietovese.

[441] EIP-AGRI (n.d.). Prospects for Farmers' Support: Advisory Services in European AKIS. Available at: https://ec.europa.eu/eip/agriculture/en/content/prospects-farmers-support-advisory-services-european-akis.

[442] EIT-Food (n.d.). Lithuania. Available at: https://www.eitfood.eu/in-your-area/lithuania.

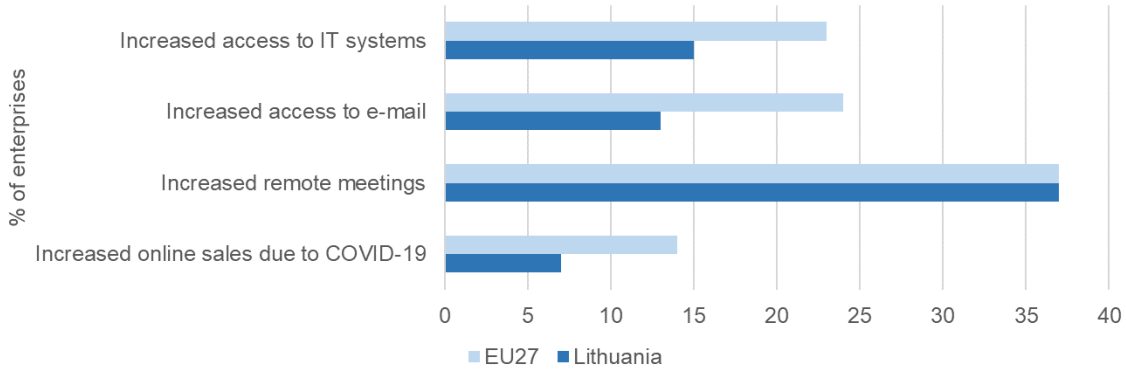
[443] Interreg Europe (2020). Agrirenaissance Interreg Europe R&I resources and capacities of the agri-food sector Action Plan for Lithuania. Available at: https://projects2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1593676646.pdf.

EU average of 3.6%.[444] According to Lithuania's Industry Digitisation Roadmap 2020-2030, one of the main challenges of advancing industry digitisation is the sustainable scaling up of successful initiatives. In particular, public R&D investments need to be transformed into commercial products, which are installed and tested in Lithuanian industry companies and later scaled up worldwide.[445]

3.4.3.4. External shocks

The impact of the COVID-19 pandemic on digitalisation in the agrifood industry is ambiguous. Looking at direct effects, 37% of Lithuanian companies in the manufacturing of food, beverages and tobacco sector increased the number of meetings conducted remotely, in line with the EU average. They also increased remote access to IT systems (15%) and e-mail (13%). However, these figures fall below the EU average of 23% and 24% of companies, respectively. Similarly, only 7% of Lithuanian enterprises increased their online sales due to COVID-19, falling short of the EU average of 14%.

Figure 44. COVID-19 impact on ICT usage (selected indicators), Lithuania and EU27, 2021 (Manufacturing of food, beverages, tobacco)



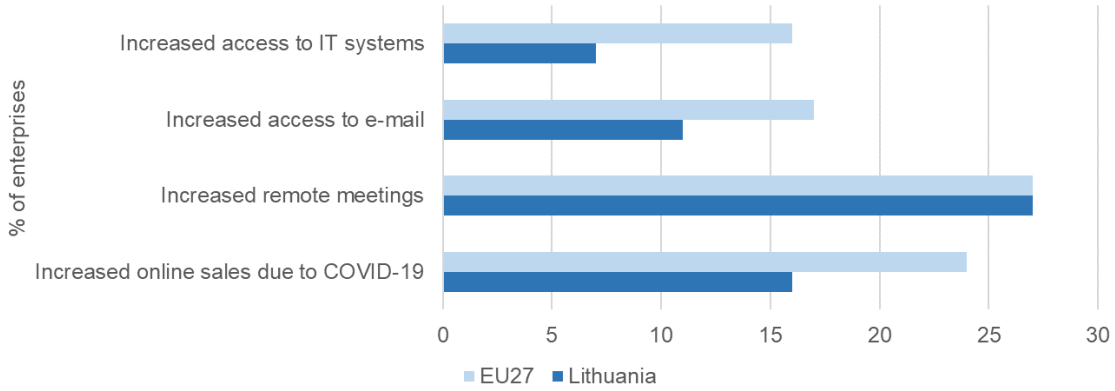
Source: own elaboration based on Eurostat: Tables ISOC_E_CVD, NACE sectors C10-12.

A similar trend is observed in the accommodation, food, and beverage services sector, where Lithuanian enterprises matched the proportion of EU companies that increased remote meetings in response to COVID-19 (27%). Only 7% of Lithuanian companies increased access to IT systems, and 11% granted remote access to email. These figures fall short of the EU average of 16% and 17%, respectively. Meanwhile, 16% of enterprises in the country increased their online sales, which is less than the EU average of 24%.

[444] SWD (2020). 395 final, Commission recommendations for Lithuania's CAP strategic plan, Brussels, 18.12.2020. Available at: https://zur.lt/wp-content/uploads/2021/01/29_EN_LT_document_travail_service_part1_v3-1.pdf.

[445] Lietuvos kaimo tinklas (2020). Kartų kaita Lietuvos kaime. Available at: https://www.kaimotinklas.lt/uploads/documents/files/LKT%20leidinys%20Kartu%20kaita.pdf.

Figure 45. COVID-19 impact on ICT usage (selected indicators), Lithuania and EU27, 2021 (Accommodation, food, and beverage services)



Source: own elaboration based on Eurostat: Tables ISOC_E_CVD, NACE sectors C155-56.

COVID-19 facilitated the implementation of remote work arrangements, with a larger proportion of employees working remotely and led to a shift in employee expectations regarding their working arrangements.[446] COVID-19 has also had a positive impact on farmers' attitudes toward digital technologies. The cautious attitudes held by some farmers toward digitalisation have changed significantly during the COVID-19 pandemic.[447] As outlined in Section 3.4.3.2, Lithuanian farmers adopted e-commerce and switched to interacting directly with their consumers. Precision farming was also among the digital technologies adopted by Lithuanian farmers in the wake of COVID-19.[448]

At the same time, COVID-19 led to some restrictions on in-person operations, especially in factories. However, most companies were able to maintain their production levels. As already mentioned in Section 3.4.1, COVID-19 also had an adverse effect on companies' liquidity, with 107 companies in the food, agriculture and fisheries sectors applying for a subsidy for the impact of COVID-19 associated lockdowns.[449]

3.4.4. Main digitalisation strengths and challenges

The Lithuanian agrifood industry is an important industry for country's economy. The industry benefits from participation in numerous European initiatives supporting its digitalisation. In addition, there is an increased strategic focus on the industry at the policy level. In recent years, a common understanding of the importance of digitalisation along the agrifood value chain among key stakeholders and policymakers has emerged. The adoption of the AgriFoodTech roadmap has the potential to greatly accelerate digitalisation in this industry.

Similarly, Lithuania is home to the Agrifood Lithuania DIH, which is part of a consortium that was recently approved as an EDIH with a priority focus on the agrifood sector. This will further support the building of a joint ecosystem and diffusion of knowledge among all players in the value chain. Considering this, agrifood sector in Lithuania has the potential to become a test bed for agrifood tech in the near future.

[446] Findings from an interview with a Lithuanian agri-food company.

[447] Findings from an interview with a Lithuanian academic specialising in agrifood.

[448] Findings from an interview with a Lithuanian academic specialising in agrifood.

[449] Data available at: https://ls-osp-sdg.maps.arcgis.com/apps/dashboards/9e3c2468417b422ca13cafb76794c5d7.

Nevertheless, the industry faces several challenges going forward. Despite numerous policy initiatives focusing on industry digitalisation in Lithuania, few funding programmes are available for agrifood sector digitalisation specifically. For example, Lithuania's Recovery and Resilience Plan does not include measures for the industry's digitalisation. Currently, support exists for investments in digital technologies, which are relevant for large-scale farming. More support is needed for small farmers, which are more likely to use digital services than to invest directly in digital technologies. The industry also faces the challenge of fragmentation, with a need for better structuring of knowledge exchange processes and sharing of research and innovation data. Gathered data suggests the need for more government support for building and strengthening agrifood cooperatives. This will allow for the diffusion of knowledge and sharing of innovation.

Similarly to the textile industry in Portugal, Lithuania's agrifood industry faces a shortage of digital skills. This issue is exacerbated by the low availability of trainings focusing on digital transformation and a changing demographic makeup of the industry. Fewer graduates choose a career in the agrifood industry, making re-skilling in this industry a challenge.

3.5. Construction in Romania

The section presents the results of the gap analysis for the construction industry in Romania. It first provides an overview of the industry's economic performance before proceeding with the overview of the state of play of the digitalisation of Romania's construction industry. The section then presents key factors that impact the construction industry's capacity for digitalisation before concluding with an overview of the industry's strengths and weaknesses.

3.5.1. State of play overview

During the 2010-2020 period, Romania's economy grew rapidly, with its GDP increasing by 35.3% and reaching RON 836.7 billion (EUR 167.3 billion) in 2020.[450] Romania's economy performed strongly in 2021, with a GDP growth of 5.9%. However, the economy is forecast to slow down to 2.6% in 2022 due to high inflation and Russia's war on Ukraine which further disturbs supply chains.[451] A similar trend has also been observed in the Romanian construction industry. According to data from the National Institute of Statistics in Romania, in 2020, the construction sector represented the third largest sector in the Romanian economy by the number of companies. The sector constitutes 11.1% of companies operating in Romania, as illustrated in Figure 46 below.[452] SMEs make up 99.9% of the construction industry in Romania.[453] The sector represented 6.3% of Romania's GDP in 2020 and ranked 4th among Romania's industries in terms of turnover, gross investments, gross added value, and profit. [454]

[450] European Construction Sector Observatory (2022). Country profile: Romania. Available at: https://ec.europa.eu/growth/sectors/construction/observatory/country-fact-sheets/romania_en.

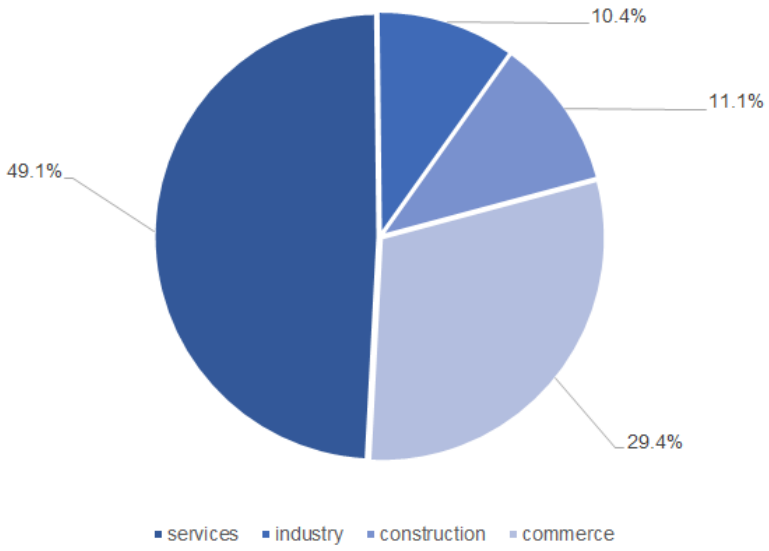
[451] European Commission (2022). Spring 2022 Economic Forecast: Romania. Available at: https://ec.europa.eu/info/business-economy-euro/economic-performance-and-forecasts/economic-forecasts/spring-2022-economic-forecast_en#forecast-by-country.

[452] Romanian Construction Industry Federation (2020). Romania's country report. Available at: https://fiec-statistical-report.eu/2021/romania#:~:text=In%202020%2C%20construction%20represented%206.3,%2C%20an%20increase%20of%2010.3%25.

[453] Ibid.

[454] National Statistical Institute of Romania (n.d.). Efectivul salariatilor la sfarsitul lunii pe activitati (sectiuni si diviziuni) ale economiei nationale CAEN Rev.2. Available at: http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table.

Figure 46. Distribution of companies in sectors of the Romanian economy, based on data from the National Institute of Statistics in Romania (2020)



Source: own elaboration based on Banilor L. (2021). ACTIVITATEA ECONOMICA IN ROMANIA – 49,1% din numarul total de intreprinderi active au avut activitate principala Servicii de piata. Available at: https://luba.ro/activitatea-economica-in-romania-491-din-numarul-total-de-intreprinderi-active-au-avut-activitate-principala-servicii-de-piata-document/.

Construction was also one of the fastest-growing sectors in Romania prior to the pandemic. The number of enterprises in the broader construction sector in the country grew by 28% between 2010 and 2020. According to the National Institute for Statistics in Romania, the last three pre-pandemic years marked a steady and rapid increase in most key performance indicators of the industry, including turnover (34%), production (35%), and gross result for the year (57%).[455] Data for the key performance indicators for the period 2017-2019 is included as part of Annex 4.

The total turnover of the broad construction sector amounted to EUR 37.6 billion in 2020, corresponding to a 47% increase compared to figures from 2010 (EUR 25.5 billion). The growth of the broad construction sector between 2010-2020 was driven by the rapid development of its key segments: real estate activities (growth of 92.6%), architectural and engineering activities (+83%), narrow construction (+42%), and manufacturing (+32%).

The Romanian construction sector employs a significant proportion of the country's workforce. In 2020, the number of employees in this sector reached almost 9% of the total workforce.[456] However, the sector faces significant challenges in terms of labour shortages. According to industry estimates, in 2021, an additional 350,000 workers are needed to implement the already announced construction projects.[457] Low wages,

[455] National Institute of Statistics (2021). Small and medium enterprises in the Romanian economy, year 2019. p.92. Available at: https://insse.ro/cms/ro/content/%C3%AEntreprinderi-mici-%C5%9Fi-mijlocii-%C3%AEn-economia-rom%C3%A2neasc%C4%83.

[456] Ziarul Financiar (2021). Industria de construcţii a ajuns la 416.000 de angajaţi în 2020, cel mai ridicat nivel din ultimul deceniu. Available at: https://www.zf.ro/companii/industria-de-constructii-a-ajuns-la-416-000-de-angajati-in-2020-cel-20243856.

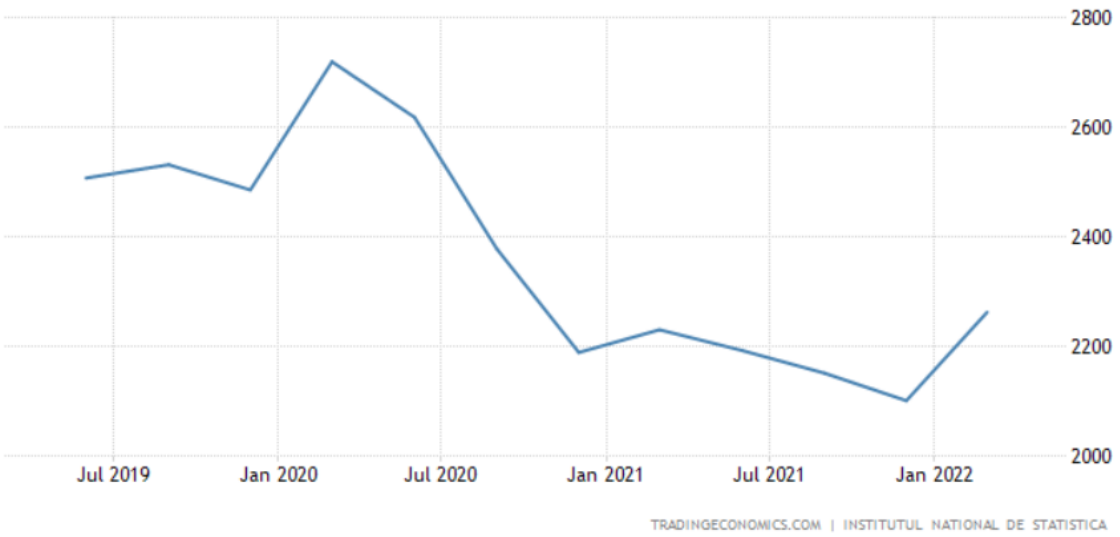
[457] Shortage of construction workers in Romania (2021). Available at: https://transylvanianow.com/lots-of-construction-projects-but-not-enoughworkers/.

migration to western European countries and the absence of vocational schools are the main drivers behind the labour shortage.[458]

Recognising the significant labour shortage in the construction industry, the Romanian government adopted ordinance OUG 114/2018[459] to stop the massive departures of construction employees abroad. The document establishes an exemption from employer social security contributions for the period 1 January 2019 - 31 December 2028, a 3.75% reduction in employee social security contributions and a minimum gross wage of RON 3,000 for construction employees.

The COVID-19 pandemic has had a dampening effect on the growth of the construction industry. During the pandemic year 2020, construction represented 6.3% of GDP, marking, on average, only a small decrease from 2019 levels (6.4%). Nevertheless, more granular quarterly GDP reports of the sector from the National Institute of Statistics reveal a sharp 23% decrease of the GDP from the construction sector between March 2020 and January 2022 levels.[460]

Figure 47. GDP in the construction sector for the last three years



Source: Trading Economics (2022). Romania GDP From Construction. Available at: https://tradingeconomics.com/romania/gdp-from-construction.

In 2021, Romania's economic activity recovered from the losses of the COVID-19 crisis. Real GDP grew at 5.9% due to strong private consumption and investment.[461] The construction sector, however, is still in the recovery phase from the consequences of COVID-19, even though it is experiencing continued growth. Romania's GDP from construction is projected to trend around RON 2,250 million (EUR 455.28 million) in 2023

[458] European Construction Sector Observatory (2022). Country profile: Romania. Available at: https://ec.europa.eu/growth/sectors/construction/observatory/country-fact-sheets/romania_en.

[459] Government of Romania (2018). Emergency Ordinance No. 114/2018 of 28 December 2018 on the introduction of certain measures in the field of public investment and fiscal-budgetary measures, amending and supplementing certain regulatory acts and extending certain deadlines. Published in: Official Monitor no. 1116 of 29 December 2018. Available at: https://static.anaf.ro/static/10/Anaf/legislatie/OUG_114_2018.pdf.

[460] Table available at: https://tradingeconomics.com/romania/gdp-from-construction.

[461] SWD (2022). 624 final, COMMISSION STAFF WORKING DOCUMENT 2022 Country Report – Romania, Brussels, 23.5.2022. Available at: https://ec.europa.eu/info/system/files/2022-european-semester-country-report-romania_en.pdf.

and RON 2,317 million (EUR 468.8 million) in 2024. Despite these positive perspectives, these predictions are well below pre-pandemic levels.

In Romania, COVID-19 affected segments of the construction industry differently. Building material distribution companies were the most affected at the outset of the pandemic, with construction managers reporting supply chain problems as they faced issues with the delivery of imported materials.[462] Design firms managed to continue operations by switching to telework, albeit at lower productivity levels.[463] Lockdowns have negatively affected the transportation of building materials, resulting in increased costs. More specifically, COVID-19 restrictions have resulted in an increase in the total construction cost index by around 18%, of which 60% was generated by the increase in the cost of building materials and 40% by the increase in labour costs.[464] Prices of raw materials needed in the manufacturing of building materials continue to rise, with Romanian manufacturers stating that they are gradually passing these costs on to final selling costs.[465]

COVID-19 has had a mild impact on construction production levels. According to the Production in Construction (PIC) index, production increased from 111.6 to 129.5 in 2020 and fell to 128.2 in 2021, a 1% decrease.[466] The increase in the PIC index for construction in the COVID-19 pandemic years can be partially explained through the measures taken by the Romanian government. In 2018, the Government of Romania and the Employers' Federations of Construction Companies signed an agreement for sustainable economic growth of the construction sector. Romania's construction industry was declared a priority sector of national importance for the Romanian economy for the next ten years, starting on 1 January 2019. Some of the measures set out in the agreement include raising the minimum wage for the employees; zero (social) taxes on the work for the employer; the obligation to advance 30% from projects' value at the start of the construction work; and establishment of a Guarantee Fund for construction.[467]

Although there was an increase in the volume of activity, the total average number of employees in construction registered a decrease of 1% in 2020. Some 50,000 jobs were lost in 2020.[468] At the same time, during the first 11 months in 2020, the volume of work increased by 18.8 % compared to a similar period in 2019. Despite the job losses,

[462] ARENA Constructiilor (2020). COVID-19 in sectorul constructiilor. Available at: https://arenaconstruct.ro/covid-19-in-sectorul-constructiilor/?cn-reloaded=1.

[463] ARENA Constructiilor (2020). COVID-19 in sectorul constructiilor. Available at: https://arenaconstruct.ro/covid-19-in-sectorul-constructiilor/?cn-reloaded=1.

[464] The construction cost index (CCI) is a European Union (EU) business cycle indicator showing the trend in the cost for new residential buildings. Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Construction_producer_price_and_construction_cost_indices_overview.

[465] Zialur Financiar (2022). ANALIZĂ ZF. Materialele de construcţii se pregătesc pentru noi runde de scumpiri: „Cherestea, oţel, ciment, beton, pavele, materiale pentru pereţii din gips-carton, fier şi aluminiu – preţul tuturor a fost în creştere în 2021 şi aşteptăm un 2022 asemănător" Available at: https://www.zf.ro/companii/analiza-zf-materialele-constructii-pregatesc-runde-scumpiri-20507378.

[466] Eurostat (2021), [sts_copr_a] tables, NACE sectors F41-43. PIC set at 100 in 2015.

[467] Romania. Government of Romania (2018) Emergency Ordinance No. 114/2018 of 28 December 2018 on the introduction of certain measures in the field of public investment and fiscal-budgetary measures, amending and supplementing certain regulatory acts and extending certain deadlines. Published in: Official Monitor no. 1116 of 29 December 2018. Available at: https://static.anaf.ro/static/10/Anaf/legislatie/OUG_114_2018.pdf; Agreement between the Government of Romania and the Employers' Federation of Construction Companies (2018). Available at: https://federatiaconstructorilor.ro/files/docs/AcordConstructiiFPSC-GuvernulRomaniei.pdf.

[468] Average number of employees in selected economic sub-sectors according to tender classification, selected timeframe for 2019-2021 period, own calculations based on data from the National Statistical Institute. National Statistical Institute (n.d.). Efectivul salariatilor la sfarsitul lunii pe activitati (sectiuni si diviziuni) ale economiei nationale CAEN Rev.2. Available at: http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table.

construction companies made most of the new hires between May 2019 and May 2021 compared to other industries in Romania, totalling 35,000 new hires.[469]

The construction industry in Romania has also seen a steady rise in investment in the last five years. According to the latest available data, the total net investment in 2020 amounted to EUR 21.9 billion.[470] Investment in construction is also seeing further growth in 2022. As a part of its EUR 29.2 billion Recovery and Resilience Plan, the Romanian government has allocated EUR 2.6 billion for building infrastructures such as the construction of new social housing and retirement homes, hospitals and health care facilities, and preschool programmes.[471]

Similarly to other European countries, Romania has seen spikes in inflation. The above-described impact of COVID-19, coupled with the Russian invasion of Ukraine, has resulted in an annual inflation rate of 13.76% in April 2022, up from 10.15% in March 2022.[472] The Russian attack on Ukraine has brought further perturbations to the European construction market, as Ukraine is the main supplier and producer of steel and raw materials for the market. The immediate consequence has been a significant increase in material prices, causing increases of over 40% for some materials used in infrastructure projects, such as asphalt mixes, bitumen, steel, or iron-concrete. The price increases of the main building materials between March 2021 to March 2022 vary between 15% and 121%. The biggest increases are observed for building materials such as OSB (up to 103% from March 2021 to March 2022), rectangular tubing (up to 118%) and sandwich panels (up to 121%).[473]

The local construction industry is expecting further steel price hikes amid the war in Ukraine, as it is among the main suppliers for Romanian firms. As a potential mitigating measure, companies plan to rely on alternatives that are available in countries such as Turkey, Greece, Bulgaria and Moldova.[474] Nevertheless, the consequences of COVID-19 and the war in Ukraine have led to a significant increase in the prices of equipment, machinery and stand-alone facilities delivered under the projects financed by non-reimbursable external funds, especially projects based on contracts on equipment, machinery or similar.[475] Additional upward pressure also came from the rising cost of both services (7.1% vs 6.5%), and non-food products (16% vs 10.9%).[476] Looking at construction industry specifically, the construction cost index increased by 19% in

[469] Zialur Financiar (2021). Industria de construcţii a ajuns la 416.000 de angajaţi în 2020, cel mai ridicat nivel din ultimul deceniu. Available at: https://www.zf.ro/companii/industria-de-constructii-a-ajuns-la-416-000-de-angajati-in-2020-cel-20243856.

[470] European Construction Industry Federation (2021). Statistical Report Romania: Available at: https://fiec-statistical-report.eu/2021/romania.

[471] European Construction Industry Federation (2021). Statistical Report Romania: Available at: https://fiec-statistical-report.eu/2021/romania.

[472] Figure available at: https://tradingeconomics.com/romania/inflation-cpi#:~:text=Romania%20Inflation%20Rate%20Rises%20to%2017%2D1%2F2%2DYear%20High&text=In%202021%2C%20the%20inflation%20rate,8.8%20percent%20rise%20in%20February.

[473] Alba24.tv (2022). Materialele de construcţii s-au scumpit de la 15% până la peste 100% în ultimul an. Când ar putea scădea prețul locuințelor. Available at: https://alba24.ro/materialele-de-constructii-s-au-scumpit-de-la-15-pana-la-peste-100-in-ultimul-an-cand-ar-putea-scadea-pretul-locuintelor-909414.html.

[474] Alba24.tv (2022). Materialele de construcţii s-au scumpit de la 15% până la peste 100% în ultimul an. Când ar putea scădea prețul locuințelor. Available at: https://alba24.ro/materialele-de-constructii-s-au-scumpit-de-la-15-pana-la-peste-100-in-ultimul-an-cand-ar-putea-scadea-pretul-locuintelor-909414.html.

[475] Romanian Government (2022). Emergency Ordinance No 64 of 9 May 2022 on the adjustment of prices and the value of general estimates in projects financed by non-reimbursable external funds. Published in the Official Monitor No 472 of 11 May 2022. Available at: https://legislatie.just.ro/Public/DetaliiDocument/255065.

[476] Figure available at: https://tradingeconomics.com/romania/inflation-cpi#:~:text=Romania%20Inflation%20Rate%20Rises%20to%2017%2D1%2F2%2DYear%20High&text=In%202021%2C%20the%20inflation%20rate,8.8%20percent%20rise%20in%20February.

Romania when comparing Q4 of 2020 and 2021.[477] Furthermore, construction companies participating in operational programmes or public construction projects could not predict price increases at the time of submitting their project proposals. This disparity in planned and real prices affects the success rate of projects financed through European funds.[478]

In response to the rapid inflation and increased construction price index, the Romanian Government issued an emergency ordinance OUG 64/2022 on adjustment of prices and the value of general estimates in projects financed through operational programmes.[479] The ordinance takes the following steps: regulates measures for the adjustment of prices necessary for the updating of investment costs in public procurement contracts, regulates the methodology for price adjustment with a view to restoring contractual equilibrium in public procurement, and states that for public infrastructure projects for which the tendering procedure has not started yet, investment cost estimates may be updated with total construction cost indices using 2022 as the reference year.

On 14 March 2022, Romanian builders sounded the alarm about the potential collapse of the construction sector caused by rising prices of construction materials and raw materials and the above-mentioned labour shortages. The heads of construction companies warned that hundreds of projects risk remaining unfinished.[480] According to the Trade Registry data, almost 700 construction companies in Romania entered insolvency or bankruptcy in 2021.[481]

3.5.2. Digitalisation in the industry

Romania lags behind the EU in terms of digital technology adoption in the country. It ranked last in the EU in DESI 2021, scoring well below the EU average in the four key dimensions. Romania is strongest in 'connectivity', where it ranks 10th in the EU and has shown steady improvement over time. It does perform poorer than most other EU countries in the 'human capital' dimension (ranking 26th). Even though the country ranks high concerning the number of ICT graduates (4th), as will be described below, the country has a significant shortage of ICT specialists. Romania also ranks last in the EU regarding the update of digital public services, constituting a barrier for businesses when it comes to using e-invoices, obtaining permits and information quickly.

[477] Eurostat (n.d.). Construction cost index – in national currency. Available at: https://ec.europa.eu/eurostat/databrowser/view/sts_copi_q/default/table?lang=en.

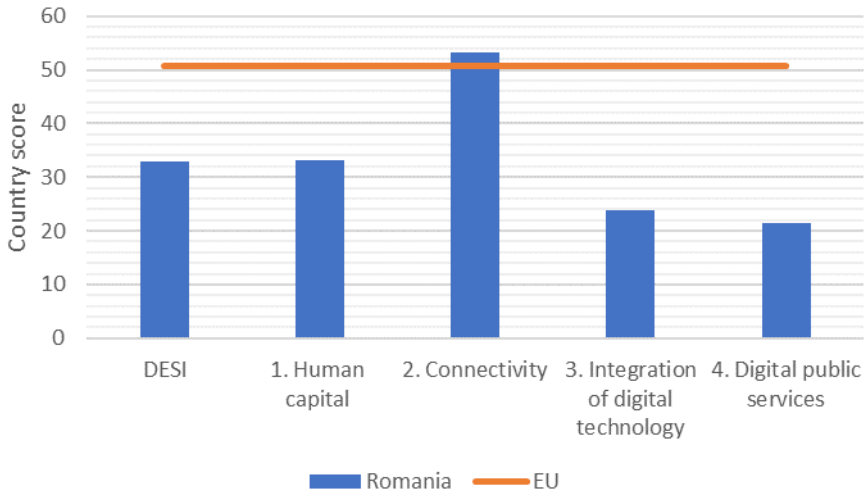
[478] Romanian Government (2022). Emergency Ordinance No 64 of 9 May 2022 on the adjustment of prices and the value of general estimates in projects financed by non-reimbursable external funds. Published in the Official Monitor No 472 of 11 May 2022. Available at: https://legislatie.just.ro/Public/DetaliiDocument/255065.

[479] Romanian Government (2022). Emergency Ordinance No 64 of 9 May 2022 on the adjustment of prices and the value of general estimates in projects financed by non-reimbursable external funds. Published in the Official Monitor No 472 of 11 May 2022. Available at: https://legislatie.just.ro/Public/DetaliiDocument/255065.

[480] Plan in Romanian available at: https://gov.ro/ro/stiri/unda-verde-de-la-comisia-europeana-pentru-pnrr&page=1.

[481] ZF English (2022). Almost 700 Builders In Romania Fell Into Insolvency or Went Bankrupt in 2021. Available at: http://www.zfenglish.com/analysis/almost-700-builders-in-romania-fell-into-insolvency-or-went-bankrupt-20539121.

Figure 48. DESI relative performance by dimension, Romania, 2021

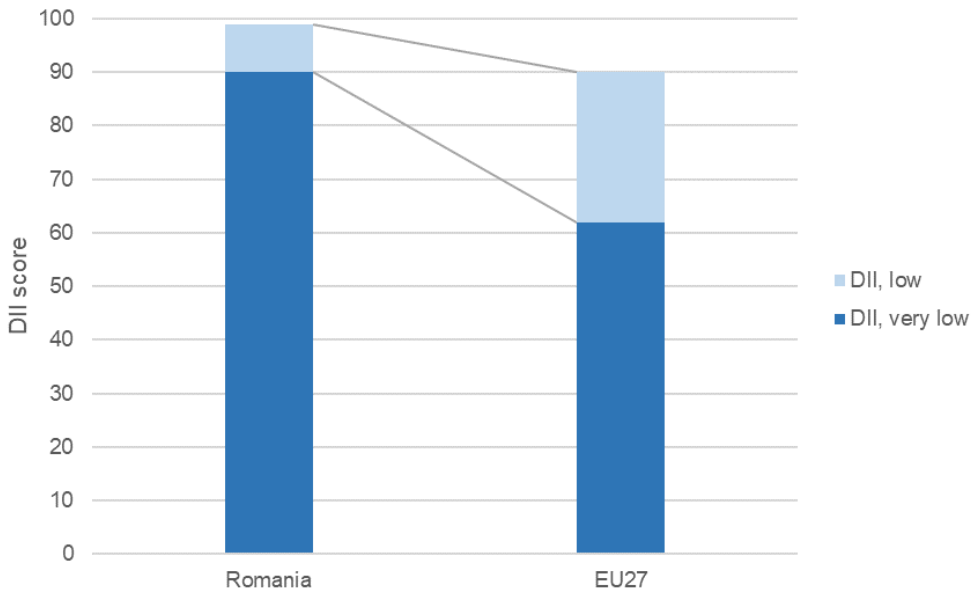


Source: own elaboration based on European Commission (2021). DESI 2021: Romania.

Looking at the 'integration of digital technology' dimension, it is evident that Romanian enterprises do not take full advantage of digital technologies, except for AI (31% of companies use it). Only 33% of Romanian SMEs have at least a basic level of digital intensity. Only 17% of SMEs sell online, and only 8% of companies make use of social media. Looking at the uptake of advanced technologies, the figures are even lower, with 5% of companies using big data for their business and 13% using cloud services.

Looking at the construction industry in Romania specifically, this sector appears to be among the least digitalised in the EU. According to the latest data provided by the Digital Intensity Index, the Romanian industry has a much larger proportion of companies with a 'very low' and 'low' level of digital intensity score compared to the EU average. A total of 90% of companies in Romania have a 'very low' DII, against the EU average of 62%. In addition, 9% of companies have a low DII.

Figure 49. Very low and low DII score comparison of construction industry, Romania and EU27, 2021



Source: own elaboration based on data from Eurostat: Tables isoc_e_dii, NACE sectors F41-43.

When it comes to the use of digital technologies in the construction industry, there are evident gaps between the uptake in Romania and the EU average. Data from the EIB Investor Survey 2021 shows that only a quarter of construction firms (26%) have implemented one or multiple advanced digital technologies, well below the EU average of 42%. Looking at the national context, Romanian SMEs also trail behind large companies in adopting digital technologies, as illustrated in Table 3 below.

A national survey conducted by the National Council of SMEs indicates that the main types of software used by the construction industry are the software tools for business management (41%) followed by the use of electronic signatures (34,5%), cybersecurity software (21%) and communication software (17%). Construction companies also stand out due to the fact that they use an electronic signature to a lesser extent than the service sector (34% compared to 58%).[482] The survey results are illustrated in more detail below.

Table 3. Main types of software used by SMEs across Romanian industry, 2021

MAIN TYPES OF SOFTWARE	Overall industry	Construction	Sales	Transport	Tourism	Services
Software for business operations	56%	41%	64%	65%	70%	72%
Electronic signature	50%	34%	49%	40%	70%	58%
Security software	17%	21%	16%	20%	30%	21%
ERO	9%	7%	16%	5%	25%	11%
CRM	10%	3%	10%	10%	15%	8%
Communication Software	13%	17%	18%	25%	25%	22%
Sales software	11%	10%	28%	20%	35%	22%

Source: own elaboration based on National Council of SMEs (2021), White Book of SMEs 2021 edition, available in print.

Looking at the construction sector specifically, several digital technologies contribute to facilitating smart industrial remoting measures, including:

- VR/AR – can be used for customer relations, simulated environments, and digitally constructed virtual models;
- Sensors & IoT devices for remote monitoring – can be used for building and infrastructure monitoring (based on IoT and AI), predictive maintenance, improved security, and structural monitoring for leaner facility management, for monitoring heating, ventilation, and air conditioning (HVAC), regulating environmental factors in buildings;
- Drones & sensors – used for supervision, scanning large industrial sites and infrastructures;

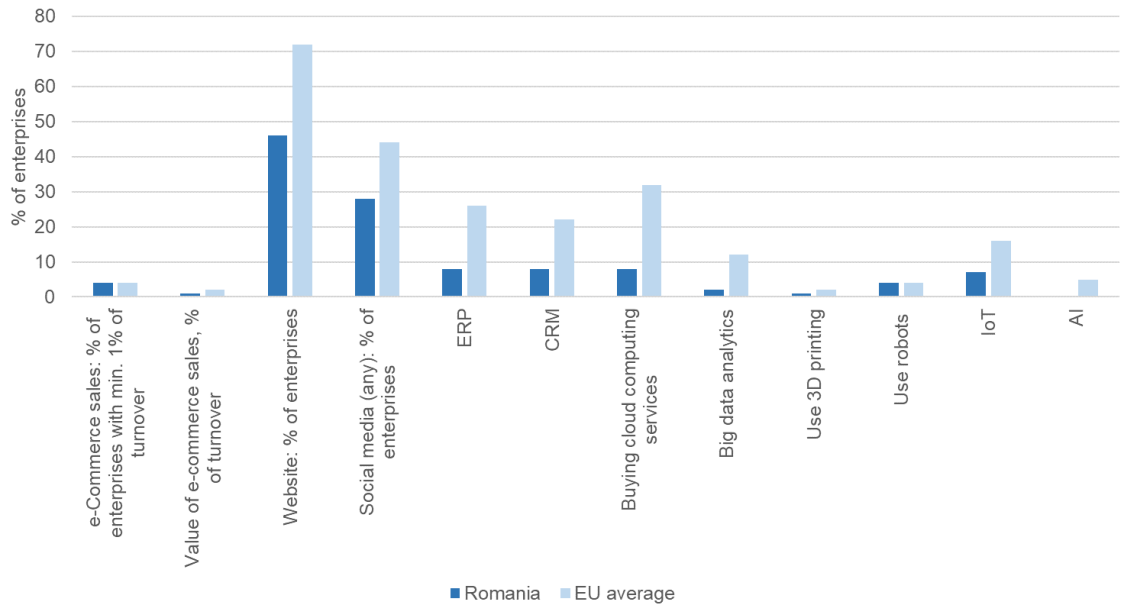
[482] National Council of SMEs (2021), White Book of SMEs 2021 edition, available in print.

- Building Information Management (BIM) systems – can be used to design and plan construction more effectively, digital twins, design buildings in virtual, and improve precision & productivity.

Despite the potential use cases of digital technologies in the construction sector, evidence shows that construction companies in Romania are hesitant to adopt them. The Romanian construction industry is lagging in the adoption of digital technologies associated with industry 4.0 and 'could be described as operating at the stage of industry 3.5 at the moment'.[483] The most prevalent digital technology used by construction companies is the creation of a website (46% of companies have one). However, as illustrated in Figure 50 below, even here, Romanian companies fall significantly below the EU average (72% of companies have one). Similarly, 28% of enterprises have a social media account, compared to the 44% EU average. The least used digital technologies in the Romanian construction sector are AI (with 0% of enterprises claiming to use it), 3D printing (1%), big data analytics (2%), use of robots (4%). In addition, only 4% of enterprises generate at least 1% turnover from e-commerce sales.

However, when it comes to being at the frontier of digital innovation, it is multinational companies with offices in Romania that are most likely to spread digital technologies in Romania and promote them as part of the implementation of larger construction and infrastructure projects.[484] In turn, even among the bigger companies in Romania, it is those with international offices that are most likely to adopt and promote the use of digital technologies.

Figure 50. Uptake of digital technologies in construction, Romania and EU27



Source: own elaboration based on Eurostat: Tables EISOC_EC_ESELN2, ISOC_CIWEB, ISOC_CISMT, ISOC_EB_IIP, ISOC_CICCE_USE, ISOC_EB_BD, ISOC_EB_P3D, ISOC_EB_IOT, ISOC_EB_AI, NACE sectors F41-43.

Based on information from online media sources, Romanian construction companies are currently mostly interested in exploring the development and adoption of BIM-related technologies and their sub-applications. This is likely due to the numerous benefits

[483] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[484] Findings from an interview with a representative of an association in Romania.

associated with the technology. Some of these benefits are elaborated upon in the box below. In turn, the uptake of BIM technologies is an important stepping-stone in facilitating the adoption of more advanced technologies in the industry.

Box 4. Importance of BIM technologies for digitalisation in construction

BIM systems act as a foundation for the adoption of more sophisticated digital technologies in the construction sector. BIM can bring several benefits to its adopters, the largest being the reduction of otherwise costly errors in the construction process. Other benefits of this technology include the possibilities it opens for remote working between contractors and construction authorities and its central role within the construction digital technologies landscape. For example, the use of BIM is a prerequisite for the uptake of drones and sensors in company's daily operation as data gathered from those devices would feed into the BIM system.

Looking at the adoption of the BIM technologies by the Romanian construction sector in 2019, less than 5% of the active construction projects were using it.[485] Although the need for standardisation and digitalisation within the construction industry is high, there are only 191 licensed BIM managers in Romania at the moment.[486] Digitalisation is thus more prevalent among construction companies that are higher in the value chain, such as engineers, architects, or designers. Companies that are on the lower end of the value chain, especially SMEs providing construction services, may struggle to uptake digital technologies due to a lack of a clear business case.[487]

Nevertheless, evidence points to efforts in Romania to expand the use of BIM. For example, the Romanian national organisation for standardisation – ASRO - has set up a technical committee CT334-Building Construction, Performance, Building Durability. At the beginning of 2019, ASRO published a new set of international standards enabling the use of BIM within projects and across borders.[488]

Ecosystem players in the construction industry are also participating to European initiatives aiming to support the digitalisation of the construction industry. For example, the Romania Green Building Council is part of the European consortium working on CircularBIM, an educational platform focused on advanced strategies for the reinstatement of building materials in the industrial value chain.[489] The goal of the platform is to promote the transition to the Circular Economy through the use of BIM learning technologies. The platform will contain information about ecological construction details, techniques for the use and reuse of construction materials, and the reduction of waste. In addition to this, students and professionals will be able to access free software to practice construction techniques that facilitate the reuse of the materials used in buildings. Similarly, to raise awareness, the Society of Construction Law in Romania offers seminars

[485] Romania Journal (2019). Romania Is Lagging Behind European States In Digitizing Its Construction Sector. Available at: https://www.romaniajournal.ro/business/romania-is-lagging-behind-european-states-in-digitizing-its-construction-sector/

[486] Romania Journal (2019). Romania Is Lagging Behind European States In Digitizing Its Construction Sector. Available at: https://www.romaniajournal.ro/business/romania-is-lagging-behind-european-states-in-digitizing-its-construction-sector/

[487] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[488] Muntean, R., et al. (2020). Approach, understanding, needs and integration of the BIM concept in the Romanian modern society: in *IOP Conference Series: Materials Science and Engineering* (Vol. 789, No. 1, p. 012043). IOP Publishing. Available at: https://iopscience.iop.org/article/10.1088/1757-899X/789/1/012043/pdf.

[489] More information available at: https://circularbim.eu/en/project/.

on BIM. Still, more training is required to increase the currently low level of its application in Romania.[490]

Overall, the uptake of digital technologies is particularly low in the construction industry in Romania. However, the low uptake of digitalisation is not unique to the construction industry but is rather a characteristic of the Romanian economy. Romanian businesses, and especially SMEs operating in construction, have low awareness about the benefits that digital technologies can bring and lack digital skills for their adoption. The situation is further exacerbated by the low digitalisation of Romania's public sector.

3.5.3. Key factors influencing digitalisation in the industry

3.5.3.1. Policy factors

In the 2021 Digital Intelligence Index[491] 'state of institutions' dimension, Romania ranks 45th out of 90 economies analysed and is shown to be receding in its performance. Romania scores relatively high in the ICT Regulatory Environment (ranking 7th) and bureaucracy (32nd) clusters. Romania ranks the lowest in transparency (52nd), the effectiveness of institutions (54th) and government digital uptake (76th).[492]

Given that the digitalisation of the Romanian public and private sectors falls below the EU average, several initiatives linked to digitalisation have been adopted by the Romanian government in the recent years. However, an overview of Romania's policy landscape points to an apparent gap of initiatives supporting digitalisation in the construction industry specifically.[493] Below we describe initiatives that directly or indirectly support Romania's construction industry digitalisation.

The consequences of COVID-19 have put digitalisation on the top of the agenda for the Romanian government.[494] One important development that has a strong potential to facilitate digitalisation in Romania is the creation of the Authority for the Digitalisation of Romania (ADR).[495] Established in December 2020, ADR is the main authority coordinating digitalisation initiatives in the country. More information about the authority is included in Box 5 below.

Box 5. Establishment of the Romanian Authority for the Digitalisation of Romania

Following the dissolution of the former Ministry for Communications and Information Society, the ADR has taken over most responsibilities related to the consistent implementation of policies in the field of digitalisation, acting as a common platform and shared expertise resource for public administration.

[490] FRD Center (2021). Building and Construction Market in Romania. Available at: https://www.frdcenter.ro/wp-content/uploads/2021/03/Building-and-Construction-Market-in-Romania-A-DEMO-Sector-Overview-by-....pdf

[491] The Digital Intelligence index is composed of two scoreboards: the digital evolution scoreboard compares the digital maturity and historical growth trajectory of countries, the digital trust scoreboard, which measures the trustworthiness of the digital ecosystem, the level and types of friction in digital experiences, the depth of engagement among Internet users, and the level of trust expressed by citizens.

[492] Tufts University (2021). Digital Intelligence Dashboard: Romania. Available at: https://sites.tufts.edu/digitalplanet/files/2021/countrydashboards/Digital_Intelligence_Dashboard_RO.pdf

[493] European Construction Sector Observatory (2021). Digitalisation in the Construction Sector Analytical report, p67.

[494] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[495] More information available at: https://www.adr.gov.ro/.

Some relevant initiatives launched by the ADR during 2020/2021 include:

- improving the National Electronic System for Online Payments (ghiseul.ro);
- launching the Centralised Digital Identification Software Platform (PSCID) project;
- conducting analysis and finalising the document on 'Barriers to the digitalisation of the public and private sector in Romania';
- finalising the Public Policy on e-Government, including an action plan for the following ten years, which includes efficient and sustainable measures for the digitalisation of public administration;
- starting an inventory of existing digital public services offered by central public administrative authorities. Once finalised, the Registry of Digital Public Services will show which areas/sectors are less digitalised, facilitating the identification of new courses of action and evidence-based needs.

Furthermore, recognising the digital skills shortage in the country, the Romanian government launched two calls for proposals to increase employees' digital competences under the Human Capital Operational Programme (HCOP) 2014-2020. The calls focus on improving the digital competences of both SMEs and large companies.[496] The National Agency for Employment is also organising vocational training programmes for registered jobseekers to help them acquire IT skills specific to any fields facing labour shortages. In 2020, the agency delivered 50 training courses on digital skills for 711 jobseekers.

Although the construction sector is not mentioned specifically in policy documents related to the digitalisation of Romanian companies, two developments indicate that policymakers responsible for the sector are starting to prioritise specific technical measures aimed at strengthening digitalisation. The measures focus on the development of the BIM sector in Romania and better coordination of the public authorities and private sector in this field. They are described in more detail in Box 6 below.

Box 6. Policy measures supporting digitalisation of Romanian construction industry

The methodology for the initiation, programming, procurement, drafting, endorsement, approval and use of technical regulations and the results of specific construction activities, sets up a new BIM Technical Specialist Committee.[497]

The Ministry of Regional Development and Public Administration is implementing a project on Increasing the Coherence of the Regulatory Framework and Efficiency of technical regulations in the construction field, MySmis code 129900/SIPOCA 731. The project aims to strengthen the capacity of the Ministry of Regional Development and Public Administration, as the regulatory authority in the construction field, by increasing the coherence of the regulatory framework and the effectiveness of the technical regulations in the construction sector.[498]

[496] The Digital Economy and Society Index (DESI) | Shaping Europe's digital future (europa.eu)

[497] Romania. Ministry of Development, Public Works and Administration. (2022) Ordinance no. 699 of 2 May 2022 amending the Methodology for the initiation, programming, procurement, drafting, endorsement, approval and use of technical regulations and the results of specific activities in construction, and approving the amount of the participation allowance for members of the specialist technical committees and the general technical coordination committee, approved by Order of the Minister of Public Works, Development and Administration No 3.363/2020. Published in the Official Monitor No 487 of 17 May 2022 Available at: https://legislatie.just.ro/Public/DetaliiDocument/255476.

[498] POCA (n.d.) Available at: https://www.mdlpa.ro/uploads/articole/attachments/5dc55f3a06f31690934278.pdf

As mentioned above, Romania ranks last in the EU in the use of digital public services. In light of this, in August 2020, the Romanian government passed an emergency ordinance[499] regulating the use of electronic signatures in relation to construction, architecture and urbanism. This was followed up in December by a set of technical norms adopted for the application of this ordinance.[500] Several categories of professionals involved in real estate planning and permitting can now use electronic signatures on the documentation they issue. This allows for all documentation of the procedural circuit for construction works to be filed online, including planning, design, permitting, execution, reception, and commissioning.[501] This legislative change is an important step in facilitating the work of the construction sector, given that the volume of construction works in Romania increased by over 16% in the first 11 months of 2020 compared to the same period in 2019, despite the pandemic.[502]

Nevertheless, further efforts to digitalise the Romanian public sector are needed. In its analysis of the recovery and resilience plan of Romania, the European Commission highlighted that the country should promote digital interactions between the State and private companies as much as possible.[503]

The public procurement process for construction projects is another factor disincentivising companies from adopting digital technologies.[504] In theory, the award criteria may be based on the lowest price or the most advantageous offer. However, interviewed stakeholders claim that in reality, the most accounted-for factor tends to be the lowest price only.[505] This results in some companies prioritising cheaper resources. Incentives for investing in digital technologies are thus reduced.[506]

Looking at European support programmes, Romania's Recovery and Resilience Plan (RRP RO) has a total allocation of EUR 29.1 billion and includes numerous initiatives linked to digitalisation. The RRP RO will act as an important catalyst for their adoption and integration in the country. The measures contributing to digital objectives account for 20.5% of the financial allocation, which is above the 20% minimum requirement of the RRF Regulation.[507] Even though the digitalisation of industry is not explicitly mentioned in the RRP RO, a total of EUR 1.817 million is allocated to component seven 'Digital transformation'. The component contains numerous important digitalisation initiatives, which are likely to spill over into industry digitalisation as well. This includes the development of the government cloud infrastructure, large-scale deployment of electronic identity (eID) cards, and development of the national building register for the digital

[499] Romanian Government (2020). Emergency Ordinance no. 140 of 19 August 2020 on the establishment of measures for the use of electronic documents in the fields of construction, architecture and town planning. Published in the Official Monitor no. 767 of 21 August 2020. Available at: https://legislatie.just.ro/Public/DetaliiDocument/229308.

[500] Rev. Universul Juridic (2020). Legislative News. Available at: https://heinonline.org/HOL/LandingPage?handle=hein.journals/univjurid2020&div=185&id=&page=.

[501] Romanian Government (2020). Emergency Ordinance no. 140 of 19 August 2020 on the establishment of measures for the use of electronic documents in the fields of construction, architecture and town planning. Published in the Official Monitor no. 767 of 21 August 2020. Available at: https://legislatie.just.ro/Public/DetaliiDocument/229308.

[502] Schonherr (2021). Romania's construction sector moves a step nearer digitalisation. Available at: https://www.schoenherr.eu/content/romania-s-construction-sector-moves-a-step-nearer-digitalisation/.

[503] European Commission (2021). Analysis of the recovery and resilience plan of Romania. Available at: https://ec.europa.eu/info/sites/default/files/swd2021_276_en.pdf.

[504] Findings from an interview with a representative of an association in Romania.

[505] Findings from an interview with a representative of an association in Romania.

[506] Patras, M. V., & Banacu, C. S. (2016). Critical phases in the process of awarding public procurement contracts: A Romania case study. Journal of Engineering, Project, and Production Management, 6(2), 104. Available at: http://www.ppml.url.tw/EPPM_Journal/volumns/06_02_July_2016/ID_141_6_2_104_119.pdf.

[507] Digital Economy and Society Index, Romania (2021).

transformation of civil service management. In addition, component nine 'Business support, research, development and innovation', with an allocation of EUR 1.064 million, contains initiatives aimed at increasing the digitalisation of business. The foreseen initiatives include significant investments aiming to accelerate the digitalisation of both SMEs and large companies with a focus on the development and adoption of advanced technologies (such as blockchain, quantum, cloud computing, and artificial intelligence).

Finally, RRP RO has a strong focus on the green transition with several measures linked to energy and climate. These will have an indirect impact on the construction sector, especially on civil engineering. The strong focus on the energy efficiency of private and public buildings, digitalisation of road and rail transport and the deployment of electric charging infrastructures, climate change adaptation and circular economy will also facilitate the green transition in all sectors of the economy. It will potentially indirectly facilitate the digitalisation of construction.

Romania also benefits from an active network of Digital Innovation Hubs, with the Smart Specialisation (S3) platform listing a total of nine fully operational hubs in Romania.[508] When it comes to specialisation in the construction industry, two hubs, namely the Future of Innovation and Technology (FIT) hub and Wallachia eHub, include the industry among its covered sectors. Finally, a total of seven hubs have received EDIH status after the first call by the European Commission.[509]

3.5.3.2. Social factors

Lack of digital skills is among the key challenges affecting Romania's uptake of digital technologies. This is pertinent not only to the construction industry but the broader Romanian economy. Only 31% of people aged between 15-74 have at least basic digital skills (compared to the 56% EU average), while 35% have at least basic software skills (EU average: 58%). In 2021, only 10% of the population had above-basic digital skills.[510] Both the RRP RO and the European Semester Country Report for Romania stress lack of digital skills as one of the key issues to be addressed.

Although Romania has a relatively high proportion of ICT graduates (6.3% of all graduates, placing it fourth in the EU in 2020), the country faces significant brain-drain with large numbers of ICT graduates seeking employment abroad. In turn, the country lags significantly below the EU average regarding the availability of ICT specialists, who constitute only 2.4% of individuals in employment between ages 15-74 as compared to the 4.3% EU average. The country is facing a significant shortage of ICT specialists in the overall workforce, which in time, might limit its capacity to innovate and capitalise upon innovation.[511]

Looking at construction specifically, given the increasing labour demand, there is an evident shortage of specialist workers with knowledge of AI, IoT and BIM technologies. Lack of training on ICT further exacerbates the issue. As illustrated in Figure 51 below, even though 15% of Romanian construction enterprises employ ICT personnel, only 3%

[508] Smart Specialisation Platform (n.d.). Digital Innovation Hubs. Available at: https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool.

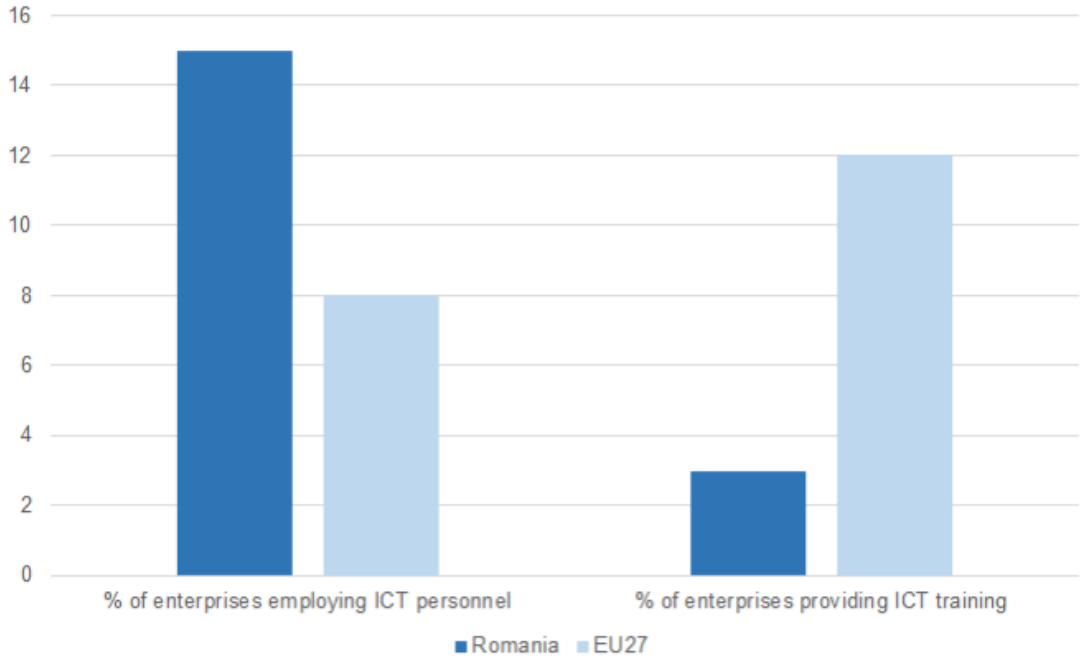
[509] DG CNECT A4 - Digital Transformation of Industrial Ecosystems (2022). Presentation 'Digitalisation of Businesses and the network of European Digital Innovation Hubs (EDIH)' during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[510] DESI (2021). Country report, Romania. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-romania.

[511] European Commission (2021). Digital Economy and Society Index (DESI) 2021. Available at: https://ec.europa.eu/newsroom/dae/redirection/document/80496.

provided ICT training to their employees in 2020, as compared to the 12% EU average. Moreover, according to a survey conducted in Romania on the use of BIM systems, 55% of the respondents did not receive any type of BIM training.[512] This was further confirmed through interviews. However, there are some bottom-up initiatives aimed at addressing the lack of specialist skills in the construction industry. The Romanian Green Building Council is participating in the UrbanBIM initiative, which aims to put together trainings on the use of BIM systems, LCA (Life Cycle Analysis) and Energy Efficiency of construction materials.[513]

Figure 51. Employment of ICT personnel and ICT training, Romania and EU27, 2020



Source: own elaboration based on data from Eurostat: Tables ISOC_SKE_ITSPEN2 and ISOC_SKE_ITTN2, NACE sectors F41-43.

Similarly to the agrifood and textile industries described above, the Romanian construction industry faces a demographic challenge. In 2021, almost a quarter of workers in the construction sector were over 55 and approaching retirement age.[514] The number of tertiary students in engineering, manufacturing and construction decreased by 38.1%, from 37,596 in 2010 to 23,263 in 2019. The number of tertiary students in engineering, manufacturing, and architectural fields dropped by 43.5%, 40.8% and 42.4%, respectively, over the 2010-2019 period.[515] Furthermore, specific educational programmes, courses, or modules for digitalisation of the construction sector within relevant higher education programmes are scarce, creating a further barrier to digitalisation even for highly trained graduates in the field.

[512] Muntean, R., et al. (2020). Approach, understanding, needs and integration of the BIM concept in the Romanian modern society: in *IOP Conference Series: Materials Science and Engineering* (Vol. 789, No. 1, p. 012043). IOP Publishing. Available at: https://iopscience.iop.org/article/10.1088/1757-899X/789/1/012043.

[513] Romania Green Building Council (n.d.). UrbanBIM. Available at: http://www.rogbc.org/en/projects/urbanbim.

[514] Adrvest (2020). Strategia Regionala de Specializare Inteligenta. Available at: https://adrvest.ro/wp-content/uploads/2021/01/Strategia-Regionala-de-Specializare-Inteligenta-a-Regiunii-Vest-2021-2027-RIS3-.pdf.

[515] European Construction Sector Observatory (2022). Country profile Romania. Available at: https://ec.europa.eu/growth/sectors/construction/observatory/country-fact-sheets/romania_en.

3.5.3.3. Economic factors

There are several economic factors that impede the adoption of digital technologies by the Romanian industry, including by construction companies. Romania scores well below the EU average regarding the overall take-up of fixed broadband (67% in Romania compared to 77% in the EU).[516] In addition, while overall broadband connectivity has been improving significantly over the last five years, parts of the country are still not connected to fixed, very high-capacity networks.[517] This has implications for the construction industry as the use of digital technologies such as BIM requires high bandwidth coverage, which might not be readily available on more remote construction sites.

Romania also scores significantly below the EU average (51%) when it comes to 5G readiness, with a score of 21%. However, the RRP RO includes plans for the adoption of the 5G security law, laying the ground rules for the deployment of 5G. As part of RRP RO, Romania also submitted a Connectivity Toolbox Roadmap to the European Commission, which outlines several reforms aimed at improving connectivity in the country.[518]

Limited broadband and 5G coverage negatively impact the application of digital technologies along the construction value chain. For example, most of the architects based in Romanian urban areas use BIM technology and have increasingly started to use various collaborative digital technologies. However, integration of digital technologies along the value chain – for example, by building contractors – remains difficult as BIM and other collaborative technologies require good internet infrastructure, which is not readily available near new buildings, as they often rely on 4G connection.

According to the 2022 European Semester Country Report for Romania, issues remain with regard to innovation and firms' capacity to absorb technology. This is caused by the low level of gross expenditure on R&D, which stood at 0.19% of GDP in 2020 and was the lowest in the EU.[519] In addition, the compound annual growth of public expenditure on R&D was at a negative 5.5.% in the period between 2010-2020.

Regarding private expenditure on R&D as a share of GDP, Romania is still behind the EU, with private spending on R&D contributing only 0.29% of GDP in 2020. Yet, private spending on R&D outweighed public spending in 2020.[520] Nevertheless, business enterprise R&D expenditure (BERD) in the narrow construction sub-sector declined by 67.8% between 2010 and 2019.[521] As mentioned in Section 3.5.2, large multinational companies appear to be most likely to invest in R&D. According to the EIBIS, in 2020, construction companies allocated the smallest share of their annual investments, only 5%, to software, data, IT networks and website activities.[522] The largest share of construction company investments (60%) went to purchasing of machinery and equipment. By

[516] European Commission (2021). DESI country profile: Romania. Available at: https://digital-strategy.ec.europa.eu/en/policies/desi-romania.

[517] European Commission (2022). European Semester 2022 Romania Country Report. Available at: https://ec.europa.eu/info/sites/default/files/2022-european-semester-country-report-romania_en.pdf.

[518] European Commission (n.d.). Roadmap for implementing the Union-wide Connectivity Toolbox at national level. Available at: https://ec.europa.eu/newsroom/dae/redirection/document/81095.

[519] European Commission (2022). European Semester 2022 Romania Country Report. Available at: https://ec.europa.eu/info/sites/default/files/2022-european-semester-country-report-romania_en.pdf.

[520] European Commission (2022). European Semester 2022 Romania Country Report. Available at: https://ec.europa.eu/info/sites/default/files/2022-european-semester-country-report-romania_en.pdf.

[521] European Construction Sector Observatory (2022). Country profile Romania. Available at: https://ec.europa.eu/growth/sectors/construction/observatory/country-fact-sheets/romania_en.

[522] European Investment Bank Investor Survey (2021). Average share of investment in different asset types: RO, EIBIS 2021. Available at: https://data.eib.org/eibis/graph.

comparison to other surveyed industries in Romania (infrastructure, manufacturing, services), construction has the lowest level of investment in software, data, IT networks and website activities.

SMEs operating in the construction industry also have limited access to finance. According to the 2021 Survey on the Access to Finance of Enterprises (SAFE) report, around 36.9% of SMEs in the construction sector in Romania reported bank loans as being relevant for them, which is below the EU average of 45.7%. Only 11.5% of the SMEs reported using bank loans recently (between April 2021 and September 2021). During the same period, 20.2% of SMEs in Romania applied for a bank loan, below the EU-27 average of 21.3%. A total of 10.3% of SMEs in Romania did not apply for bank loans fearing rejection, well above the EU-27 average of 4.7%.[523]

Labour productivity is another constraint facing the sector. While other sectors (agriculture or manufacturing) are increasing their productivity, the construction sector falls behind. This is due to the increasing complexity of projects, as well as insufficient preparation of the planning phase, lack of collaboration between stakeholders and a shortage of skilled and specialised personnel with sufficient experience.[524] Companies are thus forced to solve tasks with fewer human resources. Romania lacks workers, engineers, and qualified architects to execute its development plans.[525] With labour being one of the most important inputs in the construction sector, and a stringent problem at the moment, investments in increasing the effectiveness of daily operations through the uptake of digital technologies are thus deprioritised.

3.5.3.4. External shocks

The effect of COVID-19 and other external shocks, including Russia's attack on Ukraine, on digitalisation in the construction industry is ambiguous. Firstly, there is a lack of recent data that would capture these effects specifically. Secondly, external shocks manifested themselves differently, depending on the size of the company and its position in the value chain.

Despite COVID-19 acting as a catalyst for companies to adopt digital technologies, it appears to have had a mild impact on the Romanian construction sector. According to the EIBIS 2021, 29% of construction firms became more digital because of the COVID-19 pandemic. This is well below the reported adoption of digital technologies in infrastructure (57% of companies), services (50%), and manufacturing (37%) companies in Romania.[526] The trend is similar when looking at the expected long-term impacts of COVID-19. Just over one-third (31%) of Romanian construction companies expect COVID-19 to result in increased use of digital technologies in the long run. Again, this figure is the lowest among consulted Romanian industries, as illustrated in Figure 52 below. Romanian construction companies identified 'changes in the service or product portfolio' as the most likely long-term impact of COVID-19 (with 52% of companies claiming this).

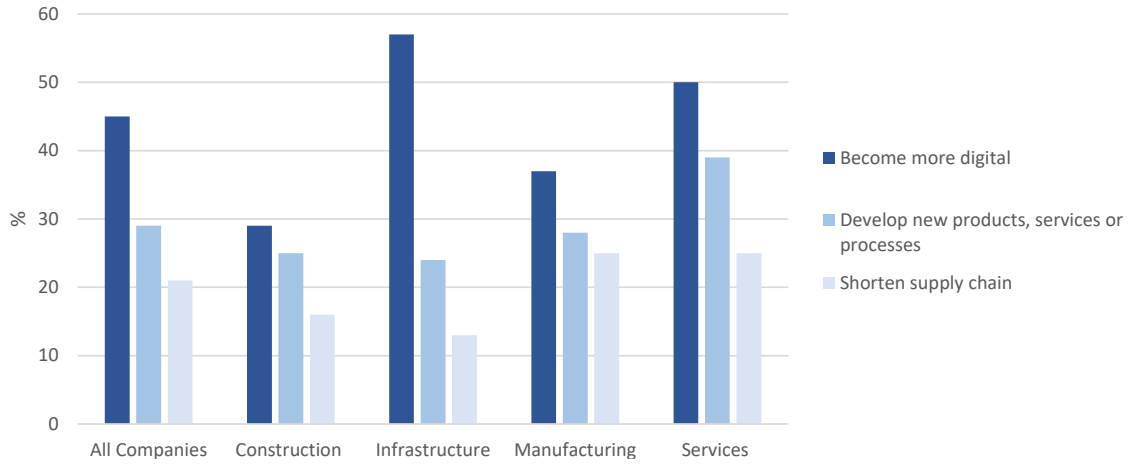
[523] European Commission (2022). Romania - ECSO country fact sheet. Available at: https://ec.europa.eu/growth/sectors/construction/observatory/country-fact-sheets/romania_en.

[524] Adrvest (2020). Strategia Regionala de Specializare Inteligenta. Available at: https://adrvest.ro/wp-content/uploads/2021/01/Strategia-Regionala-de-Specializare-Inteligenta-a-Regiunii-Vest-2021-2027-RIS3-.pdf.

[525] Business Review (2022). A SWOT analysis of Romania's construction market in 2022. Available at: https://business-review.eu/property/constructions/a-swot-analysis-of-romanias-construction-market-in-2022-228043.

[526] European Investment Bank Investor Survey (2021). Short-term actions as a result of covid-19: RO, EIBIS 2021. Available at: https://data.eib.org/eibis/graph.

Figure 52. Short-term actions as a result of COVID-19 in Romania, 2021



Source: own elaboration based on EIBIS 2021, Q70. As a response to the Covid-19 pandemic, have you taken any actions or made investments to…?

A potential reason for the limited impact of COVID-19 on the digitalisation of the construction industry is the fact that more pressing challenges are facing the industry today. Construction industries aimed for cost-effective solutions during the pandemic. Digitalisation was often seen as a more costly option and was thus deprioritised.[527]

Nevertheless, the COVID-19 pandemic acted as an incentive for Romania's public sector to accelerate its digital transformation, in turn having an indirect effect on Romania's construction companies. As mentioned in Section 3.5.3.1, in August 2020, the Romanian government passed an emergency ordinance[528] regulating the use of electronic signatures in relation to construction, architecture and urbanism. In December of the same year, a set of technical norms for the application of this ordinance were adopted.[529] Thanks to these measures, construction projects can now progress more rapidly from planning to development phases.

3.5.4. Main digitalisation strengths and challenges

Romania's construction sector is thriving in terms of the number of buildings being built, the number of employees, and the overall growth of the sector. This growth has been registered despite the COVID-19 pandemic, high inflation rates, and the shortage of skilled workers. The sector's resilience to the shocks of the past few years has been strengthened by several government measures which provide fiscal support to the sector. However, the construction industry in Romania remains frail and appears to be more concerned with daily operational challenges than digitalisation efforts.

As a result, digitalisation through more advanced digital technologies (such as drones, AI, AR/VR or BIM) is not yet a widespread priority in the construction sector. On the one hand, companies that are higher along the value chain, such as architects and engineers, are

[527] Conclusions from the panel discussion during the 'Workshop on European industry digitalisation – the challenges ahead' organised on June 28 2022 as part of the study.

[528] Romanian Government (2020). Emergency Ordinance no. 140 of 19 August 2020 on the establishment of measures for the use of electronic documents in the fields of construction, architecture and town planning. Published in the Official Monitor no. 767 of 21 August 2020. Available at: https://legislatie.just.ro/Public/DetaliiDocument/229308.

[529] Rev. Universul Juridic (2020). Legislative News. Available at: https://heinonline.org/HOL/LandingPage?handle=hein.journals/univjurid2020&div=185&id=&page=.

more likely to use digital technologies. On the other hand, building material producers and small construction companies are more likely to prioritise cheaper resources and perceive digital technology as a cost rather than a long-term investment.

There are several structural reasons for the low adoption of advanced digital technologies, particularly among construction SMEs. These include the overall lack of incentives and awareness in Romania regarding the benefits of digital technologies, labour shortages, and the high prices of advanced technologies. Difficulties in accessing public and private finance limit investment in digitalisation efforts.

Perhaps the biggest bottleneck in adopting advanced digital technologies in the Romanian construction industry is the scarcity of relevant digital skills among potential employees. Romania lacks an available pool of skilled personnel across all sub-sectors of the construction industry. Even architecture and engineering firms, which are among the most digitalised sub-sectors, lack appropriate educational programmes for the advanced use of digital technologies. This prevents companies from reaping the possible benefits of using advanced digital technologies in their daily operations.

In addition, the bureaucracy related to both the construction authorisation process and public procurement policies is a burden for companies and does not support the innovation and digitalisation of the construction industry. In response to the COVID-19 pandemic, the Romanian government took some steps to address digitalisation issues. However, companies point to a high level of administrative work that is still needed to authorise construction projects. This serves as a barrier to digitalisation for building companies, as neither operational capacities nor the pricing criteria set for public contracts incentivise digitalisation.

Nevertheless, the Romanian construction industry has strong potential for digitalisation. Although no EU operational programmes and policies in Romania directly tackle the issue of digitalisation in the construction industry, the multitude of financing opportunities for digital skills and infrastructure, shifts to green energy, and the overall uptake of digital technologies are likely to have a positive spillover effect. Similarly, digitalisation is at the top of the government's agenda in the wake of COVID-19. The creation of the Authority for the Digitalisation of Romania (ADR) will likely create opportunities for the adoption of digital technologies in the sector.

4. Conclusions

During the preparation of this report, several cross-cutting factors that influence industry digitalisation were identified. These include enterprise size and its position in the value chain, level of structural uncertainty faced by the industry due to the broader business transformation, impact of external shocks, skills shortages, availability of support instruments, and overall awareness, know-how and prioritisation of digital technology uptake.

In terms of business size, larger companies often are more digitalised than SMEs. For example, some automotive companies in Hungary face challenges implementing Industry 4.0 due to limited impact on the end-product and ability to implement 'manufacturing as a service' concept. Meanwhile, in Poland, digitalisation is led by large retailers, while many small enterprises struggle to adopt even basic digital solutions, often choosing to outsource them instead. Similarly, in the Romanian construction industry, multinational companies are the ones likely to bring digital technologies to Romania and promote them as part of the implementation of larger construction and infrastructure projects.

Similarly, companies' position in the value chain affects their level of digitalisation. Those companies that are at the higher end of the value chain, i.e., produce more value-added products and services, are more likely to be digitalised. For example, architecture and engineering companies in the construction industry are more likely to adopt BIM technologies that those producing building materials or working on construction sites.

Most of the industries analysed in this study face a high degree of uncertainty. All manufacturing industries included in the study will have to introduce significant changes due to increasing environmental standards. Moreover, consumer expectations are also changing. For example, the textile industry in Portugal will see increased demand for personalisation and the automotive industry in Hungary will face demand for new types of vehicles and mobility solutions. Meanwhile, construction enterprises in Romania will see an increased focus on energy efficiency, the digitalisation of road and rail transport, and the deployment of electric charging infrastructures. As a result, companies will face the need to pursue large-scale business transformation that includes digitalisation instead of being able to adopt digital technologies in smaller steps.

COVID-19 has had an ambiguous impact on most industries. While many large companies have accelerated digitalisation in response to external shocks, such as the COVID-19 pandemic and the Russian invasion of Ukraine, some SMEs see them as a barrier instead. For example, some textile SMEs in Portugal have paused their digitalisation efforts in response to rising input prices. Similarly, in the automotive industry, SMEs fell further behind large multinationals as they had trouble adapting to external shocks that caused significant disruptions to their production or, at times, halted production completely. At the same time, in the agrifood sector, some companies, especially those that could sell directly to customers, turned to digital solutions to support them through the crisis.

Industries are facing shortages of skills needed for digital transformation. This problem is especially pronounced for SMEs and is compounded by labour force shortages and an ageing workforce. Furthermore, across most studied industries, a low proportion of companies provide their employees with ICT training. For example, both in the Portuguese textile industry and the Lithuanian agrifood industry, an ageing workforce and lack of digital skills are pronounced problems. They are further exacerbated by the difficulty in attracting new employees to the sector. Similarly, in the Romanian construction industry, labour shortages driven by low wages, emigration and the absence of specialist training create significant challenges and deprioritise investment in digitalisation.

Support instruments present opportunities for digitalisation. However, lack of awareness and targeted instruments for some industries remain a challenge. Despite digitalisation being an increasing policy priority, low uptake among SMEs is common. Some of the industries included in the study note the lack of targeted instruments to support their digitalisation: most notably, agrifood in Lithuania and retail in Poland.

Some SMEs have limited capacity to take part in existing digitalisation programmes, including due to time-consuming application processes and lack of know-how. Smaller companies stand to benefit from the existing support network, including digital innovation hubs. However, evidence points to the fact that some SMEs lack not only expertise but managerial leadership to adopt digital technologies. SMEs are particularly risk-averse when it comes to investing in digitalisation. In turn, supporting organisations could aim to provide tailored digital solutions that suit SMEs' needs. It is also important to clearly demonstrate value-added from digitalisation as industrial SMEs may perceive digitalisation as a cost rather than a benefit. Nonetheless, the availability of a supporting ecosystem plays an important role in incentivising SMEs to pursue digital transformation. These organisations help to counter the lack of economies of scale, risks associated with digital technology adoption, and insufficient expertise.

Appendix

Annex 1. Industries, sectors, and sub-sectors included in the study

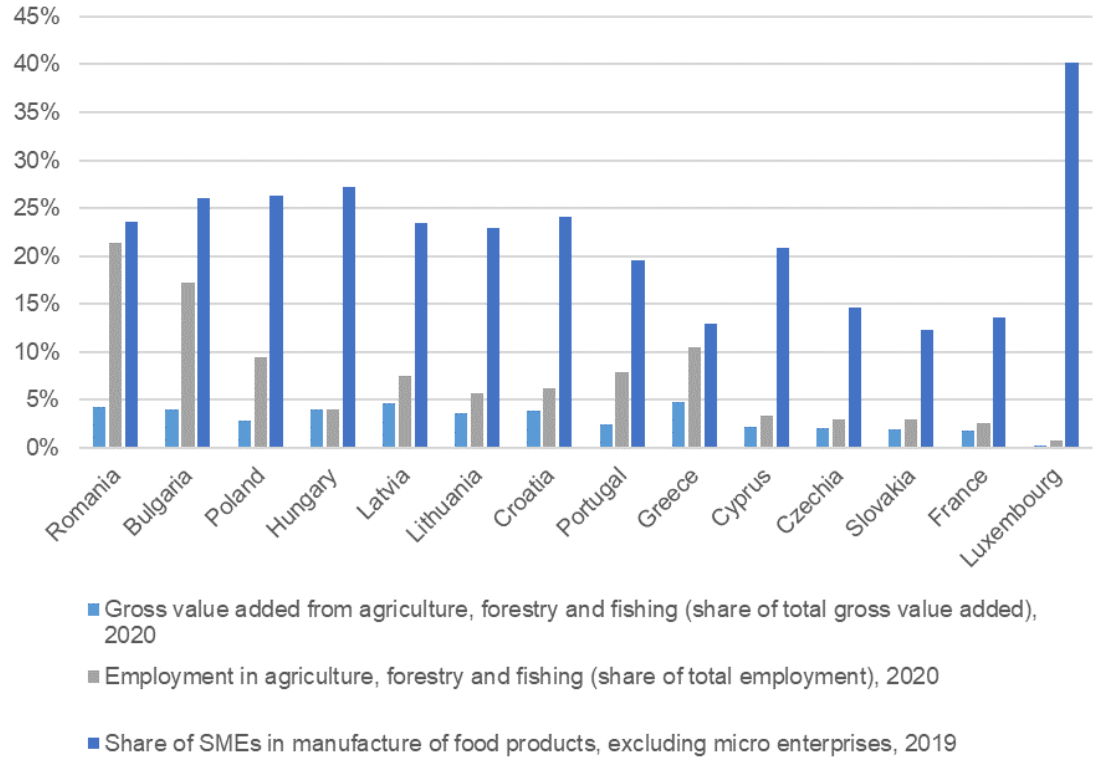
Table 4. Industries, sectors, and sub-sectors included in the study

Industry	Description of sectors and sub-sectors
Automotive	Companies and organisations involved in the design, development, manufacturing, marketing, and selling of motor vehicles, including vehicle manufacturers, upstream suppliers and downstream importers, and distributors.
Agrifood	Operators in the food supply chain (farmers, food industry, food retail and wholesale, and food service) and their suppliers of goods and services (seeds, pesticides, fertiliser, machinery, packaging, repair, transport, and logistics).
Construction	Contractors for building and infrastructure projects, construction product manufacturers, engineering, and architectural services, as well as a range of other economic activities (e.g., rental and leasing of machinery and equipment, employment agencies). In this study, the analysis of the construction industry builds on the NACE classification, whereby the construction sector is seen as composed of a) construction of buildings for residential and non-residential purposes, b) civil engineering sub-sector and c) specialised construction activities, incl. demolitions and plumbing and finishings.
Retail	Sellers of goods and services to consumers, online sellers, including relevant wholesale and online platforms, and players participating in other usual operations associated with trade (sorting, packing, storage, etc.).
Textile	Companies involved in the transformation of natural, man-made and artificial fibres into yarns and fabrics, production of yarns, bed linens, industrial filters, technical textiles, carpets, and clothing; also, the production of footwear and leather.

Annex 2. Results of country selection analysis

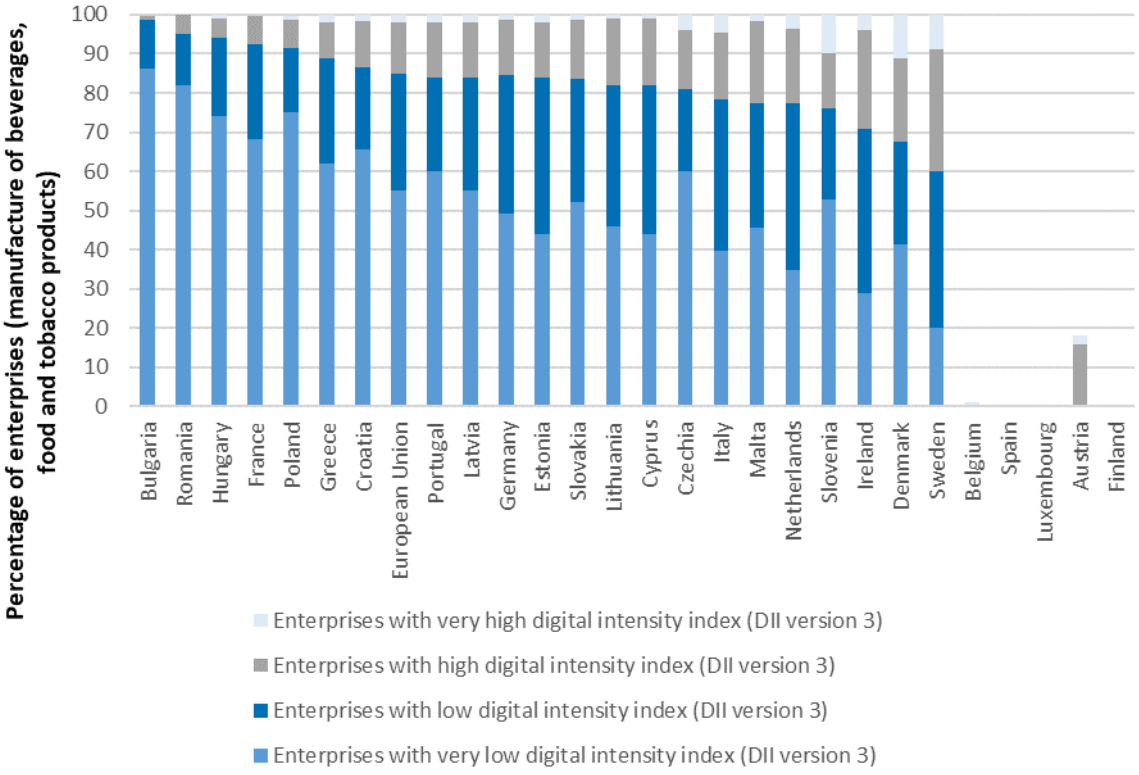
The following graphs were compiled by selecting pertinent country-level indicators from Eurostat with the aim to identify the EU Member States with a low level of digital intensity, in which the five study industries are particularly relevant. The results are summarised in the figures below. The countries appearing first from left to right in each graph are those where respective industries add the most to total gross value added, account for the largest share of employment, and include the largest number of SMEs (excluding micro-businesses).

Figure 53. Key indicators regarding the agrifood industry, by country



Source: own elaboration based on data from Eurostat tables NAMA_10_A64, NAMA_10_A64_E and SBS_SC_SCA_R2.
Note: the figure is sorted by the average of the three indicators. The latest year of available data was chosen.

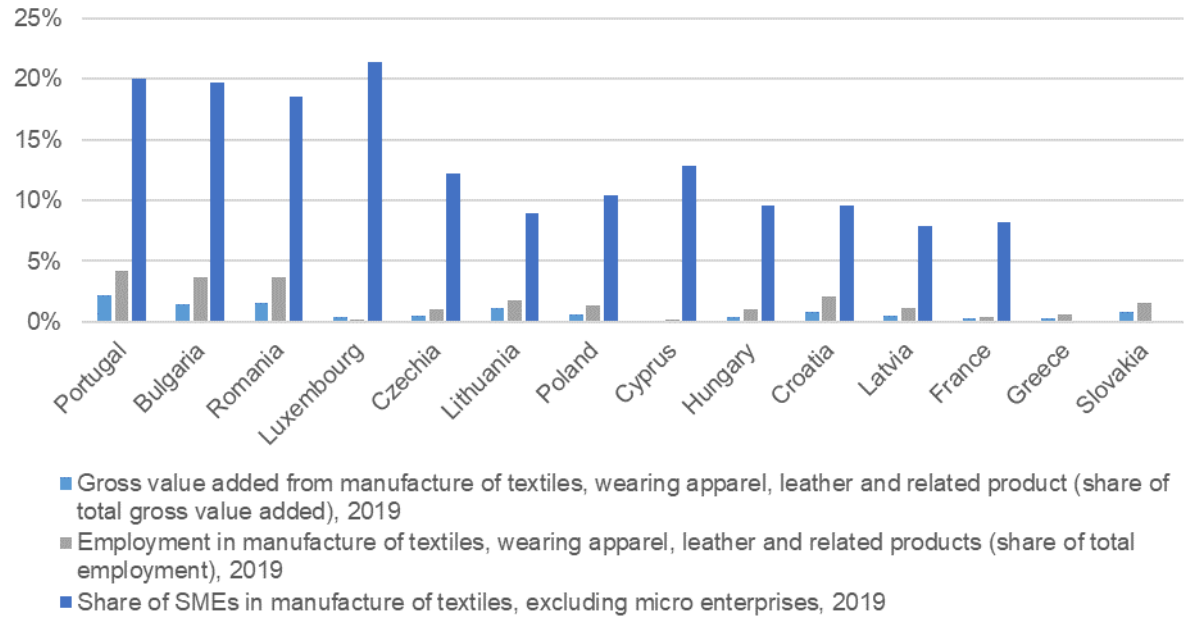
Figure 54. Digital Intensity Score for Enterprises in the manufacture of beverages, food, and tobacco industry, 2021



Source: own elaboration based on data form Eurostat: Tables isoc_e_dii: Digital Intensity, for the [10_C10_12] 'Manufacture of beverages, food, and tobacco products' industry.

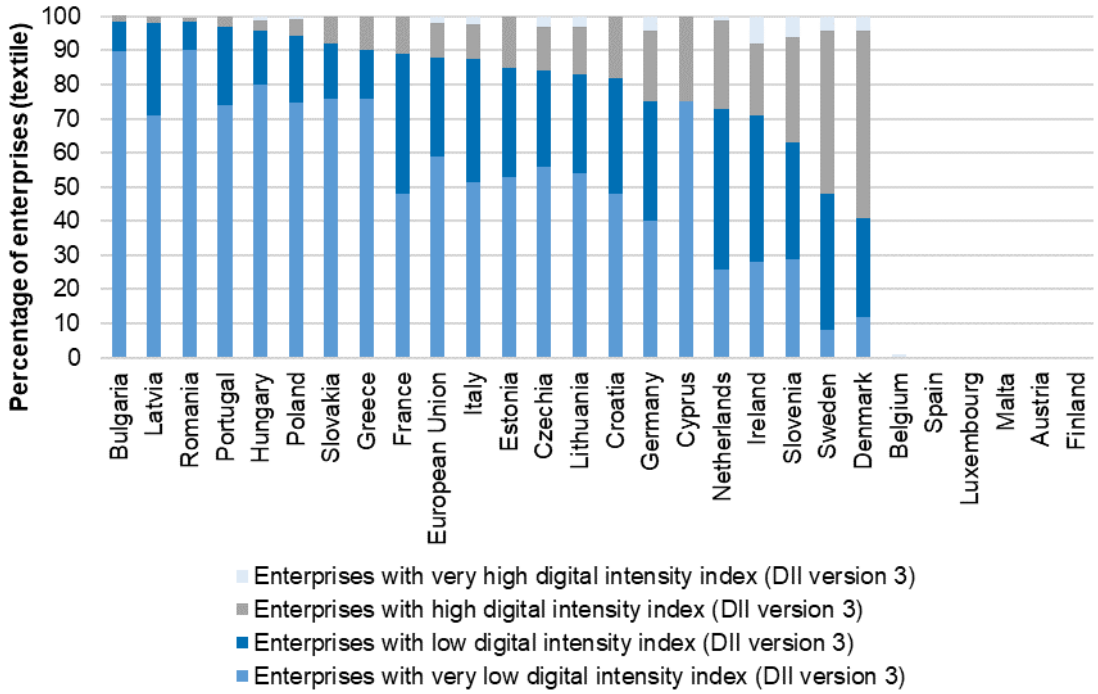
Note: the figure is sorted by the sum of the Very Low and Low Digital Intensity Index scores. Data was missing for Belgium, Spain, Luxembourg, Austria, and Finland.

Figure 55. Key indicators regarding the textiles industry, by country



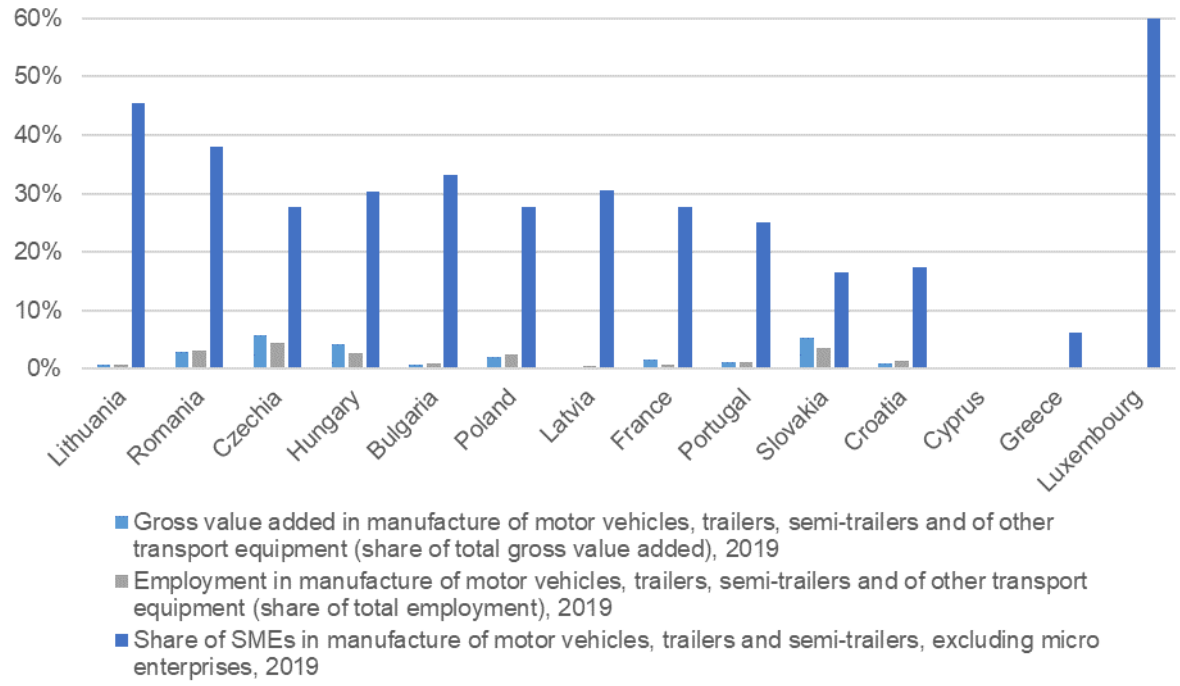
Source: own elaboration based on data from Eurostat: Tables NAMA_10_A64, NAMA_10_A64_E and SBS_SC_SCA_R2.
Note: the figure is sorted by the average of the three indicators. The latest year of available data was chosen.

Figure 56. Digital Intensity Score for enterprises in the textile industry, 2021



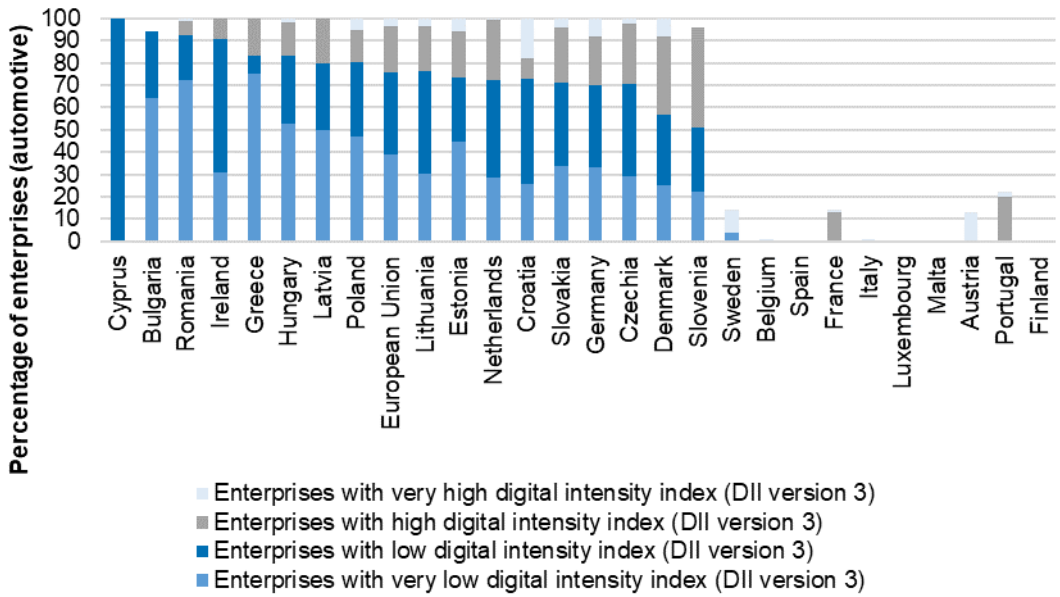
Source: own elaboration based on data form Eurostat: Tables isoc_e_dii: Digital Intensity, for the 10_C13_15 'Manufacture of textiles, wearing apparel, leather, and related products' industry.
Note: the figure is sorted by the sum of the Very Low and Low Digital Intensity Index scores.

Figure 57. Key indicators regarding the automotives industry, by country



Source: own elaboration based on data from Eurostat: Tables NAMA_10_A64, NAMA_10_A64_E and SBS_SC_SCA_R2.
Note: the figure is sorted by the average of the three indicators. The latest year of available data was chosen. Data were missing for Cyprus, Greece, and Luxembourg.

Figure 58. Digital Intensity Score for enterprises in the automotive industry, 2021

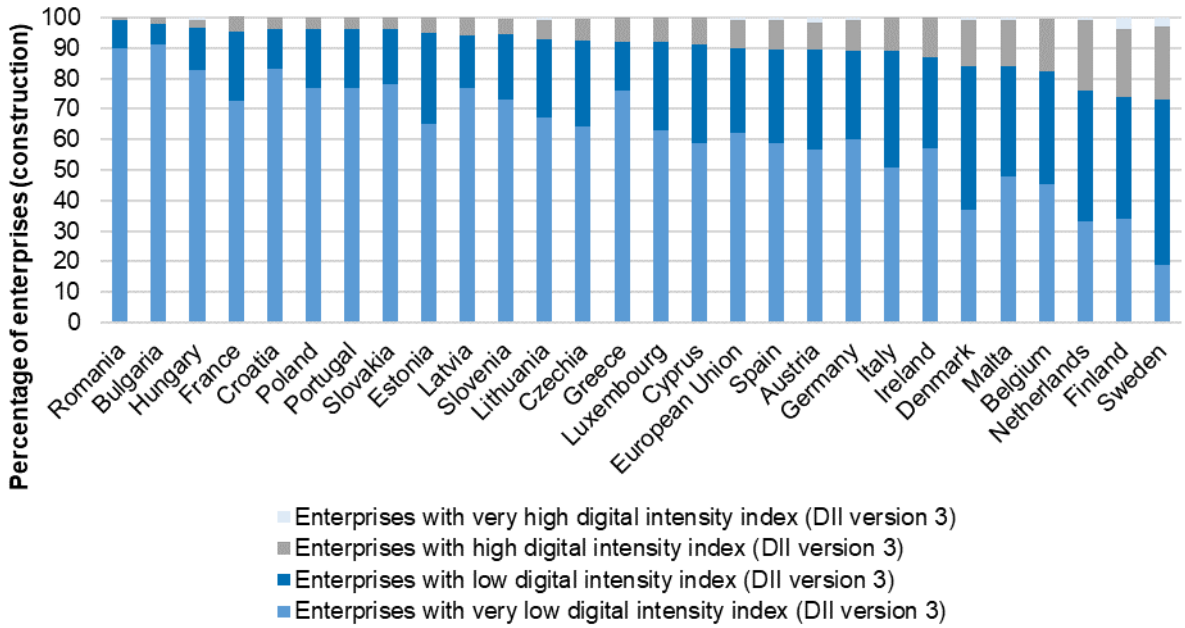


Source: own elaboration based on data from Eurostat: Tables isoc_e_dii: Digital Intensity, for the [10_C29_30] 'Manufacture of motor vehicles, trailers and semi-trailers, other transport equipment' industry.
Note: the figure is sorted by the sum of the Very Low and Low Digital Intensity Index scores. Certain data was missing for Bulgaria, Sweden, Belgium, Spain, France, Italy, Luxembourg, Malta, Austria, Portugal, and Finland.

Figure 59. Key indicators regarding the construction industry, by country

Source: own elaboration based on data from Eurostat: Tables NAMA_10_A64, NAMA_10_A64_E and SBS_SC_SCA_R2.
Note: the figure is sorted by the average of the three indicators. The latest year of available data was chosen.

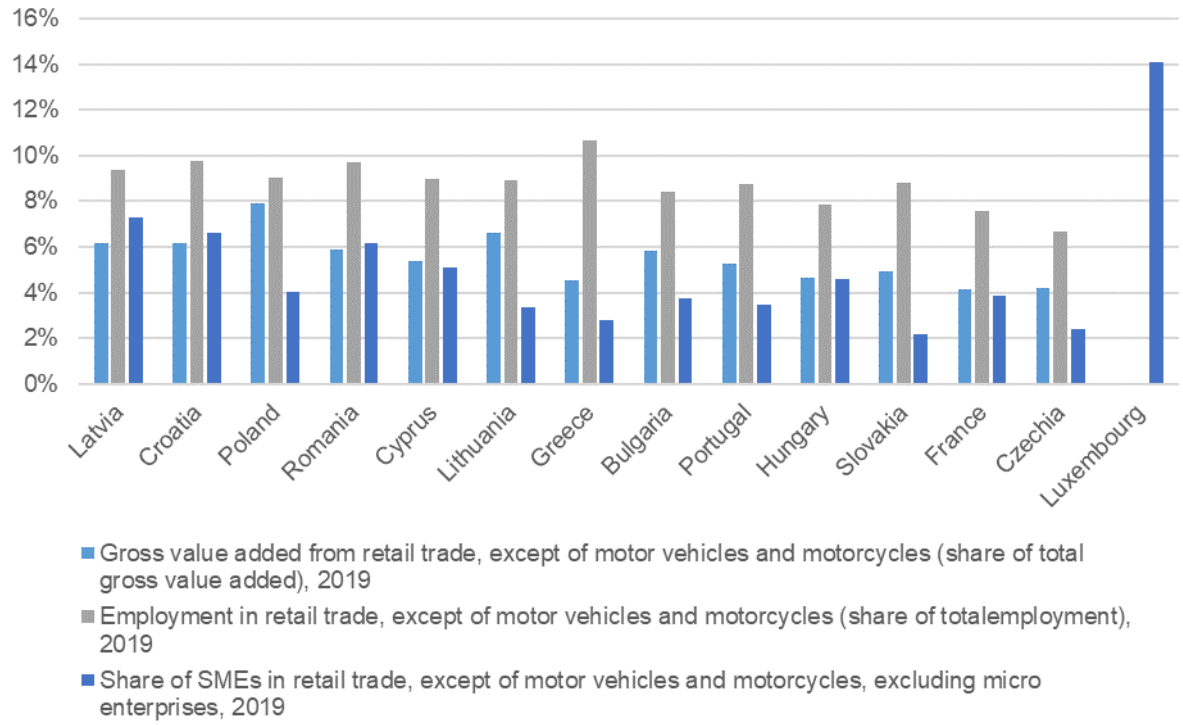
Figure 60. Digital Intensity Score for enterprises in the construction industry, 2021



Source: own elaboration based on data form Eurostat: Tables isoc_e_dii: Digital Intensity, for the [10_F41_43] 'Construction' industry.

Note: the figure is sorted by the sum of the Very Low and Low Digital Intensity Index scores.

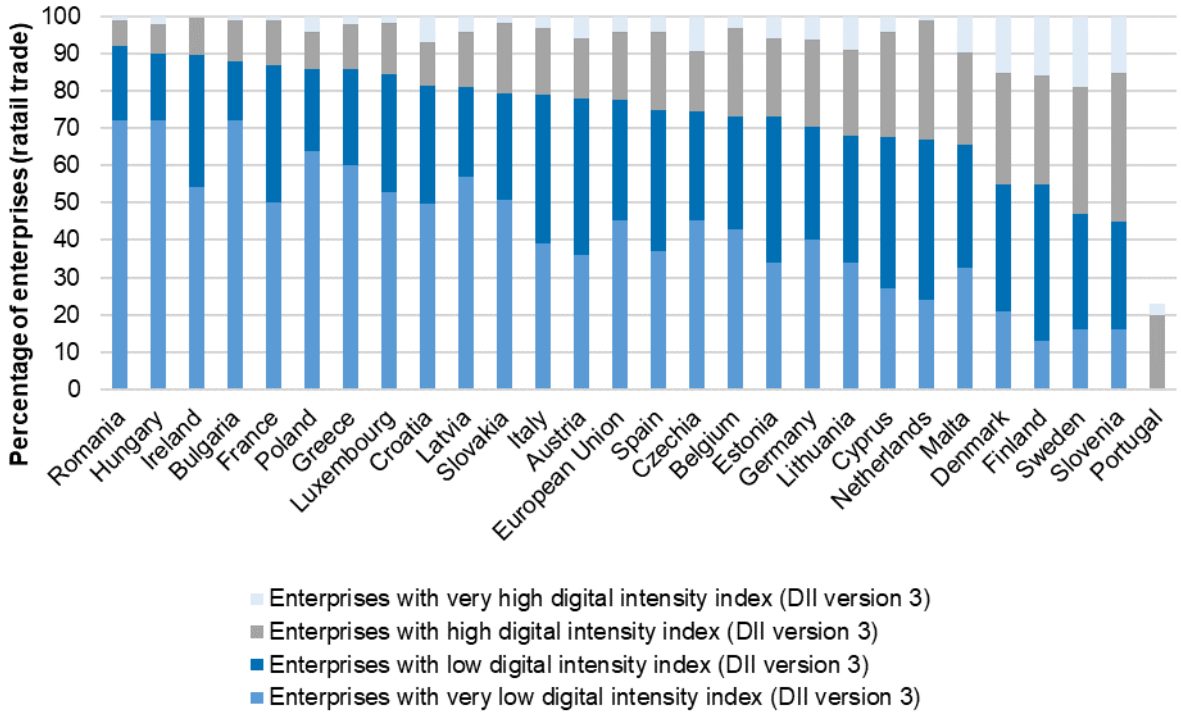
Figure 61. Key indicators regarding the retail industry, by country



Source: own elaboration based on data from Eurostat: Tables NAMA_10_A64, NAMA_10_A64_E and SBS_SC_SCA_R2.

Note: the figure is sorted by the average of the three indicators. The late st year of available data was chosen. Certain data are missing for Luxembourg.

Figure 62. Digital Intensity Score for enterprises in the retail industry, 2021



Source: own elaboration based on data form Eurostat: Tables isoc_e_dii: Digital Intensity, for the [10_G47] 'Retail trade, except of motor vehicles and motorcycles' industry.

Note: the figure is sorted by the sum of the Very Low and Low Digital Intensity Index scores. Certain data are missing for Portugal.

Annex 3. List of factors for gap analysis

Table 5. Factors for the gap analysis

Type	Dimension	Factor/impact	Description
Industry-level factors	Policy	Policy and regulatory environment	Assessment of the policy and regulatory environment includes analysis of existing policy and strategic planning documents (for example, industry digitalisation strategies), the regulatory environment and support programmes.
		Governance	Governance looks at decision-making bodies on industry digitalisation, international cooperation mechanisms and industry stakeholder involvement in decision-making.
		Education, support, and knowledge transfer	Education, support, and knowledge transfer includes analysis of existing support organisations and mechanisms (including DIH activities, competence centres, industry clusters, prototyping platforms, accelerators) and mechanisms for information and best practice sharing.
	Social	Human capital	Human capital concerns the availability and characteristics of a workforce with the necessary skills to implement and use digital technologies, as well as possibilities for the labour force to obtain those skills through formal or informal education.
		Consumers	Consumers are analysed based on their expectations and readiness (for example, in terms of digital skills and trust in digital technologies) to interact with businesses using digital technologies, as well as demand for digital products and services.
	Economic	Digital infrastructure	Digital infrastructure concerns the availability of the necessary infrastructure (for example, fast-speed broadband) to use digital technologies.
		Financing	Financing includes company investment, access to external financing and public support for digitalisation.
		Innovation ecosystem	This factor analyses incentives and barriers for innovation in digital technologies and innovation activity (for example, investment in research and development (R&D), introduction of new products or processes, patent application dynamics, digital industrial platforms).
External shocks		Supply chain impacts	Supply chain impacts may include availability, price and barriers or delays in obtaining inputs for the industry.
		Labour force impacts	Labour force impacts may include, for example, changes in employment, need to cease or alter processes due to COVID-19-related restrictions and changes in employee expectations regarding remote work and flexible work arrangements.
		Economic and consumer demand impacts	This impact relates to changes in consumer demand and economic environment, for example, increased inflation, changes in consumer sentiment and expectations.

Source: compiled by the research team.

Annex 4. Key economic indicators for Romania's construction industry

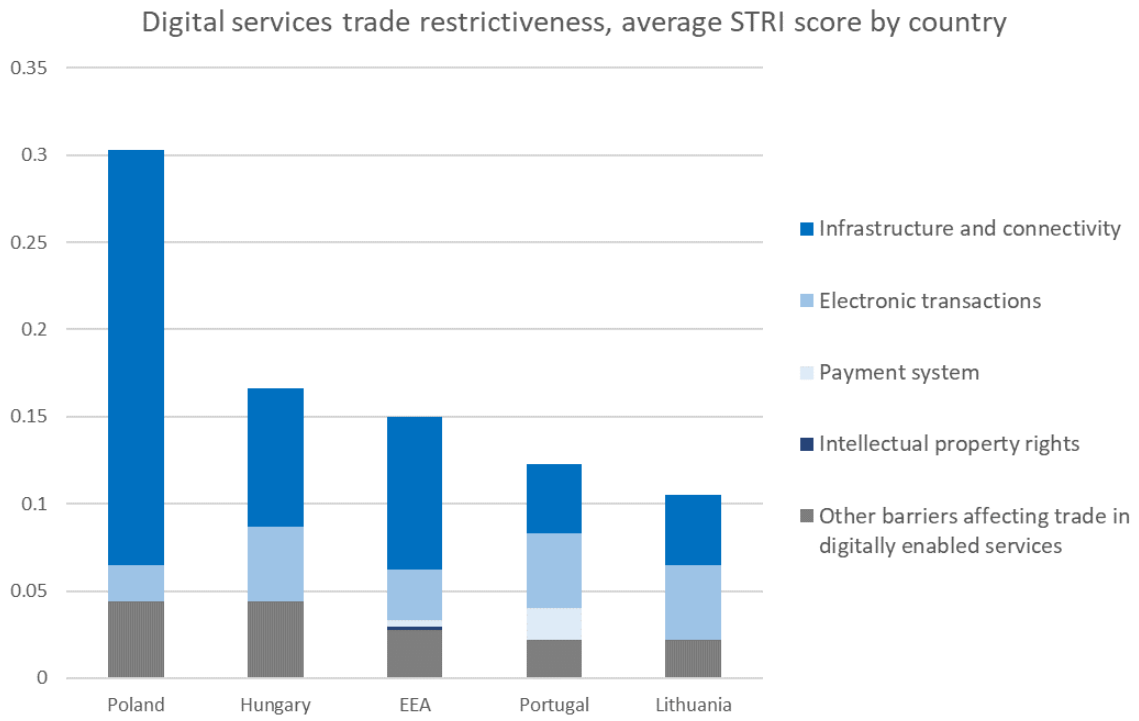
Table 6. Economic indicators for Romania's construction industry

Year		2017	2018	2019	Dynamic 2017-2019
Number of enterprises	number	52,792	55,978	60,102	+ 12%
from which are SMEs	number	52,716	55,900	60,021	+12%
% of SMEs	%	99.9	99.9	99.9	-
Staff headcount on 31 December 2019	employees	361,144	368,959	459,271	+21%
from which are SMEs	employees	317,661	326,410	412,517	+23%
% of SMEs	%	88	88.5	89.8	+2%
Average number of employees	employees	354,191	356,269	396,190	+11%
from which are in SMEs	employees	310,935	315,428	353,441	+12%
% of SMEs	%	87.8	88.5	89.2	+2%
Turnover	Mil. RON	74,841	88,322	112,564	+34%
from which are SMEs	Mil. RON	62,662	76,416	97,180	+26%
% of SMEs	%	83.7	86.5	86.3	+3%
Production of the exercise	Mil. RON	74,508	89,387	114,740	+35%
from which are SMEs	Mil. RON	62,026	77,388	98,522	+37%
% of SMEs	%	83.2	86.6	85.9	+3%
Direct exports	Mil. RON	743	645	678	-10%
from which are SMEs	Mil. RON	348	407	530	+34%
% of SMEs	%	46.8	63.1	78.2	+40%
Gross value added at factor cost	Mil. RON	20,611	26,139	36,003	+43%
from which are SMEs	Mil. RON	18,451	24,062	32,538	+43%
% of SMEs	%	89.5	92.1	90.4	+0.01
Staff costs	Mil. RON	11,482	13,116	18,352	+37%
from which are SMEs	Mil. RON	8,987	10,491	15,304	+41%
% of SMEs	%	78.3	80	83.4	+6%
Gross operating surplus	Mil. RON	9,129	13,023	17,651	+48%
from which are SMEs	Mil. RON	9,465	13,571	17,234	+45%
% of SMEs	%	103.7	104.2	97.6	-6%
Gross result for the year	Mil. RON	5,454	9,755	12,757	+57%
from which are SMEs	Mil. RON	5,496	10,011	12,692	+57%
% of SMEs	%	100.8	102.6	99.5	-1%

Source: National Institute of Statistics (2021). Small and medium enterprises in the Romanian economy, 2019. p.92. Available at: https://insse.ro/cms/ro/content/%C3%AEntreprinderi-mici-%C5%9Fi-mijlocii-%C3%AEn-economia-rom%C3%A2neasc%C4%83

Annex 5. Digital services trade restrictiveness

Figure 63. Digital services trade restrictiveness, average STRI score by country and policy



Source: own elaboration based on OECD (2021), STRI.