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Artificial Intelligence 4.0 First interim report: from launch to implementation stage

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First interim report: from launch to implementation stage

Steering group of the Artificial Intelligence 4.0 programme

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Abstract

On 13 November 2020, Minister of Economic Affairs Mika Lintilä appointed a steering group led by Jussi Herlin to prepare an action plan for Finland to speed up the introduction of artificial intelligence and to promote the fourth industrial revolution. The action plan implements the strategy of green and digital recovery following the COVID-19 crisis and responds to Finland's specific challenges related to digitalisation, such as the relatively low level of digital investment, slow reform of value creation among SMEs and delays in strategic investments to promote the fourth industrial revolution in Finland.

The preparation and launch of the program have been guided by the view that the most significant effects of artificial intelligence will become visible when it is applied as part of a wider economic, technological and social change, the so-called fourth industrial revolution.

The report is the first interim report of the program. It describes the current state of the fourth industrial revolution and progress of advanced digitalisation in Finland. This is done by analysing surveys and statistics on digitalisation of companies, with a particular interest in the digitalisation policy framework of the European Commission.

In addition, the report makes a proposal for a comprehensive target state that should be pursued when accelerating digitalisation during the Fourth Industrial revolution in Finland. The development of digitalisation should be done in cooperation between companies, research and academia as well as training institutes and public organisations. The OKR-method is used to present the vision and objectives leading to the target state, the preliminary key results and a plan for the thematic working groups.

Keywords	enterprises, means of livelihood, artificial intelligence, manufacturing industry, digitalisation, industry, businesses, green transition, twin transition, fourth industrial revolution, industrie 4.0		
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Tekoäly 4.0 -ohjelma
Ensimmäinen väliraportti: käynnistysvaiheesta toteutusvaiheeseen

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Kieli	englanti	**Sivumäärä**	80

Tiivistelmä

Elinkeinoministeri Mika Lintilä asetti 13.11.2020 Jussi Herlinin johtaman ohjausryhmän valmistelemaan toimenpideohjelmaa Suomelle tekoälyn käyttöönoton vauhdittamiseksi ja edistämään ns. neljättä teollista vallankumousta, jollaisena digitalisaatio tuotantoa ja palveluja mullistavana voimana nähdään. Ohjelma sai asettamisen yhteydessä nimekseen Tekoäly 4.0.

Ohjelma toteuttaa omalta osaltaan Covid-19 -kriisin jälkeisen vihreän ja digitaalisen toipumisen strategiaa. Se vastaa Suomen erityisiin digitalisaatiohaasteisiin, joita ovat digi-investointien verraten matala taso, pk-yritysten arvonluonnin uudistumisen hitaus ja viiveet strategisissa satsauksissa neljännen teollisen vallankumouksen edistämiseen Suomessa.

Raportti on ohjelman 1. väliraportti. Siinä kuvataan neljännen teollisen vallankumouksen ja siihen liittyvän edistyksellisen digitalisaation nykytilaa ja kehitysnäkymiä Suomessa ja maailmalla analysoimalla yritysten digitalisaatiota koskevia kysely- ja tilastotietoja sekä erityisesti EU-komission digitalisaatiopolitiikan kehystä.

Raportissa tehdään lisäksi ehdotus kokonaisvaltaisesta tavoitetilasta, johon Suomessa tulisi pyrkiä neljättä teollista vallankumousta edistävän digitalisaation kehittämisessä ja hyödyntämisessä yritysten, tutkimus- ja koulutuslaitosten ja julkisten organisaatioiden yhteistyönä. OKR-menetelmällä esitetään tavoitetilaan johtavat kehittymistavoitteet, alustavat avaintulokset sekä suunnitelma niitä tarkentaviksi ja toimeenpaneviksi alatyöryhmiksi.

Asiasanat	yritykset, elinkeinot, tekoäly, valmistava teollisuus, digitalisaatio, teollisuus, vihreä siirtymä, kaksoiskäänne, neljäs teollinen vallankumous, industrie 4.0		
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Artificiell intelligens 4.0
Första delrapporten: Från startperioden till verkställandet

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Referat

Näringsminister Mika Lintilä tillsatte den 13 november 2020 en styrgrupp som leds av Jussi Herlin för att bereda ett åtgärdsprogram som syftar till att påskynda ibruktagandet av artificiell intelligens i Finland och främja den s.k. fjärde industriella revolutionen, det vill säga utnyttjande av digitalisering för att revolutionera produktionen och tjänsterna. Åtgärdsprogrammet fick namnet Artificiell intelligens 4.0.

Programmet genomför för sin del strategin för en grön och digital återhämtning från covid-19-krisen. Målet med åtgärderna är att hantera de digitaliseringsutmaningar som är specifika för Finland. Till dessa hör den relativt låga nivån på digitala investeringar, den långsamma förnyelsen av små och medelstora företags värdeskapande och fördröjningarna i Finlands strategiska satsningar på att främja den fjärde industriella revolutionen.

I rapporten beskrivs den fjärde industriella revolutionen och det nuvarande tillståndet och framtidsutsikterna för den framstegsvänliga digitaliseringen i Finland och i världen genom att analysera statistik gällande digitaliseringen i affärsverksamhet hos företag och särskilt utvecklingen av EU-kommissionens digitaliseringspolitik.

I rapporten läggs också fram förslag till heltäckande strategiska mål, som Finland borde sträva till i utvecklandet av en digitalisering som driver den fjärde industriella revolutionen och för att dra nytta av samarbete mellan företag, forsknings- och utbildningsenheter samt offentliga organisationer. Med hjälp av OKR-metoden presenteras utvecklingsmål som leder till de strategiska målen, preliminära nyckelresultat samt en plan för underarbetsgrupper som har för uppgift att specificera och verkställa målen.

Nyckelord	företag, näringsgrenar, artificiell intelligens, tillverkningsindustrin, digitalisering, industri, grön övergång, twin transition, fjärde industriella revolutionen, industrie 4.0		
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Contents

1 Artificial Intelligence 4.0 programme: what is it all about?

1.1 Initiated to speed up AI deployment

On 13 November 2020, Minister of Economic Affairs Mika Lintilä appointed a steering group led by Jussi Herlin to prepare a Finnish action programme to speed up the deployment of artificial intelligence and to promote the 'fourth industrial revolution', a term used to describe digitalisation as a force that transforms production and services. At the time of its launch, the programme was named Artificial Intelligence 4.0.

The programme contributes to implementing the Strategy for green and digital recovery in the aftermath of the COVID-19 crisis. It responds to Finland's particular challenges in the field of digitalisation, which include a relatively low level of digital investment, slow renewal of value creation in SMEs, and delays in strategic investments that would promote the fourth industrial revolution in Finland.

The purpose of the programme is to increase digital investments that promote productivity and sustainability, to diversify the manufacturing industry's ecosystems and services through new value creation and partnerships, and to strengthen Finland's position in actions aiming to increase Europe's strategic autonomy.

Four tasks were identified for the steering group of the Artificial Intelligence 4.0 programme:

1. To form a *situation picture* of the current state of the fourth industrial revolution and advanced digitalisation associated with it in Finland and globally.
2. To prepare a proposal for *an overall target state* which Finland should aim for in the development and use of digitalisation that promotes the fourth industrial revolution, drawing on the digitalisation strategies and roadmaps produced for different sectors and in cooperation between companies, research institutes, educational institutions and public organisations.
3. To make proposals for *actions* needed in the current government term to attain the target. Particular attention should be paid to renewing SMEs' value creation, increasing digital investments that support the achievement of the sustainability goals, and European cooperation in building strategic capabilities.
4. To prepare an *implementation model* that ensures the efficient execution of the action programme as well as to guide its implementation.

In the course of its work last winter and in the early spring, the steering group produced a more detailed definition of the programme's priority areas and actions. They are set out in Chapter 3 of this publication.

From the start, it was clear that Finland has a great deal of unused potential in the field of AI. Low investment rates, sluggish productivity development and an SME sector with potential for development, together with ambitious sustainable development goals and enabling basic structures, is a promising, albeit challenging, combination in terms of reaching the global leading edge. In order to fulfil this potential and achieve the desired change, Finland will need more effective strategic collaboration, public-private partnerships as well as synergistic use of different organisations' and national, European and regional actors' resources.

1.2 Underpinned by Finland's Age of Artificial Intelligence programme

In May 2017, Finland was one of the first countries to launch the preparation of a national AI strategy. Finland's Age of Artificial Intelligence programme was a strategic period of acceleration of around three years, during which the goal of Finland becoming a global leader in AI application was set. The first roadmap of the strategy was published in October 2017, and the programme reported on its results in March 2019. This Artificial

Intelligence 4.0 programme is based on the outcomes of Finland's Age of Artificial Intelligence programme and continues the work achieved by it.

The ultimate goal of Finland's Age of Artificial Intelligence programme was to secure the country's wellbeing also in an era of wide-spread AI use. The programme prioritised three areas and key challenges, based on which key actions marks were prepared to ensure that

- the potential of AI is utilised to guarantee the competitiveness and economic growth of **businesses**,
- the **public sector** can make use of the possibilities offered by AI in its activities and thus produce high-quality public services effectively,
- the social structures will adapt to the changes brought about by AI and that Finland will continue to provide a **well-functioning society and wellbeing** for its citizens.

The final report of the programme, Leading the way into the age of artificial intelligence, highlighted the following key actions:

1. Clarify the rules of how data is used from the perspectives of companies, society and users. Provide support for the use of data by means of legislation, agreements and self-regulation of industries.
2. Support the development of significant test environments and testbeds, and international cooperation. Integrate the operations as part of the Finnish Digital Innovation Hub network.
3. Recognise the business potential of different types of ecosystems and the B2B market and develop solutions for using data in them.
4. Continue AI accelerator style operations based on the lessons learned and seek opportunities to expand the operations. Ensure Finland's ability to secure major strategic investments in AI and RDI investments in competences.
5. On the basis of experiences gained, create an extensive provision of online courses to those in working life, thus providing an opportunity for the adult population to supplement and renew their competences. Explore whether every Finn in working age could be provided with a learning voucher or account, which would create a well-functioning adult education market in Finland.
6. Ensure human-centric introduction of artificial intelligence and the implementation of ethical principles in the public sector through the AuroraAI project. Encourage companies and public-sector actors to introduce ethical self-regulation and to share best practices.
7. Introduce the digital economy, founded on artificial intelligence, data and platform economy, as one of the key themes of Finland's EU Presidency.

8. Monitor how the implementation of the Artificial Intelligence Programme's objectives is advancing. The responsibility for the monitoring should belong to a monitoring group with representatives from both the private and public sectors or a broader cooperation forum promoting the digitalisation of business.

Most of the recommendations made by the programme continue to be relevant. They have also been widely implemented in different branches of government and organisations in the public and the private sector alike. The Artificial Intelligence 4.0 programme now adds detail to these recommendations and promotes their implementation, focusing on improving the operation and operating preconditions of the manufacturing industry.

1.3 Operating model of the programme

The implementation of the Artificial Intelligence 4.0 programme is directed by a steering group, in which the authorities, companies of different sizes operating in a variety of sectors as well as higher education institutions are represented:

- Chair: Jussi Herlin, Kone Oyj
- Vice Chair: Ilona Lundström, Director General, Ministry of Economic Affairs and Employment
- Members: Cristina Andersson, Airawise Oy; Milja Köpsi, Mimmit koodaa; Minna Lanz, University of Tampere; Anni Ronkainen, Kesko Oyj; Teemu Roos, University of Helsinki; Markku Räsänen, IQM Finland Oy; Samuli Savo, Stora Enso Oyj; Ville Miettinen, Varjo Oy; Eeva Raita, Futurice Oy, and Moaffak Ahmed, Kasvuryhmä
- Secretariat: Petri Räsänen, Ministry of Economic Affairs and Employment; Toni Mattila, Business Finland; Riikka Virkkunen, VTT Technical Research Centre of Finland.

The steering group's term of office began on 13 November 2020 and will continue until the end of the electoral period.

The programme has three main phases: preparation, launch and implementation. The key components of the preparation phase (from autumn 2019 till November 2020) were drafting carried out by public servants under the auspices of a preparatory secretariat consisting of MEE Corporate experts; compiling a sustainable digitalisation strategy for

industry based on MDI Oy's facilitation and an ethnographic interview study; and a study project titled Strategic options for data-based value creation[1].

The launch phase (from November 2020 till April 2021) consisted of steering group workshops which formed a situation picture based on the preparatory materials produced earlier, created a vision, and identified the objectives and key results leading to the realisation of the vision.

As the implementation phase began in spring 2021, five subgroups were established to support the steering group and continue the work started by it at the practical level. In addition to the thematic sub-groups, the steering group's work is supported by a communication team, the main task of which is to encourage more concrete societal discussion on companies' digital transition and sustainable digitalisation.

Subgroups:

1. SMEs' digital capabilities and innovation cooperation, Chair Joonas Mikkilä, Federation of Finnish Enterprises
2. Effective EU cooperation, Chair Samuli Savo, Stora Enso Oyj
3. Technology leadership, Chair Teemu Roos, University of Helsinki
4. Digital green transition, Chair Cristina Andersson, Airawise Oy 5. Communication and making sense of the digital transition, Chair Eeva Raita, Futurice Oy.

The management by objectives framework of the OKR model2 is applied in the programme: its steering system is based on Objectives and Key Results. The attainment of the qualitative objectives set for the programme will be promoted by quantitative key results, which measure both inputs and outcomes in a balanced way. The methods for attaining the programme's main objectives and the indicators that measure their achievement will be defined more accurately by the thematic subgroups based on this programme.

1 Paavola, Heli – Seppänen, Marko – Eloranta, Ville 2021: Strategic options for data-based value creation. Publications of the Ministry of Economic Affairs and Employment 2021:3. http://urn.fi/URN:ISBN:978-952-327-667-3

2 Niven, Paul R. & Lamorte, Ben 2016: Objectives and Key Results: Driving Focus, Alignment, and Engagement with OKRs. John Wiley & Sons, Incorporated 6 September 2016.

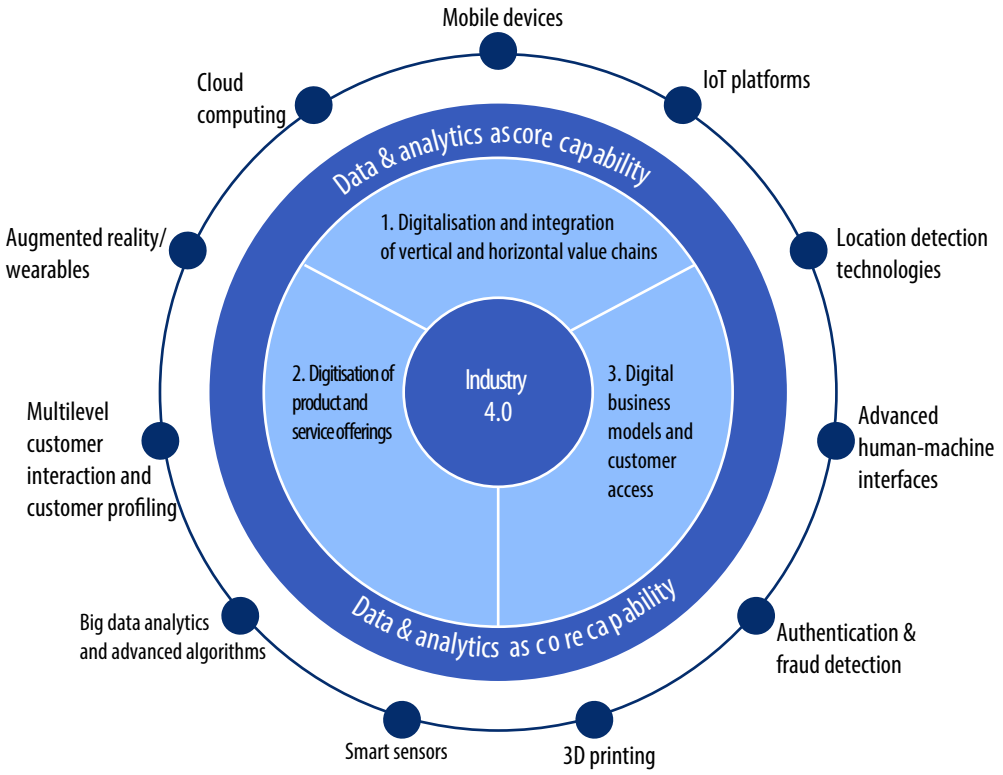
2 Artificial intelligence and the fourth industrial revolution: the situation picture

The preparation and launch of the programme were guided by the view that the most significant effects of AI on promoting business will become visible as part of a wider economic, technological and social change, or the fourth industrial revolution.

The fourth industrial revolution will regenerate the structures of economy, break down boundaries between sectors and alter their traditional division of labour and character. It will give rise to business ecosystems of a new type, in which the material and immaterial value creation enabled by seamless digitalisation will combine into customer-oriented innovation, production and service processes. In addition to the manufacturing industry, the fourth industrial revolution will extend to other sectors, including expert services, software development, trade and logistics as well as society's infrastructures and energy production.

While AI is one of the technologies enabling the fourth industrial revolution, others include ultra-fast wireless data connections (5G/6G), the Internet of Things (IoT), additive manufacturing (3DP), augmented and virtual reality (AR/VR), and high-performance and quantum computing (see Figure 1). When these technologies are combined with data utilisation they will, among other things, enable real-time management of value chains, new digital products and services, and new customer-oriented business models.

Figure 1. Digital technologies as enablers of the fourth industrial revolution. Industry 4.0 framework and digital technologies that support it



Industry 4.0 framework inputs of digital technologies (Global Industry 4.0, Survey, 2016

The fourth industrial revolution is not only a technological and economic transformation but also one that will bring about deep and diverse changes in society. In recent years, resolving global environmental and sustainability challenges with the aid of technologies has also been included in the content of the fourth industrial revolution.3 Consequently, now is the time to promote sustainable digitalisation as part of the fourth industrial revolution and to examine AI as one of its elements.

3 World Economic Forum 2021: Fourth Industrial Revolution. https://www.weforum.org/agenda/archive/fourth-industrial-revolution

2.1 Artificial intelligence and the technologies that support it in the green transition

Finland has set the goal of becoming carbon neutral by 2035 and being the first fossil free welfare society. Consumer habits are also changing, which generates a growing demand for products manufactured following sustainability principles. Consequently, not only industrial productivity and international competitiveness but also climate objectives are significant drivers of industrial regeneration.

AI and digitalisation, on the other hand, are key methods for rethinking the manufacturing industry and thus achieving the objectives of the 'twin transition'. AI and digitalisation can help Finnish companies not only reduce their carbon footprint but also, and above all, use their products and services to support other actors in attaining their environmental objectives. The market for such solutions is growing at an increasing rate, and gaining a foothold in it in time is a huge opportunity for Finnish companies.

A European Commission publication[4] identifies key technologies for shaping the sustainable digital transition (Table 1).

In the manufacturing industry, AI will have positive impacts especially on proactive maintenance, process automation and control, delivery chain management and, in general, improving efficiency, flexibility and safety and reducing costs. Companies will be able to get their products into the market proactively, faster, at a lower cost and with a better quality. Other examples include anticipating trends in global markets, developing new business models and services and speeding up product development.

Robotisation is also a key method for improving the productivity and quality of industrial work. Robots will become more widespread as technologies mature and prices are reduced. Modular, multi-use solutions have become more common, which means that robots' ability to perform multiple tasks has improved. This will lower the threshold for investing in them, even in smaller companies. Moving robots and ones that can work together with humans will proliferate.

4 Shaping the digital transformation in Europe, 2020

Table 1. Key technologies for European economy and society

THE NEW DIGITAL REVOLUTION
High-impact technologies that will shape the European economy and society

Enabling technologies and infrastructure	High-impact applied technologies
ARTIFICIAL INTELLIGENCE	**ADVANCED ROBOTICS**
Intelligent machines that work and react in a similar fashion to humans (incl. machine learning, natural language processing, computer vision, virtual assistants, AI robotics)	Advanced robots capable of complex, previously non-automatable, tasks
BIG DATA ANALYTICS	**AUTONOMOUS MOBILITY (CAVs)**
Use of large and varied data sets to uncover information incl. hidden patterns, unknown correlations, market trends and customer preferences	Autonomous and near-autonomous vehicles, incl. UAVs (drones)
QUANTUM AND HIGH-PERFORMANCE COMPUTING	**SMART CITIES**
Supercomputers with capacity to solve large scale, complex analytical tasks; use of quantum mechanics (via qbits) to increase computing power	Cities which incorporate ICT to enhance efficiency, quality of life, the economy and other performance metrics
INTERNET OF THINGS (INCL. EDGE COMPUTING)	**ADDITIVE MANUFACTURING**
Multi-layer technology that enables management, and automation of connected devices	Creating 3D, solid objects from a digital file by adding layer-upon-layer of material
NEXTGEN INTERNET AND INFRASTRUCTURE	**VIRTUAL AND AUGMENTED REALITY**
Infrastructure enabling next generation of technology: e.g. 5G and beyond, digital twin, highspeed WLAN	Software-created, fully artificial environments/ technology that superimposes a computer-generated image on a user's view of the real world
CLOUD COMPUTING	**DIGITAL ENERGY INNOVATIONS AND SUSTAINABILITY**
On-demand computing resources ran on distant computers, connected to users via the internet	New digital technologies enabling innovative energy applications: storage, smart grids, renewables
DIGITAL PLATFORMS	**DIGITALLY ENABLED BIOTECHNOLOGIES**
Digital platforms on which outside firms can develop their own activity or develop their own technologies	Group of technologies enabling new applications of biological innovation (e.g. biohacking, next-gen genomics)
DISTRIBUTED LEDGER TECHNOLOGY	**ADVANCED MATERIALS**
Peer-to-peer network with unique member digital signatures: all transactions are recorded by the entire network, notifying the network of a breach	New materials developed to obtain superior performance (e.g. graphene) power

The seamless interoperability of fast data networks, cloud services and AI will play a key role in the digital transformation. 5G technology will enable significantly faster data transfers and open up possibilities for new digital products and services. Network architectures of the future and developing concepts associated with 6G systems will also be important.

Quantum technology and its applications will transform conventional industries while creating a completely new sector. Quantum computing, and also the advancement of today's supercomputers, will enable the modelling and solving of increasingly complex systemic problems. Quantum computing, in particular, is expected to bring about a major productivity leap in different industries. The first applications of quantum computing are believed to be different optimisation tasks, for example in the financial market, industrial processes and materials development.

Quantum computers can also be expected to influence the way in which AI is used in the future. Additionally, quantum computing and other technologies will revolutionise telecommunication and information security: the emerging Quantum Internet will enable a more secure information network with higher computing power. Quantum technology sensors will also make possible more accurate measurements and new types of measurement applications, which will produce data for the Quantum Internet to process. Quantum computers are currently undergoing intensive development, and advancement will be needed in several fields of science and technology, including superconductors and low temperature physics, microelectronics and photonics.

The need for reliable digital infrastructure as well as more frequent cyberattacks and attempts at influencing by information will stress the importance of cyber security. Continuous focus on information security will also be needed to enable the large-scale use of AI and telecommunication in industry. Cyber security is currently based on encryption methods, some of which can easily be broken by quantum computers. The solutions lie in new quantum-proof cryptography, standards applicable to it and security assessment methods. They can guarantee cyber security well into the future. It is possible that current forms of encryption used on the Internet can be broken by means of quantum technologies in the future. These technologies will enable the development of new cryptographic techniques, for example those relying on QKD methods, which means that information security could also be ensured when the possibilities of breaking encryption by quantum computers become more widespread.

2.2 Situation picture of business digitalisation in Finland: state of play in companies

2.2.1 Finland's degree of digitalisation today

Finland is one of the pioneers and long-time leaders of digitalisation development in the EU. For the last two years, Finland has ranked first in the EU's DESI index (Digital Economy and Society Index[5]), which measures the advancement of digitalisation in society on a large scale. In the DESI index, human capital, connectivity (apart from fixed broadband coverage) and digital public services emerge as Finland's particular strengths.

The DESI index also monitors the integration of digital technology in companies[6]. In the DESI2020 comparison of European countries, Finland came second after Ireland in business digitalisation. Finnish companies rank highly in all areas of the index and are ahead of Finland's reference countries, especially in the use of cloud services. The use of artificial intelligence by Finnish companies is third most common in Europe. In 2020, 12% of Finnish companies, employing more than 10 people, reported using some sort of artificial intelligence application, whereas the EU average is 7%[7]. It appears that the use of digital tools will continue to make strong headway in Finland, as in SMEs' current plans, investments associated with basic level digitalisation are the most common.[8]

The **Digibarometer**[9], a study conducted by ETLA Economic Research, evaluates how well individual countries utilize digitalization. It compares 22 small and high income level countries, Finland's neighbouring countries and key large countries within and outside of the EU. Finland is also one of the leading countries in the Digibarometer comparison and came second in this index in 2020. This comparison also finds the civic and the public sector as Finland's strengths, and the country had also improved its placement in these areas. In the company sector indicators, however, Finland only came seventh overall.

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5 European Commission 2021: Digital Economy and Society Index. https://digital-agenda-data.eu/datasets/desi/visualization

6 The section on the integration of digital technology includes social media use, selling online and the use of enterprise resource planning (ERP) and customer relationship management (CRM) software, cloud services and big data

7 Eurostat News. Artificial intelligence in EU enterprises. https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20210413-1. Referred to on 13 April 2021.

8 Kivikoski, Jouni – Kauppinen, Tatu 2021: Pk-yritysten opit digitalisaatiosta 2020: Miten digitalisointi on auttanut pk-yrityksiä menestymään? Priot Konsultointi Oy https://www.yrittajat.fi/sites/default/files/tutkimus_pk_yritysten_digitalisaatiosta_2020.pdf

9 Mattila, Juri et al. 2020: Digibarometri 2020 (Digibarometer 2020): Kyberturvan tilannekuva Suomessa. Etlatieto 2020. Download at: https://www.etla.fi/julkaisut/digibarometri-2020-kyberturvan-tilannekuva-suomessa/

Significantly, Finnish companies lost three places in this ranking and, in particular, as many as six places regarding the deterioration of preconditions for digitalisation.

A survey[10] addressed to companies by the Confederation of Finnish Industries examined the challenges of digitalisation and especially the skills needs it creates. According to this survey, 90% of companies consider that digitalisation affects their business but only 9% feel they are forerunners in this matter. Companies need competence associated with pioneering, especially in communication, RDI, and sales and marketing. Over two years (2017–2019), the proportion of pioneers has gone up slightly.

The COVID-19 pandemic has speeded up the progress of digitalisation as, in particular, teleworking, videoconferencing and online selling have become more widespread and the data connections they require have been improved[11]. Routine use of digital tools and the improved infrastructure are likely to also lower the threshold for the deployment of more advanced digitalisation. As a result of the pandemic, companies have paid increasing attention to resilience and crisis tolerance in their activities, which is likely to motivate more investments in process digitalisation and improved information security[12]. The considerable inputs in digitalisation included in recovery packages, such as the Sustainable Growth Programme for Finland[13], will provide further incentives.

However, so far there is no clear evidence of how deeply and permanently the pandemic will affect companies' ways of and capabilities for using digitalisation innovatively to rethink their business and value creation.

2.2.2 Significant disparity in digitalisation development

The business field is divided in terms of digitalisation. SMEs are making considerably slower progress in the introduction of digital technologies and operating models than

10 Tuuliainen, Mika – Heikinheimo, Riikka 2019: EK:n yrityskyselyn tulokset digitalouden osaamistarpeista 2019. https://ek.fi/wp-content/uploads/Digikysely_infografiikka_2019_final.pdf

11 Erkkilä, Merita – Mäntyniemi, Maaria 2020: Impetus to growth and wellbeing through the digital leap forward: Digital measures in the aftermath of the coronavirus crisis – final report of the working group. http://urn.fi/URN:ISBN:978-952-243-590-3

12 In US industries, for example, 49% of procurement managers say they have significantly increased investments in digitalisation following the crisis (Preview of the 2021 MHI Annual Industry Report – Innovation Driven Resilience)

13 Government 2021: Sustainable Growth Programme for Finland: Preliminary Recovery and Resilience Plan. http://urn.fi/URN:ISBN:978-952-383-583-2

large companies.[14] In particular, small companies are lagging significantly behind larger ones in data analytics, IoT use and using ICT professionals. On the other hand, there are also major differences between SMEs. Digital sector start-ups typically are pioneers of digitalisation, whereas in SMEs linked to export companies and markets in conventional sectors, progress is somewhat slower. Low-productivity sectors companies operating in the domestic market usually form the rear guard.

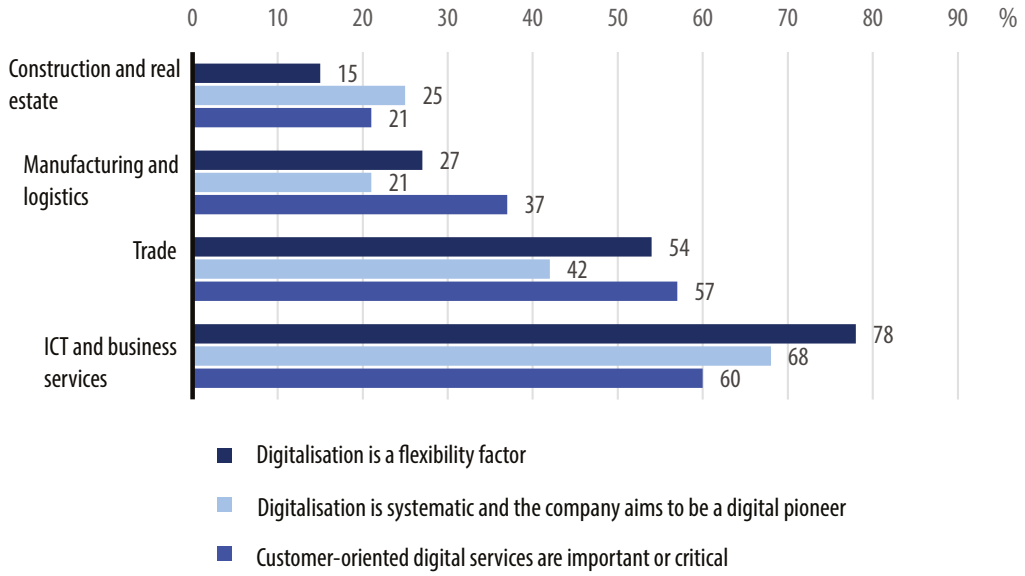
There also are major differences in digitalisation development between sectors. ICT and business service companies make the greatest investments in digitalisation and use it the most, closely followed by the trade sector[15]. Company investments in digitalisation are considerably less common in industry, logistics and construction. On the other hand, the piece goods manufacturing industry is deploying advanced technologies ahead of other sectors. Sectors also differ regarding their growth orientation. A recent survey found that, whereas 8% of SMEs on average are seeking strong growth, this figure in manufacturing was as high as 15%.[16]

14 Statistics Finland 2021: Use of information technology in enterprises 2020. https:// ek.fi/ wp-content/uploads/Digikysely_infografiikka_2019_final.pdf; For example, 78% of all large companies have Enterprise Resource Planning (ERP) software, whereas this figure for SMEs is 33%. Similarly, a Customer Relation Management (CRM) system is used in 62% of large companies but only 32% of SMEs. Additionally, SMEs are making limited use of the possibilities offered by online trading: only 18% have online sales (cf. 39% of large companies), and as few as 8% have international sales. There are also differences in the use of cloud services and big data: 38.5% of large companies rely on advanced cloud services and 32.7% use big data, whereas most SMEs said they do not deploy these technologies yet. Only 17% of SMEs use cloud services and 12% big data analytics.

15 As an example, service sector companies in Finland are more aware of the significance of digitalisation for business than industrial companies: in the services sector, 41% of companies consider digitalisation essential for the company's operation, whereas this view is held by 25.4% of industrial companies. A survey published by the Federation of Finnish Enterprises and Elisa Oyj in 2019 shows that digital skills are a challenge to many Finnish SMEs. While one out of two SME managers has completed three or more digitalisation projects in the last two years, most of them were strongly associated with the digitalisation of marketing and sales. The second largest focus area is digitalisation of office systems. Only slightly over a third considered themselves highly skilled users of digital resources. The greatest challenges were a lack of time and difficulties in finding suitable ways of improving digital skills.

16 Federation of Finnish Enterprises 2021: SME Barometer 1/2021. https://www.yrittajat.fi/ suomen-yrittajat/tutkimukset/pk-yritysbarometrit/pk-yritysbarometri-12021-642333

Figure 2. Differences between sectors in a survey on digitalisation conducted in spring 2021 (Priot Oy, Elisa and the Federation of Finnish Enterprises), % of business respondents.



Digitalisation is an important enabler of and precondition for growth in companies. Companies' digital capabilities are often combined with other growth-enabling capabilities, including innovation cooperation and networking skills17. Growth-seeking companies invest in digitalisation and consider it important: the better the company's digital capabilities are, the more likely it is to grow.

One of the surveys used to monitor the state of innovation cooperation, the SME Barometer, indicates that currently of Finnish SMEs

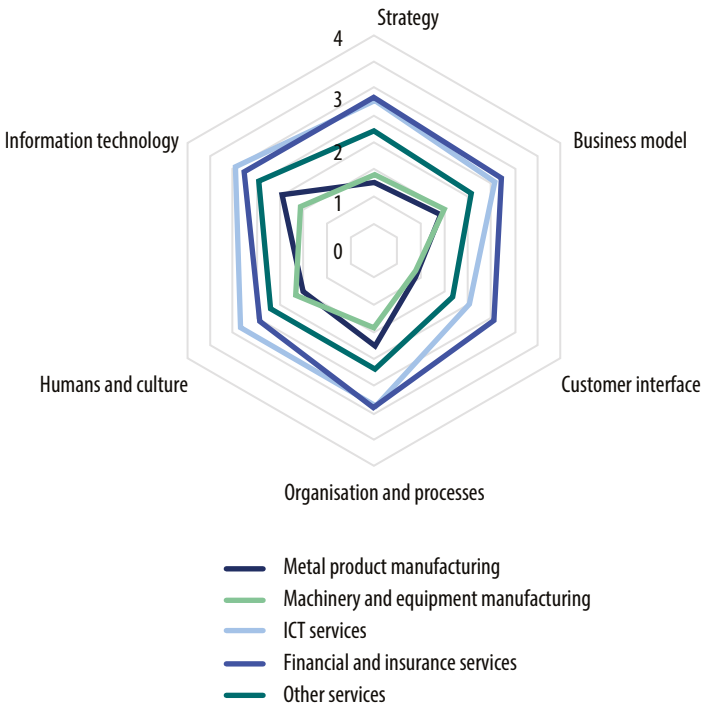
- 84% do not engage in collaboration with research institutes or higher education institutions
- 11% collaborate with universities of applied sciences
- 7% collaborate with universities
- 4 % collaborate with research institutes.

When the degree of digitalisation in companies is evaluated, attention is frequently drawn to the spread and deployment of individual technologies, to a great extent guided by the available information sources. This is not a satisfactory situation from the perspective of planning business digitalisation, however, as choices of technology and investment decisions made at company level are always context specific, and the monitoring should focus on the company rather than the technology. Methods are needed for monitoring the

17 Larja, Liisa – Räisänen, Heikki 2019: Yritysten digitalisaatio ja kasvu: Pk-yritysbarometrin näkökulmia. TEM-analyyseja 93/2019. http://urn.fi/URN:ISBN:978-952-327-448-8

overall development of companies' digital capabilities, taking into account not only the development and deployment of technologies but also skills, value creation, management and the organisation's operation.

Figure 3. Digital maturity of an industry and its dimensions in different sectors modelled using VTT's DigiMaturity tool



One such approach is the DigiMaturity tool developed by VTT[18]. This tool can be used to conduct an overall examination of the organisation's operation, including its strategy, business models, customer interface, organisation and processes, humans and culture as well as information technology. A similar tool has been developed to assess AI maturity[19].

The DigiMaturity tool has been piloted in a small number of Finnish companies. The results show that service companies have a higher level of comprehensive digital maturity than other sectors. The level of digital maturity in the manufacturing industry appears to be clearly lower than in the service sector.

18 Companies can use the tool to monitor the development of their digital and AI capabilities and compare their activities to other companies. Based on the results, a suitable level can be selected as the organisation's goal and measures can be targeted at achieving it. While comprehensive monitoring tools are not currently widely used, systematising their use would be justified to improve the situation picture. https://digimaturity.vtt.fi/

19 VTT 2021: Digi Maturity: DigiMaturity tool. https://digimaturity.vtt.fi/

2.2.3 Potential of the first and second digital decile

A frequently repeated observation in Finnish monitoring studies of digitalisation is that around 10% of companies – depending on the formulation of the survey question – stand out as pioneers of digitalisation, leaders of renewal, or organisations engaging in innovation cooperation or making the best use of technologies. Whether this top group is exactly the same from one survey to the next is not quite sure. If we presume that it mostly is, however, we can refer to this group of companies by the simplified term **first digital decile**. There are good grounds for presuming that this group of frontrunners has played a crucial role in promoting digitalisation in Finnish business by making large investments, investing in RDI, rethinking products, services and value network operating models as well as engaging in cooperation with other companies and research actors. Large companies, especially export and technology companies operating in global markets, are strongly represented in the first digital decile.

The preparation of the Artificial Intelligence 4.0 programme was shaped by the question of whether this group of pioneers, the current first digital decile, could be expanded, thus finding new resources for promoting digitalisation and productivity development. On the other hand, methods for improving the inclusion of SMEs, in particular, in digital pioneering have been considered. In addition to the first digital decile, could a **second digital decile** be identified? And could the second decile contain new productivity potential for digitalisation that the digital policy has, up till now, failed to adequately reach?

In order to answer this question, hypothetical first and second digital decile companies were analysed more carefully as the programme was prepared, their special attributes, particular needs and characteristics were identified, and possible policy instruments for developing the second digital decile towards a pioneering status were considered[20]. Table 2 contains a summary of the observations made on the basis of the interviews concerning first and second decile companies in industrial sectors.

20 In the preparation phase, five presumed first decile companies, four presumed second decile companies and three broker organisations operating in the manufacturing industry were interviewed. The companies represented both large, internationally successful enterprises and small businesses that also operate in the international market. Representatives of different manufacturing industries were selected for the interviews: mechanical, health, metal and forest industry as well as consumer electronics. The aim was to identify first and second decile company types and their qualitative features.

Table 2. Key observations on first and second decile industrial companies' typical features in terms of digitalisation and its challenges.

	First decile	Second decile
Geographic focus	International	Local
Digitalisation strategy	New business and decentralised process organisation	Cost savings, process automation
Priority in digitalisation	Processes, control, culture, customer interface, change	Production and technology
Skills needs	Continuous training of entire staff	Staff shortage
Future training needs	Extensive understanding of digitalisation encompassing business, technologies and service design, also technological skills in particular	Improving the understanding of what digitalisation can achieve (technologies)
Platform economy	Brought up as an emerging possibility	Not recognised by most companies yet
Networks	Extensive and international	Local and national delivery chains
Sustainable development and digitalisation	Potential competitive advantage for Finland. Should be incorporated in the brand	Circular economy is well covered in production
Hopes for the AI 4.0. programme	Training, a national export strategy, extensive cooperation (e.g. Sweden and the EU), influencing regulation	Training, manufacturing industry's image

Clear differences can be discerned between the companies in the two deciles regarding their perception and use of digitalisation. Larger companies operated globally and were well advanced in the digitalisation of their processes. Rather than individual technologies or solutions, they talked about the changes enabled by digitalisation in the company's management, culture and organisation. Large international companies additionally recruit talent from around the world and consider it important to keep the entire organisation up to date with the Industry 4.0 transformation through continuous learning. Sustainable digitalisation requires continuous learning, and a wide perspective of the required skills, in which technological capabilities are linked to other skill sets relevant to business, is emphasised in companies. The larger companies interviewed in the project are Finnish leaders in sustainable development, and they already have 'greened' their business in many ways and integrated sustainability into their brands and marketing. The first decile has also taken initial steps towards a platform economy, and some are involved in consortiums of their sector, creating new practices for such purposes as sharing data between companies.

Second decile companies differed from the first decile significantly in their size and operation. They are clearly more likely than the first decile to operate locally, even if most companies' networks and customer relationships are international. A second decile industrial company often operates as a subcontractor for a first decile enterprise. Their business is strongly focused on manufacturing, which is why they have made large investments in the technology, automation and digitalisation of their production lines. Circular economy thinking is also prominent in their production, and an effort is made to avoid wasting materials. The second decile primarily perceives digitalisation from the perspective of different (production-related) technologies. Digitalisation of the customer interface, on the other hand, is usually not particularly advanced. Availability of labour force with digital skills turned out to be a challenge for smaller companies around Finland. The companies would like to see experts and current employees receiving targeted training at work in skills required by Industry 4.0.

The interviews indicate that it is mainly the largest companies that appear to have separate digitalisation strategies. Most companies see digitalisation as part of business development, which is indeed logical considering that rather than being a goal in itself, digitalisation supports business. The lack of a strategic approach may, however, lead to a short time span and fragmentation of RDI and investments.

The greatest bottleneck for companies in promoting digital solutions is staff skills. Both large and small companies stress the importance of training related to digitalisation. Even before the COVID-19 crisis, the sector experienced a shortage of digital experts at all levels of education with skills linked to key areas of the manufacturing industry. Labour force would be needed both for specialised technical tasks and business development. In particular, companies operating outside the Helsinki Metropolitan area would like new training solutions that could alleviate the shortage of skilled workers. Companies stressed that digital skills should complement competence related to the task and sector. Digital skills alone are not sufficient, as they must be integrated into other processes. All in all, the interviewed companies highlighted skills as the primary factor in promoting sustainable digitalisation. Change always starts with people, and the manufacturing industry needs new skills for implementing the digital transformation.

"*Everything that can be digitalised has already been digitalised*" describes the view of the second decile of their operation and the possibilities of digitalisation related to it. Larger companies, on the other hand, saw a great deal of potential in the wider use of digitalisation in the future.

A recent SME survey[21] conducted by VTT provides a more detailed picture of the development needs and possibilities of second decile industrial companies. In this survey, advanced Finnish SMEs assessed their situation in 2030.

The importance of cooperation in tomorrow's business is stressed in the responses. Almost 90% of the respondents see themselves as being part of a customer-oriented network in which digitalisation is used widely in the future (Table 3). Accordingly, almost as large a group of companies will also make significant investments in digital technologies and systems in this decade. Pleasingly, advanced Finnish SMEs also see the green transition as an opportunity. 70% of the respondents believed that sustainable development and corporate social responsibility will offer companies plenty of new business opportunities. Additionally, 80% of the respondents said their company would significantly reduce its carbon footprint during this decade.

The survey also brought up the challenge: while both digitalisation and the green transition are seen as creating opportunities, the figures were not particularly high when companies were asked about their investments in these areas.

Table 3. VTT survey addressed to 200 SMEs in 2020: Views of SMEs and midcaps of their situation in 2030. Proportion of companies believing that the statement will be true of them (N=156)

Companies' situation in 2030	%
Business cooperation will enable the use of digitalisation.	88
The company will operate as part of a large network which responds quickly to customers' individual preferences.	88
Significant investments will have been made in digitalisation.	83
Carbon footprint will have been reduced with a goal-oriented approach.	81
Sustainable development and CSR will offer plenty of business opportunities.	70
Circular economy will be an essential part of the company's business.	52
AI technologies will be used extensively.	49

21 In this survey, the respondents were asked to consider the company's situation in 2030 and to assess to what extent certain statements were true about their company. The statements concerned the digital transformation, the green transition and company collaboration. Source: VTT 2021: Pk-yritykset haluttomia investoimaan uuteen teknologiaan – vetoapua on tarjolla. 09 February 2021. https://www.vttresearch.com/fi/uutiset-ja-tarinat/pk-yritykset-haluttomia-investoimaan-uuteen-teknologiaan-vetoapua-tarjolla

2.2.4 Data economy and data market

Data economy is a business area in which business models are based on utilising data. Business value is produce by collecting raw data from different sources, collating and analysing the data, and using the results in different business areas. While manufacturing is only taking its first steps in data use, wider exploitation of data offers significant growth potential for it.

In addition to the company's internal activities, data can also create more extensive benefits in its partner network. This can already be referred to as data economy, as the parties must agree on the principles of sharing or exchanging data. A company's subcontracting network, in which the order-delivery chains are managed in real time through multidirectional information exchanges, is an example of the data economy in manufacturing. In the future, network-based cooperation and partnerships built on digital platforms will be at the core of industrial productivity and competitiveness. In a platform economy, producers and users will be connected to a multilateral market in which data will be exchanged and exploited and, through its business value, turned into a commodity whose value can be measured in monetary terms. In an industrial platform economy, services are digitally connected to physical production capacity, which enables a completely new type of value creation in manufacturing.

The data market is growing more rapidly than other sectors[22] and creating business opportunities of an entirely new type. In the future, business models will also be more strongly anchored to different methods of data exploitation, and value creation will revolve around data rather than products. While production was previously controlled by large capitals, skills and capabilities will now become a crucial factor in data-based value creation. This will also provide growing business opportunities for SMEs capable of creating value from data.

A precondition for the realisation of the data economy is advanced digital capabilities: digitalisation of processes, managing the data thus generated, and an ability to apply data as part of business. The customary laws of business will be challenged, as in the data economy the factors of production will not be subjected to wear and tear. Data can be used multiple times, and its value grows as it is processed and used. High-quality data in a digital format is a key resource for creating economic growth, competitiveness,

22 European Data Market Study 2020

innovations and jobs.[23] Data is not necessarily very valuable in itself; the value is created by processing the data into information or services that have a value for somebody. This is why data exploitation and data-based value creation require expertise in processing valueless data reserves into something valuable . Elements of this expertise include an understanding of how data can be processed, combined and analysed as well as business insight.

Business exclusively based on data is strongly scalable and led by such large multinational companies as Google, Facebook, Amazon, Tencent and Baidu. In SMEs, integrating data exploitation into existing value chains, solutions and customer relationships plays a key role in benefiting from the data economy.[24] In order for Finland to keep up with the data economy development in Europe and become a leading country in it, investments in developing SMEs' data economy know-how and the creation of new data-based business will be needed, in particular. Finland's advantages in grasping the business opportunities offered by the data economy include an excellent rate of digitalisation and digital skills as well as high-quality conditions for digital entrepreneurship[25] and top expertise in the field. However, these strengths are not yet being realised as increasing business value.

2.2.5 Digital investments and productivity

From companies' point of view, investments in digitalisation are investments in improved competitiveness and higher productivity. A strong link between digital investments and productivity development can also be seen at the level of the national economy.

In several contexts, Finland has been found to lag behind its key reference countries in the development of industrial productivity. Matti Pohjola brought this up in 2020 in

23 Halenius, Laura – Suokas, Jyrki – Parikka, Heli – Hämäläinen, Hannu 2018: Datatalous suomalaista kilpailukykyä rakentamassa. Sitra 12 June 2018. https://vm.fi/documents/10623/10841416/Halenius-Suokas-Parikka-Hamalainen-Mitä+on+datatalous.pdf/4681f7c4-eed0-f39d-56e8-0ed3383ee8d3/Halenius-Suokas-Parikka-HamalainenMitä+on+datatalous.pdf

24 Halenius, Laura – Suokas, Jyrki – Parikka, Heli – Hämäläinen, Hannu 2018: Datatalous suomalaista kilpailukykyä rakentamassa. Sitra 12 June 2018. https://vm.fi/documents/10623/10841416/Halenius-Suokas-Parikka-Hamalainen-Mitä+on+datatalous.pdf/4681f7c4-eed0-f39d-56e8-0ed3383ee8d3/Halenius-Suokas-Parikka-HamalainenMitä+on+datatalous.pdf

25 Erkkilä & Mäntyniemi 2020: Impetus to growth and wellbeing through the digital leap forward: Digital measures in the aftermath of the coronavirus crisis – final report of the working group.

the Ministry of Economic Affairs and Employment's report[26] 'Technology, investments, structural change and productivity: Finland in international comparison' and, more recently, in a report[27] published by the Ministry of Finance in February 2021. According to Pohjola, productivity growth has been exceptionally weak in Finland since the financial crisis of 2008, and we are significantly behind our reference countries Sweden, Germany and the USA.

Digitalisation is one of the most important instruments of industrial regeneration and productivity growth. Thanks to their capability for renewal, digitally advanced companies are significantly better placed to take on environmental, growth and productivity challenges than those which have progressed slowly in this area.

According to Pohjola[28], the reasons for the poorer productivity development of Finnish companies than their counterparts in competitor countries include, in particular, a low level of intangible investments, including investments in ICT. In an OECD[29] comparison (Figure 4), Finland ranks below the key reference and competitor countries in the level of ICT investments. The percentage share of GDP of investments was approx. one half of the same ratio in Sweden and the Netherlands, for example, in 2017.

Low ICT investments can, first of all, be explained by small inputs in digitalisation in general. On the other hand they may be inputs that, rather than creating ICT capital for the company, or software, databases and hardware owned by it, are realised as service charges or leases.

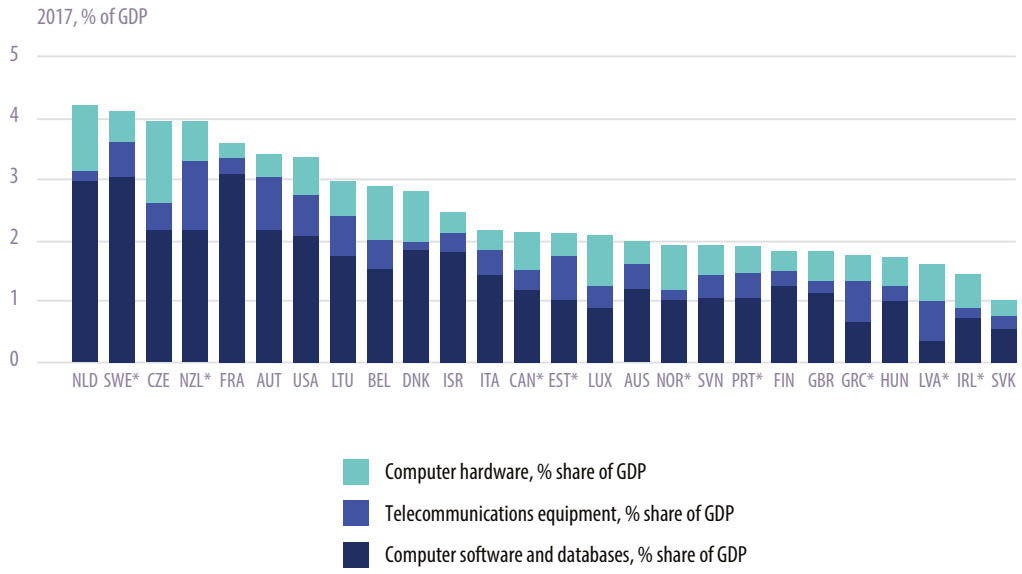
26 Pohjola, Matti 2020: Technology, investments, structural change and productivity: Finland in international comparison. http://urn.fi/URN:ISBN:978-952-327-492-1

27 Stenborg, Markku – Ahola, Ilari – Palmén, Olli – Pääkkönen, Jenni 2021: Unlocking Finland's economic growth: Outlook, priorities and solutions. http://urn.fi/URN:ISBN:978-952-367-504-9

28 Pohjola 2020: Technology, investments, structural change and productivity: Finland in international comparison. http://urn.fi/URN:ISBN:978-952-327-492-1

29 OECD 2020: OECD Digital Economy Outlook 2020. https://doi.org/10.1787/bb167041-en

Figure 4. OECD 2017: ICT investment as a percentage share of GDP[30]. This indicator provides a measure of ICT diffusion throughout the economy. ICT investment refers to gross fixed capital formation (GFCF) of 'information and communication equipment' and 'computer software and databases', as defined by the System of National Accounts 2008 (SNA08)



Source: OECD Going Digital Toolkit, based on OECD National Accounts Database; Eurostat National Accounts Database and national sources.

ICT investments appear to play a particularly small role in Finnish SMEs. According to the SME Barometer of 2021[31], only 8% of SMEs accessing external funding are planning to spend it on ICT hardware or software investments, whereas 44% are planning to spend it on other investments in machines, equipment or buildings. While deployment of new technologies and business models is similarly relatively rare in SMEs' actions for renewal, renewal through new technologies is more common in manufacturing than in other sectors.

30 OECD 2021: ICT Investment as a percentage of GDP. Description 2017. https://goingdigital.oecd.org/indicator/30.

31 Federation of Finnish Enterprises 2021: SME Barometer 1/2021. https://www.yrittajat.fi/suomen-yrittajat/tutkimukset/pk-yritysbarometrit/pk-yritysbarometri-12021-642333

2.2.6 Skills in an increasingly digital operating environment

An organisation's ability to recognise and use its members' existing skills and its preparedness to develop and acquire the required new skills is a precondition for continuous improvement, renewal and productivity growth. The importance of skills and innovativeness is stressed especially in connection with productivity development[32]. The Artificial Intelligence 4.0 programme approaches companies' skills from the perspective of the organisation's capabilities: *what type of skills, innovation capabilities, leadership and preparedness for change in the organisation will the companies need in an increasingly digital business environment?*

Education plays an important role in promoting data-based value creation. According to an OECD report[33], individuals and companies lack capabilities needed to make full use of the potential of the digital transformation. To promote data-based business, not only technological, data and analysis capabilities but also especially service and business skills must be improved[34]. Digitalisation and data-based value creation change the operating methods but also the leadership culture.

The availability of skilled labour is looming as a major obstacle to growth and competitiveness. The talent deficit is particularly visible in the most demanding tasks that require innovation and RDI inputs, but there is also a severe shortage of digital experts in manufacturing. This shortage has a number of underlying factors: reduction in the working age population, lower employment rate than in reference countries, and insufficient labour reallocation.

In the report[35] of a working group on sustainable growth, talent deficit is seen as hampering the refining and scaling up of ideas. In general, inability to refine and scale up innovations into high added-value production in Finland is considered a challenge. Insufficient attention paid to the development of high-productivity ecosystems is another problem. There is a need to change innovation cooperation.

Companies investing in RDI are highly important from the perspectives of upskilling, innovations and renewal. Stepping up cooperation between companies and research

32 Pohjola, Matti 2020: Technology, investments, structural change and productivity: Finland in international comparison. http://urn.fi/URN:ISBN:978-952-327-492-1

33 OECD 2020: OECD Digital Economy Outlook 2020. https://doi.org/10.1787/bb167041-en.

34 Paavola, Heli – Seppänen, Marko – Eloranta, Ville 2021: Strategic options for data-based value creation. pp. 177–178. To download the publication, go to: http://urn.fi/URN:ISBN:978-952-327-667-3

35 Government 2021: Sustainable economic growth and our future wellbeing. http://urn.fi/URN:ISBN:978-952-327-599-7

actors as well as mobility between research and business play an equally large role. If expertise could move dynamically and bidirectionally between companies and higher education institutions, this would efficiently promote the deployment of technologies, including AI.

Both publication analyses and expert assessments indicate that Finnish AI research is of a good international standard. Finland has both a strong tradition of AI research and current leading edge research in this area. Typically of Finland, the expertise is not limited to the core technologies of AI; good generic know-how in providing digital services and developing system level solutions can be found in the country. A great deal of research closely related to AI is also conducted in Finland, for example in the areas of signal processing, electronics and radio technology, theoretical algorithm research as well as in edge computing and 5G/6G technologies, which have been successfully integrated with AI. A high standard of technological expertise and research lays a solid foundation for AI use, but are companies able to make use of top AI experts? If the level of competence in manufacturing is not high enough, companies are unable to benefit from the added value of research and knowledge capital in their business. In addition to RDI, close cooperation between companies and local educational institutions is important to ensure the availability of experts and a sufficiently high level of competence. Konepajakoulu 2.0 in Tampere is an interesting example of stepping up cooperation in a new way. The application and exploitation of new technologies in business changes practices and forces workers to acquire skills in using continuously developing applications and tools.

Online courses should be developed and used more effectively to provide for continuous learning and re-training. Rapid actions, massive open online courses (MOOCs) as well as coordinated cooperation between universities, other educational institutions and education service providers are needed, particularly to respond to the need for digital skills in manufacturing. In this, existing implementations and cooperation can be used; in Sweden, for example, an online learning environment on the themes of Industry 4.0 has been produced for the manufacturing industry in cooperation between 13 universities[36].

Attracting skilled labour from abroad is one way of tackling the talent deficit. In order for this to work, not only actions to attract experts and streamline their entry into Finland but also companies that appreciate multiculturalism and show it at the practical level are needed.

36 Produktion2030 2021: Ingenjör 4.0 – Education for smart production of smart products. https://produktion2030.se/en/portfolio_page/ingenjor-4-0/

Automation has contributed to reducing the number of simple, repetitive tasks in manufacturing work. Recent research and practical experience indicate that digital technology can also complement skills and lead to upskilling and work development. The importance of cognitive abilities is stressed in many types of tasks.[37]

2.3 Policy guidelines for promoting digitalisation in Finland

2.3.1 Overview of EU policy programmes

The EU's industrial programmes

The needs for changes in Europe's industrial sector have increasingly strong associations with the extensive transformation of the operating environment. This transformation will affect the traditional patterns of the political operating environment (including geopolitical factors of uncertainty and growing protectionism), sustainability of the economic system, the role of economic growth, competition and complexity in value chains. On the other hand, it is also relevant to changes in consumer behaviour, which are further linked to broader global social factors: a larger share of the middle classes, urban population and older people; cultural diversity; and reconciliation of work and leisure. The regeneration of industry is now firmly considered a precondition for employment and general vitality as well as an instrument for defending European or Nordic values.

The EU's Green Deal[38] informs everything the European Commission does, including industrial research and development programmes, investments and legislation. The aim of the Green Deal is that a competitive industry will help Europe to become climate neutral by 2050. The change compared to the previous Commission's priorities is significant: rather than settling for mere digitalisation, the aim is now at a twin transition towards a digital and climate neutral Europe. For industry, this means new business, development and investment opportunities but also new regulation and classification principles based on climate objectives. The Circular Economy Action Plan[39], in particular, contains production-related objectives which are in line with sustainable development and which will influence regulation. The European Data Strategy and the updated version of the Coordinated Plan on Artificial Intelligence are also linked to the green transition.

37 The Nordic Council of Ministers 2020: Digital Transformations of Traditional Work in the Nordic Countries, Nordic Co-operation 19 November 2020. https://www.norden.org/en/publication/ digital-transformations-traditional-work-nordic-countries

38 European Commission 2021: European Green Deal. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_fi

39 European Commission 2021: Circular Economy Action Plan. https://ec.europa.eu/environment/strategy/circular-economy-action-plan_en

In its New Industrial Strategy for Europe[40], the Commission points the way to globally competitive, climate-neutral and digitalised industry and proposes a set of measures to achieve the twin transition. As part of the twin transition, the EU will strive to create a digital single market, support European industry in climate neutrality and effective use of resources, promote a more circular economy as well as secure the basis of innovations, knowledge and skills. While the Industrial Strategy is based on the EU's Green Deal, it contains a large section on digitalisation (in line with the Shaping Europe's Digital Future strategy[41]) which, among other things, takes a stand on education and training, investments and the single market as well as technology-based initiatives, including cybersecurity, 5G and artificial intelligence.

A large-scale EU recovery instrument with a strong focus on the green and digital transition has been created to repair the damage brought about by the COVID-19 pandemic. The Member States must address the country-specific recommendations of the European Semester for economic policy coordination in their national recovery plans associated with the EU instrument. In these recommendations, Finland is urged to focus investments on research and innovation.

The EU's Industrial Strategy is also undergoing an update due to the pandemic. In addition to competitiveness, it advocates stronger efforts to reduce the vulnerability of industrial value chains and to promote Europe's technological autonomy. Key questions include safeguarding Europe's strategic value chains and digital infrastructure; self-sufficiency in critical materials and components; and rules for information security, platform economy and data sharing. To support the implementation of the Industrial Strategy, an Industrial Forum was established (2021–2024) to take stand on how Europe's resilience could be bolstered, which value chains and ecosystems should be invested in, how the digital and green transition can be realised and how the recovery measures should be targeted in the aftermath of the pandemic.

European Digital Strategy and Artificial Intelligence Strategy

Improving Europe's global competitiveness and safeguarding Europe's autonomy are identified as key objectives in the EU's Digitalisation Strategy, Industrial Strategy and the Recovery Fund: European expertise in artificial intelligence and other critical technologies must be the best in the world.

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40 European Commission 2020: Commission Communication: A New Industrial Strategy for Europe. https://ec.europa. eu/info/sites/info/files/communication-eu-industrial-strategy-march-2020_en.pdf

41 European Commission 2019: Shaping Europe's Digital Future. https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/ shaping-europe-digital-future_fi; European Commission 2020: A new industrial strategy for Europe. COM(2020) 102 Final, Brussels 10 March 2020. https://ec.europa.eu/info/strategy/ priorities-2019-2024/europe-fit-digital-age/shaping-europe-digital-future_fi

For example, global platform giants' major impact on the data market is a threat. Europe's share in this market is as small as 3%, while the USA has cornered 66% and China 30% of the market[42]. Additionally, the giants' way of doing business is not always compatible with European values. This is why Europe now has a sharp focus on cooperation, policy actions and enabling regulation (including GDPR and the forthcoming AI legislation) to facilitate progress in data sharing and to allow European companies to find more business opportunities in the data economy. Initiatives on developing the rules and infrastructure of data sharing as well as its standards have also originated in Europe, including the IDS (International Data Space) and GAIA-X, in which Finland is strongly involved.[43]

The global dimension is increasingly present in the European Commission's updated version of the Coordinated Plan on Artificial Intelligence[44], one of the aims of which is that Europe will be on the global cutting edge of promoting artificial intelligence. Europe's position as a promoter of human-centric artificial intelligence and digitalisation is also addressed in the Commission's plan for Europe's Digital Decade. This plan promotes the European way, which stresses a human-centric approach to deploying artificial intelligence and new technologies and to promoting digitalisation. The Commission encourages like-minded countries in the sphere of artificial intelligence and digitalisation to engage in closer cooperation to promote the European way and open digital economy globally. The Commission has also proposed the establishment of a new EU-US Trade and Technology Council.[45]

Among other things, Finland participates in the informal D9+ group of digitally advanced countries. The EU countries in the D9+ group promote digitalisation at the strategic level and the sharing of best practices. At the group's previous meeting chaired by Finland in January 2021, the ministers got together to discuss Europe's technical competitiveness. As the outcome of this meeting, a joint declaration titled Leading the Way to Europe's Digital Decade was adopted, under which the development and deployment of innovative

42 Sitra 2019: Globaalissa datataloudessa vallitsevat villin lännen lait – Suomi-vetoisesta mallista vastaus Euroopan kilpailukykyyn? https://www.sitra.fi/uutiset/globaalissadatatataloudessa-vallitsevat-villin-lannen-lait-suomi-vetoisesta-mallista-vastaus-euroopankilpailukykyyn/

43 Sitra 2021: GAIA X – yhteiseurooppalaisen dataekosysteemin kivijalka. https://www.sitra.fi/hankkeet/gaia-x-yhteiseurooppalaisen-dataekosysteemin-kivijalka/#mista-on-kyse

44 European Commission: Update of Coordinated Plan on Artificial Intelligence. 21 April 2021

45 European Commission 2021: Communication: 2030 Digital Compass: the European way for the Digital Decade. https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fitdigital-age/europes-digital-decade-digital-targets-2030_fi; European Commission 2021: 2030 Digital Compass: the European way for the Digital Decade. COM(2021) 118 final 9.3.2021. https://eur-lex.europa.eu/legal-content/fi/TXT/?uri=CELEX%3A52021DC0118

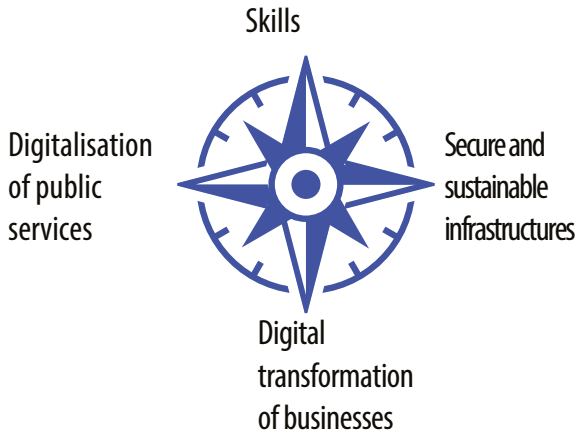
technologies such as Artificial Intelligence, Quantum Computing, and Future Connectivity will enable us to accelerate the digital transition as well as to achieve and maintain technological leadership in the Digital Decade.[46]

Europe's Digital Decade

In March 2021, the European Commission presented a vision, goals and actions for promoting Europe's Digital Decade. This communication is based on the EU's Digital Strategy[47] and stresses the EU's goal of being an independent player in an open and interconnected digital world. The Communication contains a proposal for a digital compass (Figure 5), in which the objectives until 2030 are expressed in concrete terms under four themes: skills, secure and sustainable digital infrastructures, digital transformation of businesses and digitalisation of public services.

The Commission will issue a proposal for achieving the objectives of the compass in the form of a digital policy programme, which will be monitored by means of annual reporting.

Figure 5. Europe's Digital Decade: Digital Compass



46 Ministry of Economic Affairs and Employment 2021: D9+ Declaration: Leading the Way to Europe's Digital Decade. https://tem.fi/documents/1410877/53440649/D9%2B+Declaration.pdf/536c1b37-2b93-57d6-1313-bfe943f3c17e?t=1611759617528

47 European Commission 2019: Shaping Europe's Digital Future. https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/shapingeurope-digital-future_fi; European Commission 2021: Communication: Europe's Digital Decade – digital targets for 2030. https://ec.europa.eu/info/strategy/ priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_fi

At least three out of the four main areas of the compass are within the remit of the Artificial Intelligence 4.0 programme. The initial objectives of the compass until 2030 that are of interest for the programme include:

- Digitalisation of businesses: 75% of European enterprises have taken up cloud computing services, big data and Artificial Intelligence. More than 90% of European SMEs should reach at least a basic level of digital intensity, and the number of rapidly growing companies, such as 'unicorns' should be doubled in Europe.
- Skills: The target on basic digital skills established in the Pillar of Social Rights has been reached. Additionally, there are 20 million employed ICT specialists in the EU, with convergence between women and men as the aim.
- Digital infrastructure: all European households will be covered by a Gigabit network, with all populated areas covered by 5G1. The production of cutting-edge and sustainable semiconductors in Europe including processors is at least 20% of world production in value. 10,000 climate neutral highly secure edge nodes should be deployed in the EU, and Europe will have its first computer with quantum acceleration.

In addition to the listed priorities, the Commission stresses the importance of multi-country projects in its Communication. The Commission notes that it is assessing options, such as the feasibility and features of a specific instrument for Multi-Country Projects, as part of the future proposal for the Digital Policy Programme.

According to the Commission, the EU should promote a human-centric approach in international partnerships and be a global leader in the promotion of human-centric digitalisation. The EU should reinforce its international digital partnerships, among other things through regulatory cooperation and investments in research partnerships. By 2030, international digital partnerships should be enablers of business for European companies.[48]

48 European Commission 2021: Communication: Europe's Digital Decade – digital targets for 2030. https://ec.europa.eu/info/strategy/priorities-2019-2024/ europe-fit-digital-age/europes-digital-decade-digital-targets-2030_fi; European Commission 2021: 2030 Digital Compass: the European way for the Digital Decade. COM(2021) 118 final.

Ethical promotion of artificial intelligence in the EU

An EU Declaration on Cooperation on Artificial Intelligence and a Communication on Artificial Intelligence for Europe[49] were published in 2018. Based on this Declaration and Communication, the Commission and Member States prepared the Coordinated Plan on Artificial Intelligence with the purpose of intensifying cooperation between the Member States and the EU and harmonising national artificial intelligence plans. The Coordinated Plan on Artificial Intelligence encouraged the EU Member States to publish their national artificial intelligence strategies by 2019.[50]

The EU has also prepared a White Paper on Artificial Intelligence[51] to promote ethical and fair AI use and data sharing based on European values in industry and society across a broad front. According to the White Paper, in the global competition between companies and economic zones, efforts are needed to make the EU a favourable operating environment for developing and applying artificial intelligence. The White Paper on Artificial Intelligence notes that it is imperative to create more synergies between national and European inputs in artificial intelligence and increase AI investments, for example in the form of the testing centres proposed in the Digital Europe Programme. The White Paper also lays the foundation for a European approach to the regulation of artificial intelligence. The White Paper on Artificial Intelligence is based on the earlier Coordinated Plan on Artificial Intelligence (2018), an updated version of which was to be published in April 2021.

The European Commission's AI initiatives play a key role for Finland. It should be noted, however, that significant policy initiatives have also been drafted within the OECD, Council of Europe and UN and in Nordic cooperation.[52]

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49 European Commission 2018: Artificial Intelligence for Europe. COM(2018) 237 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A237%3AFIN

50 European Commission 2018: Coordinated Plan on Artificial Intelligence. COM(2018) 795 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:795:FIN

51 European Commission 2020: White Paper: On Artificial Intelligence – A European approach to excellence and trust COM(2020) 65 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0065

52 The large-scale horizontal 'Going Digital' project launched by the OECD in 2017 is a significant artificial intelligence initiative. The objective of this project has been to understand and recognise impacts of the digital transition on societies and economies and to identify the challenges and opportunities associated with it. From 2019, more attention has been paid to artificial intelligence (Going Digital II 2019–2020). In terms of artificial intelligence, key digital policy issues are the OECD's AI Principles, the AI Policy Observatory and the 'ONE AI' expert network. The digital policy agenda for 2021–2022 (Going Digital III) is based on the digital transformation and its drivers, including artificial intelligence and the Internet of Things (IoT). As key themes are highlighted the significance of and opportunities offered by data as a key innovation resource and enabler of business renewal.

Implementation of European industrial and digital programmes

Many instruments have been adopted to implement the European industrial and digitalisation programmes, ranging from support for leading edge research to local Structural Funds actions. The most important instruments from the perspective of the Artificial Intelligence 4.0 programme are Horizon Europe and Digital Europe, actions that directly support competitiveness and investments in industry as well as regional development funding.

The Horizon Europe programme finances ambitious research and innovation projects to speed up industrial digitalisation, to develop new technologies and to implement the green transition. From the perspective of Artificial Intelligence 4.0, Horizon Europe offers opportunities for research, development and demonstrations related to advanced technologies, especially for progressive companies. They are also promoted by a number of partnerships (PPPs) under the programme.

The Digital Europe programme promotes a digital single market in Europe. The programme focuses on developing digital infrastructure and technologies (including AI, cyber security and high-performance computing), improving digital skills and broad deployment of digital technologies in companies and society. A network of European Digital Innovation Hubs (EDIHs) will additionally be launched under Digital Europe to accelerate the digital transformation, also in sectors and SMEs where digitalisation is less advanced. The Artificial Intelligence 4.0 programme can help boost the activities of Finnish digital innovation hubs.

European industrial and digitalisation strategies also impact Member States' choices linked to EU funding, including recovery measures and the targeting of regional development funds.

In the new structural policy programme being drafted in Finland, which is titled 'Renewing and competent Finland 2021–2027', digitalisation has a central and cross-cutting role. According to the draft programme, more than 60% of the forthcoming ERDF financing will be allocated to the Priority Axis 'Innovative Finland', the third specific objective of which is not only supporting RDI and SMEs but also 'capitalising on the advantages of digitalisation for the benefit of citizens, companies and public administration'. From companies' perspective, key activities supported under the programme will include:

- Developing, applying and deploying new technologies and digital tools as well as business models and processes
- Building up SMEs' cyber and information security capabilities
- Supporting digitalisation in SMEs in terms of increasing the automation degree, robotisation and application of new technologies

- Strengthening SMEs' digital capabilities (e.g. new digital products, services, business models and processes, information security and data protection as well as cyber security)
- Developing companies' electronic business, customer service and technological skills.

2.3.2 National industrial programmes and artificial intelligence strategies in Europe

The financial crisis of 2008 led to the creation of an industrial programme titled Industrie 4.0 in Germany. The programme was launched by key political actors, the manufacturing industry and the most important companies delivering equipment to this industry[53]. Many countries rapidly followed Germany's lead and created their national smart industry programmes; Finland, however, has had no such programme. A number of national programmes, including the one drafted in Germany, have been underpinned by a strong political will and public support, even if they have been implemented online.

53 Federal Ministry of Education and Research (2013). Recommendations for implementing the strategic initiative Industrie 4.0. Securing the future of German manufacturing industry. Final report of the Industrie 4.0 Working Group.

Figure 6. National industrial programmes in European countries

The national visions seek to bolster the global position of the manufacturing industry in terms of competitiveness, circular economy, productivity and technological leadership. Creating more and more attractive jobs while safeguarding ecological, economic and social sustainability is an important goal. The ambitions of these visions vary: some are nationally significant but lagging behind at the international level, whereas others are almost utopistic. However, they put the importance of digitalisation for industrial renewal and increased productivity at the centre. Such technologies as AI, cyber-physical systems, the Industrial Internet of Things and robotisation are a precondition for maintaining and improving the global competitiveness of the manufacturing industry in Europe. Improving digital skills is also prominent.

As a default, European countries' national industry programmes (following the example of Industrie 4.0) have a strong focus on technology. However, the updated strategies tend to have a greater emphasis on business perspectives as well as environmental and societal viewpoints. Germany's Industrie 4.0 programme also has a dedicated working group on digital business development.

Many resilient and digital operating models introduced during the pandemic are in line with earlier Industry 4.0 visions. The extent to which the changes in demand or value chains, for example, are here to stay is not known, however. Recovery measures can nevertheless be expected to speed up the green transition, which will also be visible in national programmes.

Encouraged by the Coordinated Plan on Artificial Intelligence[54], increasing numbers of European countries have included AI in their national competitiveness programmes or prepared a national artificial intelligence strategy. While France, Germany and the United Kingdom got there first, the Finnish Age of Artificial Intelligence programme published in 2017 was also a forerunner in Europe. The priorities of Germany's artificial intelligence strategy[55] updated in 2020, for example, are research, increasing expertise, deployment of AI applications, the regulatory framework, and AI in society. Its aim is to step up both national and international cooperation as well as to bolster Germany's and Europe's position and technology neutrality in global competition. Environmental protection, responsibility and transparency play a key part from the perspective of AI development and deployment. Germany is also having a discussion on the current state of the data infrastructure and the need to update the country's data strategy.

Most Member States have now launched their national AI strategies, most recently Spain and Poland in 2020. In those EU countries which are only drafting their national AI strategies, action plans related to AI have been included in digitalisation and industrial programmes.

European countries' national AI strategies differ in their higher level plans as well as operative actions. The 2020 update of Germany's AI strategy, for example, contains 87 actions through which the government strives to implement its strategy[56]. The sectors most commonly referred to in AI strategies are the manufacturing industry, health, agriculture, transport, logistics, education, energy and public administration. Especially France, Italy and Finland identify sectors with a high growth potential in their national

54 European Commission 2018: Coordinated Plan on Artificial Intelligence. COM(2018) 795 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:795:FIN

55 Federal Ministry for Economic Affairs and Energy 2020: Strategie Künstliche Intelligenz der Bundesregierung. https://www.bmwi.de/Redaktion/DE/Publikationen/Technologie/strategie-kuenstliche-intelligenz-fortschreibung-2020.html

56 Federal Ministry for Economic Affairs and Energy 2020: Strategie Künstliche Intelligenz der Bundesregierung.

AI programmes[57]. The French AI strategy (*AI For Humanity*[58]) additionally highlights the ethical principles of AI application, similarly to the Finnish programme.

2.4 Conclusions on the situation picture and interfaces

In addition to capitalising on competence and learning, Finland's strengths include a human-centric approach to AI and data economy development. Finland can show the way in AI deployment and responsible data use, thus becoming a forerunner in digital promotion of the green transition. For the manufacturing industry, the data economy is a strategic priority in which data utilisation and renewal of value creation should be put at the centre.

The national artificial intelligence strategy for industry underpins efforts to step up EU cooperation and bilateral collaboration with our reference countries. Based on the Artificial Intelligence 4.0 programme and by optimally leveraging the EU, we can promote Europe's and Finland's global leadership in sustainable industrial digitalisation. At the same time, we can facilitate and speed up the internationalisation of small companies.

As part of Europe, Finland should take a stand on the European strategies and actions listed above and optimise the targeting of domestic inputs. We must ensure that we have sufficient knowledge for making choices and that Finnish companies are involved as much as possible in key European actions and also tap EU funding. This is the best way of leveraging the European Union for success in global competition.

The situation picture compiled for this programme indicates that tackling the following five challenges, in particular, will be vital.

1. Finland lacks an overall strategy for the fourth industrial revolution

Finnish innovation activities are currently fragmented, and a unifying agenda and measures are needed for them. Finland's strategy and agenda should be influential in both European and international forums.

57 European Commission (2021): Commission Communication: Update of Coordinated Plan on Artificial Intelligence. 21 April 2021

58 AI for Humanity 2021: The President of the French Republic presented his vision on a strategy to make France a leader in artificial intelligence (AI) at the Collège de France on 29 March 2018. https://www.aiforhumanity.fr/en/ Villani mission

2. We look to digitalisation for solutions to the sustainability challenge

The green transition not only faces entire society with a challenge to renew but also offers a major opportunity for Finnish companies. As yet, the palette of opportunities remains large and partly scattered, and the growth potential is not the same in every sector.

3. While Finnish expertise is on the leading edge of digitalisation, competition is getting tougher and companies' investments still lag behind

The cutting edge of Finnish expertise is currently narrow and must be expanded. Transitioning to the data economy still remains a challenge to companies. In artificial intelligence, the time for speeches and principles is over; concrete actions and investments are now needed.

4. As Europe faces challenges, it sharpens the focus of its innovation and industrial policy

As a European country, Finland should take a stand on EU strategies and actions and optimise the targeting of domestic inputs. This means that clear choices must now be made. It must additionally be ensured that AI technologies are used for ethical and socially acceptable aims.

5. A dire shortage of digital experts in industry

The need for continuous upskilling is ever more urgent. In addition to technical skills, there is a growing need for competence related to digital business and value creation. What is more, the skills needs are changing at an increasingly fast rate. These facts should be addressed in both industry and policy-making.

3 Target state and focus areas

3.1 Vision of Finland in 2030: Finland will be a sustainable winner in the twin transition

Should the Artificial Intelligence 4.0 programme achieve its goals, in 2030 Finnish industry will be clean, efficient and digital. It will produce competitive solutions that increase customers' carbon handprint for a global, uniformly regulated market. Solutions that promote the twin transition will have been turned into significant international business for Finnish companies. Their success is based on cooperation, responsibility and ability for renewal. Finland will have become a dynamic, well-known and networking trailblazer in sustainable industrial digitalisation.

Industry will be capable of renewal and draw open-mindedly on a seamless data flow and advanced digital technologies. By applying the new opportunities created by digitalisation to export products, Finnish companies will be able to create superior and sustainable competitive advantage, while the digitalisation of manufacturing enables cost-effective production of even individual pieces in Finland.

In the world of the vision, Finnish industry's competitive factors can be summed up in two sentences:

1. We are profiled in the global market by assisting our customers to operate sustainably and responsibly.
2. We have the ability to bring actors together to solve complex problems fast and thus be winners in responding to a global and growing need.

In 2030, Finland will punch above its weight in promoting sustainable digitalisation and be a leader in selected technologies. Industrial investments in ICT capabilities and capacity will have started increasing significantly. The data economy will have become significant business, and data will be used to turn the circular economy into reality.

AI research and technological know-how in Finland will additionally be among the best in the world.

In 2030, the boundaries between industrial sectors will become devoid of meaning. Rather than digitalisation being seen as a separate theme, data and digital technologies will be enablers for rethinking processes and business. The focus will have shifted from manufacturing to customers and service. Industry will be the foundation of the welfare society and its services and create meaningful jobs. The meaningfulness will stem from the social responsibility of work and companies as well as opportunities for exerting influence, innovation and self-development. Agile, career-length solutions will have been developed for keeping the labour force's skills up to date.

3.2 SMEs undergoing a transformation

What does the realisation of the vision 2030 mean for industrial SMEs in Finland? Which are the challenges of 2021 that the companies will strive to solve by means of digitalisation? How are they related to sustainable development?

The stories of three fictional managers were created to describe the change brought about by the vision when realised. Each from their own perspective, managers Jukka, Jaana and Timo describe the current state of their companies in 2021 and the change that has taken place by 2025 as digitalisation and AI development have advanced further and Finland has taken the first meaningful steps on its way to making the vision a reality.

These stories are fictional rather than based on real-life companies and persons. However, an effort has been made to incorporate in these stories the challenges of sustainable digitalisation identified in numerous studies, interviews and development projects. Experts from VTT, Business Finland, the Ministry of Economic Affairs and Employment, companies and the University of Tampere participated in producing these stories.

3.2.1 Production Ltd in 2021 and 2025

In 2021: The machine shop needs machinists and digital experts

Jukka Makkonen, **aged 54**, is the Managing Director of a machine shop with 57 employees. Jukka is a second generation entrepreneur who grew up with the routines of the workshop, started working in it as a teenager, completed a specialist qualification as a machinist when young, and later continued his studies in an engineering programme at the local university of applied sciences. Apart from short internships, Jukka has always worked in Production Ltd, and after a change of generation, he became its MD 12 years ago. Jukka owns the company with his two siblings, of whom one is the Technology Manager and the other a Board member.

Production Ltd is a strong expert in its field and a family company that manufacturers parts for machinery. The company has 57 employees and its turnover is EUR 21 million. The company has improved its processes and invested in machine tools in which robotics is used. While the key market of this company located in Savo is the domestic one, it also has around 1,000 customers around the world. In 2021, Jukka says:

In 2021, Jukka says:

"The factory floor is where the key skills of the machine shop are found. We operate in a technological field, which means that deploying and understanding all new technologies is important for us. We digitalise everything that is worth digitalising. We have invested in automation and robotics in our production. We have used robots for handling pieces for as long as 20 years, even if the machine tool automation is rather rigid. But I have noticed that not all employees use these robots, either, for many possible work stages and prefer to do everything by hand. We have an ERP system, and we are working on integrating stock control with it.

The greatest challenge is that our customers have a large number of different solutions and systems, and ours should be compatible with all of them. We have more than one thousand customers around the world, all of which have their own processes, most of them still manual. For example, we do not share 3D images with customers. Instead, each actor in the value chain draws their own images and then connects them to their machines. In other words, we do the same work in different stages! There is no 'master data'. Consequently, version management and updates of drawings in the supplier network are rather messy. This is something I would like to sort out.

Our three most important customers are located within a 100-kilometre radius. The purchasing manager said that one of the customers is considering some new interfaces for data sharing. Well, I guess they'll let us know what changes that will require in our processes. It is unlikely to affect the chains of the other 900 customers.

Lack of know-how is the greatest factor hampering digitalisation. So far, developing digital solutions has been the Technology Manager's job, and others also do it for the part of their own tasks. It is not part of anyone's core skills, however. I should improve my personal understanding of it. We would be happy to hire young employees who have the skills needed in the machine workshop combined with digital competence if we could only find some. Recruiting employees for a small workshop in the province is difficult. Young people are not queuing up to enter this field. There is a huge shortage of skilled machinists, too, and we could hire half a dozen expert machinists straight away. A machine shop's productivity is based on the people who operate the increasingly complicated machines. Finding more labour force is a precondition for our company's growth. When production is being digitalised, the processes must also be modified, otherwise the benefits will be limited. We don't really have time, and perhaps also not the skills either, to plan all this.

We must get a certain return on digital investments, and we cannot take risks with experiments in the same way as larger companies. We must also be able to deploy the outcomes of development work rapidly.

I have been wondering why young people are not interested in this work. After all, nowadays this is indoor work in which you do not get your hands dirty, we have a great team, and the work is also international. You get to work on interesting challenges in the workshop, you can see the results of your work, and you can also apply technology if you like that sort of thing. We should have more women in this sector. Maybe people still have outdated perceptions of machine shops as dark caves where welding sparks fly around. Young people could be more interested if they could see our splendid machine halls and what we do for the environment. There is no waste of materials in our factory. Waste would be too costly. The machinery industry is doing its bit for circular economy."

In 2025, young talent and networking have boosted the company's growth

Production Ltd has increased both its sales and its efficiency. The company now has 87 employees, and its turnover is EUR 35 million. Key changes have included the digitalisation of customer interfaces and more efficient internal ERP.

In 2025, Jukka says:

"Our workshop entered a new era when it occurred to me to market Production Ltd as a place offering internships for new graduates from the university of applied sciences. My quirky sense of humour inspired me to write a spiel about summer jobs in our company for the social media and to plan an 'obstacle course' for the best candidates. We got more than a dozen applicants, among which we selected the dream team consisting of Mikael, Enni and Abdullah. This young threesome turned out to be quite the experts; they were a multiprofessional team, and between them they mastered 3D CAD software, basics of AI and CRM, and they were quick to learn about the machines, too.

Above all, they enjoyed working together and at the workshop, and once they had they foot in the door, they stayed with us. What is more, in addition to wanting to develop our activities, they also have networks of highly educated mates, whom we soon started recruiting to the workshop. We assigned a great deal of responsibility for our digitalisation to this young trio, and they signed us up with a local development platform, in which the regional university of applied sciences played an important role.

This enabled us to access physical and virtual testbeds, in which we have developed robotics and familiarised ourselves with the potential of AR. Our main three local customers are also involved in the testbed programme. With them, we have been able to access a data sharing platform and managed to harmonise our interfaces and processes. We no longer draw our own 3D images! This has improved our productivity in leaps and pounds.

I have also used my gift of the gab on a good number of evenings when we have got together with key customers to consider a growth strategy for the entire market and also spreading our data sharing practices abroad. It seems that today, our local customers are actually our sparring partners. We are also constantly testing new operating methods and developing prototypes with them, which is helping us to expand to new parts of the world. We have even drawn up a growth strategy.

And these young people! They have really been a breath of fresh air in our middle-aged workshop.

Abdullah is now our Chief Digital Officer and has worked wonders with the production control system. Enni is responsible for environmental matters. She has figured out the total carbon footprint of our operations and also come up with handprints for us. Mikael is busy with the customer interface, and today we even have CRM software integrated into the ERP system. What is even more important, however, is Mikael's ability to understand different customers and also convert this understanding into data."

3.2.2 Product Ltd in 2021 and 2025

In 2021: What could a health technology SME do with data and AI?

Jaana Peltola, **aged 47**, is the Managing Director of a company which employs 103 people and manufactures health technology components. The key market is in Asia but the company also has customers in Europe, North America and South America. Jaana is the family business's first professional manager hired from the outside. She has worked with business development in health technology companies operating in the international market throughout her career. Jaana has been managing Product Ltd for three years, and she is expected to find new business areas for the company to improve its productivity and increase sales. Jaana is a consummate business professional and knows the international networks of her sector.

Product Ltd manufacturers high-tech plastic components for the health technology sector. The turnover of this family business located near Turku is EUR 45 million. The company has extremely solid expertise in health technology product development: its product development processes and methods are second to none in the world. Product Ltd also engages in agile development of new products and continuously improves the old ones.

In 2021, Jaana says:

"We are a high-tech business in the health sector. We have several employees with a PhD, and developing both our operations and the quality of our products constantly is vital for our business. I am trying to keep up with digitalisation and figure out how it could be used in our company. Responsibility for digital development has not been specifically assigned to anyone in the company, and we would need more expertise. What we would like is an overall digital strategy. Launching our MES system last year was a great effort. We now have better control over the production cells, too. The MES helped us improve our data capture. We can now track our products in real time and also offer this information to our customers. We are already producing a great deal of monitoring data. We believe that this is important in the international investment goods business.

However, our factory still has enormous production machines with no digital user interfaces. We are wondering if they should have – at least we would have more data. But what would we do with it? We have been thinking about how AI could be used in our production processes and if our data could be used for this purpose. Being able to improve quality through AI use would be particularly interesting to us. We are not sure if our data is sufficient and of the correct type to enable this.

How should we store, edit and manage data so that we can convert it into AI?

We are also working on real-time and transparent exchanges of order and delivery data, which we cannot do without our customers' cooperation. I have to say that many of our customers are really conservative. In Central Europe, some of them even use fax machines! And they have no CRM or digital archives of our deliveries. It is difficult to see these customers getting involved in data sharing and real-time data exchanges, let alone developing such solutions themselves.

We naturally have other types of customers, too. Especially in Asia, many large customers are ambitious about new technologies. Once during the coffee break in a negotiation, they started visualising how quantum computing could be used to analyse product development models in the future. That seemed quite a distant idea. Another customer's idea of using AR in the product development of our plastic components as part of their hardware seems a bit more realistic.

In the future, the value chains may well concentrate around data exchanges. This would require strong mutual trust as well as clear processes and data specifications, however, and perhaps also standardisation. It may be necessary to rethink the entire value chain from design and production to delivery and end user. What worries us is the question of who will ultimately control these immense volumes of data in the value chains. Are we not taking the risk of losing control over our production?

The most important question related to AI and the data economy for Product Ltd is, however, how it will benefit our business. How will our business grow and our relations with customers improve?

The company is aiming for rapid growth and believes that AI and data will create possibilities for this. To achieve this goal, we will need new operating methods and people, perhaps digital natives, who would understand the new business models and be able to implement changes in our organisation and customer interface."

A sales boost from AI in 2025: a testbed and data sharing accelerated the health technology company's transition to service business

Product Ltd's productivity has improved over five years. While its employee number has stayed the same, the turnover has reached EUR 55 million. The company has been particularly successful in increasing its customer numbers by digitalising sales and customer relationship management and improving its ERP.

In 2025, Jaana says:

"Over the last year, I have learned more about technology and business development than I did in my years at university. Everything started from realising that we did not know what to do with data. While the world was in the grip of a pandemic, both regulation in the health technology sector and restrictions of data business appeared to become increasingly stringent. All this worked in our favour in the end.

We became involved in a health technology testbed established in the aftermath of the COVID-19 pandemic, in which we had an opportunity to develop and test AI solutions together with leading companies and research institutes of the sector. This way, key persons in Product Ltd established long-term multiprofessional relationships with higher education institutions and other business development agents. In discussions and workshops with scientists, we learned to recognise future technologies and the business opportunities associated with them. In the end, we were able to draw up our digital strategy under our own steam and, together with a consultant, provide training that prepared the entire personnel for the AI era. This led to enormous quantities of new initiatives and development activities within our organisation.

We were able to refine the best ideas into experiments with our testbed partners. Gradually, we learned how to create a new type of modular product architecture that responds rapidly to customer needs, enabling the efficient modification and scaling of products. We can also use learning algorithms to automate sales and anticipate customer needs. All this has helped to turn our plastic components partly into a service business. We look after the customer's stocks and component circulation.

As we are a plastic technology company, we have racked our brains over sustainable development and the recycling of our plastics. The data economy has helped us to get a grip of circular economy principles, and we are able to optimise our material use and circulation better. Ultimately, the more stringent global restrictions proved a competitive advantage for Finnish know-how."

3.2.3 Data Platform Ltd in 2021 and 2025

In 2021: Data Platform Ltd brings together the sector's large and small actors

Timo Kuusi, **aged 34**, is one of the founders of Data Platform Ltd, a small shareholder and the company's Business Development Manager. Timo is a visionary who has been involved in several start-ups. In his previous job in a large international forestry company, Timo picked up on a need to improve the efficiency of value networks by developing cooperation and digital sharing platforms with subcontractors. Timo persuaded five larger companies operating in the field to back up his idea, and they established Data Platform Ltd together, initially with funding from the large companies. Timo himself moved to the new start-up to develop and manage its business.

Data Platform Ltd offers a platform on which forest machine manufacturers and service companies can securely share their data. So far, the start-up has hired 12 employees who outsource project implementations. The company's turnover is EUR 5 million. The platform also enables remote maintenance. As an innovation and integration platform, it is a pioneering company striving to alter the practices of the entire sector. The company is strongly involved in EU projects on data regulation and standardisation. While the main shareholders of this company based in Helsinki Metropolitan area operate in the global market, the focus of the start-up's activities is on Northern Europe. Data Platform Ltd has strong connections with actors in the sector, it has a good understanding of what different actors in the value network need, and it is able to catalyse development in the sector.

In 2021, Timo says:

The platform provides for transparency as well as shared rules and interfaces.

"In many small workshops, digitalisation is carried out from the customer's perspective. Our perspective is that digitalisation helps both small and large companies to improve their productivity and to develop their processes when this is done together on a shared platform. Our platform provides its members with common rules, interfaces and transparency, giving the entire field a boost.

Creating trust between companies is the most vital part. Otherwise data sharing cannot happen in real life, as in practice it means that all members open up the secrets of their core business for the others to use. All participating companies must believe that they can win in this.

For this purpose, we have forged stringent rules regarding the use of the data on the platform and transparency as well as modelled its business logic.

Over the long term, everyone must benefit from this economically. A persistent myth associated with platforms is that the winner takes it all and that large companies walk all over smaller ones. We are striving to prove this myth wrong: the data platform supports digitalisation in SMEs, in particular, by offering them ready-made data standards, interfaces and processes which all of their customers will hopefully be using before long. This frees up immense amounts of time spent on routines and streamlines global business, making it possible for the company to turn its attention to the quality of what it does and the innovativeness of its products and services.

The data economy is only taking its initial steps, and our Data platform is ground-breaking. We are striving to transfer our knowledge and learn from others by participating in various EU standardisation projects and the drafting of regulation on the data economy and artificial intelligence."

Remote maintenance creates value for everyone

"Our platform also promotes servicification in the forest machine sector. We help all participating companies with their remote service business. When a company sells a machine or component through our platform, they also sell the remote maintenance service. Carrying out the maintenance is simple. This alone increases the turnover and productivity of the participating companies.

Of course, this is also a major growth business for us. We are growing together with our platform. The owners of Data Platform Ltd are major companies, and they will finance us for a few years. They find that over the long term, this will save their expenses on managing subcontractor networks and improve quality. The presence of these large companies on the platform and their promise to harmonise their interfaces already send a loud message to smaller companies. This platform is worth participating in, this is where you find the customers and the latest development. We believe that in this model everyone wins, and a platform operated from Finland can grow into a global market leader in this sector."

In 2025, Data Platform Ltd conquers the world

In five years, Data Platform Ltd has grown into a company of 75 employees with a turnover of EUR 30 million. The company has expanded its platform services to training and consultation offered to its member companies. It also consults other sectors' data platforms in business development. Data Platform Ltd has also set up branch offices in Canada and China.

In 2025, Timo says:

"Data Platform Ltd has developed its business and now offers a more extensive range of services to the companies in its network. It helps small businesses with data integration and enterprise architecture know-how. The harmonisation of companies' interfaces and data within the sector has supported this. When providing technical consultation services, we discovered a need to develop our customers' processes and to train their personnel. Previously, many companies attempted to recruit people knowledgeable in both the forest machinery sector and digitalisation from outside, but our 'digital agents' in the training programme noticed that they can cope by teaching digital skills to their existing staff.

The secret of our success has been keeping the functions and rules of our data platform as clear as possible. Offering subcontractors plug&play access to modules in large companies' information systems has emerged as really important. From the start, we have also believed in the data platform's ability to produce added value through its own services, and our remote control maintenance using AR/VR technologies has proven highly successful. It has shortened the downtime of forest machines by a quarter and significantly improved the efficiency of the entire value network's operation. Of course, it is also profitable business for our company."

International and EU cooperation help Finnish companies to develop their digital business

"As an agent that creates and offers new practices, it is also the role of the data platform to help the sector develop. We have wide global networks, and we have participated in a number of EU initiatives. As a pioneer, we have been able to influence European regulation and to advance effective solutions for a transparent data ecosystem in such forums as GAIA-X.

In this business, we start from the principle that common global rules and supervision of cyber security are necessary. Data can go around the globe in the blink of an eye, and it can be refined anywhere. We have launched projects that promote international data economy in cooperation with research institutes and higher education institutions and advised large and small companies in our network to participate in them. Our latest idea is to offer companies AI-based management of value network logistics across the delivery chain. For example, it would make it possible to share personnel resources optimally between companies.

Responsible sustainable development and data associated with it are a central perspective in the platform's operation. Through it and AI, we tell our customers and our customers' customers about the energy efficiency and environmentally friendly operation of the forest machines. On our platform, the customer can access directly such documents as the recycling and climate data related to a product. Data travels in all directions in the (value) network; in other words, it is available to all our members. The resources of a single company would not have been enough for this, which is why the idea of establishing Data Platform Ltd was, form the start, to support the entire sector."

3.3 Objectives and key results of the programme

The management by objectives framework of the OKR model[59] will be applied to the steering of the Artificial Intelligence 4.0 programme: the programme's management system is based on *Objectives* and *Key Results*. The attainment of the qualitative objectives set for the programme will be promoted by quantitative key results, which measure both inputs and outcomes in a balanced way. The methods for attaining the programme's main objectives and the indicators that measure their achievement will be defined more accurately by the thematic subgroups based on this programme.

59 Niven, Paul & Lamorte. Objectives and Key Results : Driving Focus, Alignment, and Engagement with OKRs, John Wiley & Sons, Incorporated, 2016. ProQuest Ebook Central, https://ebookcentral.proquest.com/lib/kutu/detail.action?docID=4688970. Referred to in: 13 April 2021

Table 4. Objectives and key results of the Artificial Intelligence 4.0 programme

Objectives (O) and Key Results (KR)	
O1:	**WE WILL BOOST FRONTLINE SMES TO THE GLOBAL LEADING EDGE OF INDUSTRIAL DIGITALISATION**
KR1.1:	Cooperation both among SMEs and with large companies and research institutes will be stepped up
KR 1.2	A culture of experiments will make headway and the use of test environments become more common
KR 1.3	Know-how will be developed through sharing experiences, making sense of technology and effective continuous learning actions
O2	**WE WILL ENHANCE FINLAND'S IMPACT IN THE IMPLEMENTATION OF EUROPEAN ARTIFICIAL INTELLIGENCE, DATA AND INDUSTRIAL STRATEGIES**
KR 2.1	We will take on a leading role in selected themes, value networks or clusters
KR 2.2	We will strengthen and diversify networks
KR 2.3	We will adopt a more goal-oriented approach and enhance the positive impact of EU cooperation
O3	**WE WILL REINFORCE AI LEADERSHIP THROUGH TARGETED INVESTMENTS IN THE DEPLOYMENT OF CUTTING EDGE TECHNOLOGIES**
KR 3.1	AI will be used more widely in industry
KR 3.2.	Data economy and data-based value creation will be more common in industry
KR 3.3.	High-performance computing will be used more widely in industry
KR 3.4.	Start-up activities based on top technological expertise will grow
O4	**ADVANCED DIGITAL TECHNOLOGIES WILL SERVE SUSTAINABLE DEVELOPMENT GOALS AND THE TRANSITION TO A CARBON NEUTRAL FINLAND IN 2035**
KR 4.1	Data-based circular economy promotes ecologically sustainable business
KR 4.2	Green and ethical digitalisation will be an important asset for Finnish exports

O1: We will boost frontline SMEs to the global leading edge of industrial digitalisation

The fastest rate of business digitalisation is seen in globally competitive leading edge companies. They comprise at most around 10% of Finnish businesses, however, of which a large proportion are large companies, while SMEs are underrepresented. The leading edge companies have good capabilities for developing and deploying digitalisation and making investments. They make versatile use of the opportunities and support offered by RDI policy. However, there are many companies that would be willing and able to develop and

have the preconditions for making it to the top in digital renewal, especially among SMEs. Helping this target group, the so-called second decile, join the leading companies on the cutting edge of sustainable digitalisation is a key goal of this programme.

Key results for achieving this objective:

1. *Cooperation both among SMEs and with large companies and research institutes will be stepped up*
2. *A culture of experiments will make headway and the use of test environments become more common*
3. *Know-how will be developed through sharing experiences, making sense of technology and effective continuous learning actions*

KR1.1. Cooperation both among SMEs and with large companies and research institutes will be stepped up

Innovative new products, services and business practices developed by companies themselves are a key source of sustainable economic growth. Merely improving existing products and services and developing cost competitiveness are rarely adequate as drivers of growth. Completely new ideas and innovations based on them are at the core of economic growth, making it possible to generate from the same factors of production outputs that are increasingly valuable for customers.

Finding the right solution often is a significant bottleneck in creating new production-related, product or service innovations. While customers' wishes rarely provide the impetus for digitalisation projects, different seminars, peer learning and other entrepreneurs' experiences are extremely important for renewal and investment decisions. Companies need peer support and concrete trailblazers, and they listen to other companies. This is why drawing attention to success stories is important. Consequently, contacts between SMEs as well as between small and large companies are considered a vital factor that promotes the spread of digitalisation.

Cooperation with large companies and research institutes will bring SMEs plenty of valuable experience, knowledge and business opportunities. In open innovation workshops and projects conducted by large companies, SMEs can solve practical challenges presented by the large companies and, while doing so, learn from each other. In shared R&D projects of companies and research institutes, digitalisation can also be accelerated through co-design: research institutes and digital service providers resolve end users' digitalisation challenges and find new partners and customers, and all ecosystem actors learn. Companies' cooperation with higher education institutions and research institutes also speeds up the development of new technologies and helps solve problems associated with them, thus supporting the full realisation of their benefits.

Initial actions recommended by the programme:

1. Cooperation networks for development and innovation, which benefit especially SMEs, will be created in Finland through European Digital Innovation Hubs (EDIH). The aim is to create four innovation hubs in Finland in strategically selected priority areas of business growth.
2. There is significant growth potential in large-scale use of data in industry. This is about not only properties that bring added value to the products and services a company sells but also methods that improve its internal efficiency and ecological sustainability. In addition to making use of data in individual companies, significant growth potential can be found in network-based cooperation, trade and partnerships underpinned by digital platforms. This is why the aim should be set at significant SME participation (more than 1,000 SMEs a year) in the development of data-based business.
3. A considerable increase in cooperation projects that engage SMEs (over 30% from the 2020 level) is another key aim. In this context, a project refers to both direct and informal development projects between companies and cooperation within various formal frameworks or ecosystem level cooperation projects financed by the EU or Business Finland. In particular, the programme wishes to encourage SMEs in cooperation and mutually beneficial information exchanges with each other.

KR 1.2 A culture of experiments will make headway and the use of test environments become more common

A precondition for making progress in the twin transition is developing and deploying different new technologies and operating models that support business growth. In practice, companies will not invest in individual technologies, such as 5G networks or AI-controlled industrial automation, unless they are part of a more extensive overall solution that promotes their business. This often emerges as a problem, as it should be possible to test a new technology in production before it is deployed. However, downtime in manufacturing required for experiments is rarely an option, which is why development and test environments corresponding to actual production environments are needed for rapid experiments. The same environments can also serve as co-design platforms. Coordinating the operation of various hubs, testbeds and innovation platform as well as gathering together and scaling the lessons learned in them will be crucial. Rather than being limited by national borders, the scope of such activities should be at least EU wide.

Initial actions and objectives recommended by the programme:

1. Creating new test environments that promote industrial digitalisation. Different test environments should be created around key themes that promote business renewal. They include exploiting AI and data in industrial manufacturing as well as additive manufacturing and business renewal based on it. The goal is set at increasing the number of open test environments by at least 20% from the 2020 level.
2. A significant increase in the utilisation rate of test environments. The number of innovation projects and companies using test environments will grow significantly (an increase of over 30% in each test environment).
3. Mainstreaming a culture of experiments in companies' internal operating methods and business culture at large. An external test environment is not always necessary for all experiments. It may be quite possible to carry them out in close cooperation with a supplier or a customer in open or co-created environments described above.

KR 1.3 Know-how will be developed through sharing experiences, making sense of technology and effective continuous learning actions

While there are many possibilities for business development and different solutions are also readily available, the reason for reservations about grasping these possibilities is not necessarily financial. The fundamental reason for being slow to develop and deploy new technologies may lie in the fact that companies are not always fully able to perceive how a new technology, including AI or data, can be used to create significant business value for the company. This is why promoting the sharing of experiences and effective practices also plays a key role. Above all, it is desirable that large companies and advanced SMEs will be open about their achievements and proven practices. It may be assumed that sharing knowledge and practices across the boundaries of industrial sectors will be a particularly effective way of advancing and accelerating industrial renewal in general. Attention must also be paid to upskilling companies' personnel, especially in the area of digital capabilities. Making proactive use of the competence development measures offered by both society and companies and comprehensively supporting the individual's independent learning opportunities will be desirable.

Initial actions and objectives recommended by the programme:

1. Organising more events focusing on open industrial digitalisation as well as producing publications on this theme and distributing them more effectively.
2. Increasing investments in capabilities that enable AI utilisation by creating and building up thematic ecosystems (including robotics, telecommunications and computing capacity, 3D printing, digital twins).

3. Improving and clarifying the offer of education and training that supports the continuous learning of manufacturing industry professionals.
4. Promoting work-based immigration as part of the solution to the talent deficit.

02 We will enhance Finland's impact in the implementation of European artificial intelligence, data and industrial strategies

Finland has global leader companies, top level expertise and good European partnerships. Finland can help the EU develop and leverage European cooperation when seeking global AI leadership. However, we have lacked an overall agenda that would allow us to select national priorities and enhance our visibility and impact in European and international forums. Additionally, EU activities in Finland are in the hands of a relatively small number of companies and public sector actors.

We need stronger networks, more effective financing and jointly selected themes in which we will strive for a leadership position. This way we can get a firm foothold in Europe, enhance the impact of the cooperation and improve our success in global competition.

Key results for enhancing Finland's impact in European artificial intelligence, data and industrial strategies:

1. *We will take on a leading role in selected themes, value networks or clusters*
2. *We will strengthen and diversify networks*
3. *We will adopt a more goal-oriented approach in and enhance the positive impact of EU cooperation*

KR 2.1 We will take on a leading role in selected themes, value networks or clusters

Finland must choose the themes in which it wishes to be a global leader and leverage EU structures to strengthen its leading position in them. We must focus our inputs on a few themes in which we can become leaders.

Significant initiatives are about to be launched in European cooperation which are associated with the data economy, reinforcing the critical value chains of industry and developing AI technologies. Concerns over the competitiveness of European industry and unfair global competition have led to a need for European value chains of strategic

importance (*Important Projects of Common European Interest, IPCEI*60). The IPCEIs form a close-knit cooperation network between companies and research institutes, with intensive collaboration also after the actual project has been completed. It is important to involve as many Finnish companies as possible in the selected projects.

Initial actions and objectives recommended by the programme:

1. **Finland will be on the frontline of deploying industrial data platforms**. Finland will take on a leading role in GAIA-X and IDS development, standardisation and implementation of data sharing, especially in the context of the manufacturing industry and circular economy. Examples of data sharing and industrial business based on it will be created that are ground-breaking at the international level and beneficial for companies.
2. **Finland will remain on the leading edge of connectivity technology**. European supremacy in telecommunication and technologies associated with it is of key importance. Finland's leading position in network technologies of the future and their industrial applications will be maintained, and synergies of Finnish actions as part of European cooperation will be ensured. Investments will be made in European partnerships and strategy work in the telecommunication sector.
3. **Finland will participate in IPCEI projects on microelectronics and cloud services**. Telecommunication technology, which is important for Finnish businesses, Nokia's market position and an innovative microelectronics sector support participation in the Connectivity and Microelectronics IPCEI. Finland has a good chance of being one of the leading microelectronics developers and manufacturers in Europe, thanks to a growing company ecosystem and strong research and innovation competence (including SoC Hub, Printocent and Micronova). A cloud service IPCEI is also being planned. The AI, SaaS and data platform services promoted by this project will extend from data use in the manufacturing industry through cyber security and high-performance computing to telecommunication. Finland's large inputs in European cooperation on high-performance computing and quantum technology (EuroHPC)[61] as well as data platform development (including Gaia-X, IDS) support Finland's participation in the cloud service IPCEI.

60 IPCEI refers to multinational projects in sectors which are strategically important for the EU and which are considered significant in order to achieve the EU's economic, industrial or climate policy objectives, among other things. The underlying objective of the IPCEI processes in the battery sector, for example, is to generate a new industrial sector in Europe. A separate set of State aid rules with less stringent criteria is applicable to the IPCEI projects.

61 CSC 2020: LUMI supercomputer. https://www.csc.fi/en/lumi

KR 2.2 We will strengthen and diversify networks

Both international and European cooperation require long-term work and strong networks. While Finns already are involved in many European networks, better use should be made of networking. At the same time, Finland must take a stand on new consortiums that will be crucial for the future.

The Artificial Intelligence 4.0 programme strives to promote European AI cooperation and Finland's role in this community. We will strive to influence high-level working groups and strategies on AI and industrial regeneration which will lay the foundation for the choices of the current and future Commission. We will additionally participate intensively in key partnerships of industrial digitalisation, including public private partnerships (PPPs) under the Horizon programme, through which we will influence the EU's priorities in the years to come.

Initial actions and objectives recommended by the programme:

1. **A hub of the European AI partnership network will be established in Finland**. Under Horizon Europe, the European AI ecosystem will be reinforced through the ELLIS research network. The goal of the ELLIS network is to compete with global AI centres, attract top experts and lay the foundation for AI development in line with European values. While the Finnish Center for Artificial Intelligence (FCAI) is already networking internationally and a member of the ELLIS network, further investments will be needed to enhance its international impact. The aim is that an ELLIS institute will be set up around the FCAI as one of the first in Europe.
2. **Finland will play an active part in key advocacy groups of industrial digitalisation**. The Artificial Intelligence 4.0 programme will be leveraged to open doors to key European advocacy groups of artificial intelligence. Extensive but thematically targeted 'EU Ambassadorships' will be supported and increased. Their task will be to promote plans in the EU with a national mandate.
3. **Finland will play a strong role at the core of key EU partnerships**. The new Horizon Europe partnerships (PPPs), including DAIRO (Data, Artificial Intelligence and Robotics), KDT (Key Digital Technologies), Smart Networks and Services (SNS), Photonics, HPC (High Performance Computing) and MIE (Made In Europe), will offer opportunities for exerting influence and networking. Participation in these partnerships will be supported and mechanisms for leveraging them more effectively will be built (including support networks in Finland, intensified communication, a national map of partnerships and partners).

KR 2.3 We will adopt a more goal-oriented approach and enhance the positive impact of EU cooperation

Facilitated by the Artificial Intelligence 4.0 programme, an overall national agenda for the fourth industrial revolution will be created, which will combine long-term business, regional and scientific objectives. In order to develop this overall agenda, extensive dialogue with different industrial sectors and innovation policy actors will be needed. The goal is that industrial sectors, business ecosystems, research project participants and advocacy organisations could link their roadmaps and actions plans to the implementation of the national agenda.

The national agenda for the fourth industrial revolution should influence European programmes, direct Finland's national resources and improve Finland's status in European and global cooperation. The agenda will help us raise awareness of Finnish know-how and influence future priorities.

We will also develop ways of facilitating Finnish companies' participation in European research and development, enhancing the impact of funding and improving the likelihood of applications being approved. Knowledge created in networks and projects and the scaling of the outcomes in Finland will be improved, for example by linking regional specialisation plans and local ecosystems more tightly to the national and European frame of reference.

Initial actions and objectives recommended by the programme:

1. Finland's agenda for the fourth industrial revolution will be recognised in Europe and exert influence on the themes selected for the agenda. Finnish actors across a broad front will be committed to implementing the agenda.
2. The amount of EU funding granted to companies will go up. The goal is to increase the EU funding accessed by leading companies by 50%. Additionally, new SMEs will be within the scope of EU networks, and SMEs will be able to access more funding.
3. Cooperation between research actors and companies in EU projects will be stepped up. A Finnish company will be a partner in most EU-funded joint projects between research institutes and universities.
4. Regional actions, including projects drawing on European Regional Development Fund (ERDF) support, will be more strongly linked to European cooperation.

03 We will reinforce AI leadership through targeted investments in the deployment of cutting edge technologies

Partly thanks to the Finnish Age of Artificial Intelligence programme, Finland has achieved a recognised position as a promoter of artificial intelligence and an AI hub. In international comparisons, Finland is placed with globally advanced AI countries and Europe's digital frontrunners[62]. In particular, our strengths include high-profile research expertise and coordinated investments, in which public inputs and active support policy are key elements.

New and growing innovative companies will renew sectoral structures, challenge large companies to reinvent themselves and provide examples of flexible and growing enterprises that are willing to take a business risk and apply new technologies. The more innovative business based on high-level expertise is emphasised in the national economy, the more important new, growth-seeking companies are. Start-ups are highly important for promoting the national economy's competitiveness and providing impetus for the mechanism of creative destruction.

When investments in AI grow globally, preserving the frontrunner status will not be possible without continuous investment. In addition to thought leadership and leading expertise, Finland should strive for leadership in AI exploitation, in which investments made by companies and venture capitalists will be crucial.

Key results for building AI leaderships:

1. *AI will be used more widely in industry*
2. *Data economy and data-based value creation will be more common in industry*
3. *High-performance computing will be used more widely in industry*
4. *Start-up activities based on top technological expertise will grow*

KR 3.1 AI will be used more widely in industry

The preconditions for using AI in companies include new digital systems and operating processes, making use of new generation telecommunication, expertise in digital design and manufacturing processes, efficient and secure use of data, rules and platforms for data sharing, and competence in value creation of a new type and managing networking

62 McKinsey Digital 2020: How nine digital frontrunners can lead on AI in Europe. Harnessing the opportunity of artificial intelligence in Europe's digital frontrunners. https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/how-nine-digital-front-runners-can-lead-on-ai-in-europe#

cooperation. We will need operating models that facilitate the better and faster creation and market entry of industrial innovations. We will need an agile development and experimentation culture which creatively brings research actors and companies together in productive cooperation. As this is typically about parallel and systemic use of several digital technologies, different organisations' investments should be coordinated. The risks related to investment decisions can, for example, be reduced by offering information, creating open test and experimentation environments and providing financial support.

Initial actions and objectives recommended by the programme:

1. *At least one AI test and experimentation environment that is part of the EU network will be located in Finland*. Under the Digital Europe programme (DIGITAL), Testing and Experimentation Facilities (TEFs) for AI will be set up in four areas: the manufacturing industry, smart cities and transport, health, and agriculture. The objectives also include building a horizontal Edge AI TEF concentrating on edge computing, which will produce components and solutions for vertical testing and experimentation facilities. Finland should have a strong involvement in the selected testing facilities.
2. *The support for AI development provided by Business Finland and the Academy of Finland will be increased further*. Inputs in AI innovation ecosystems and ambitious RDI projects will be increased. The AI Business Finland programme has financed 264 AI projects with a total amount of EUR 112 million. The Academy of Finland's FCAI flagship and other research funding has also been significant. The actions aiming to keep investments on a growth trajectory may consist of new, dedicated programmes, continuation of previous programmes, or incorporating an AI theme in other programme packages.
3. *More investments will be made in using AI in automation, robotics and export products*. In industrial activity, automation and robotics are important uses for AI. AI enables multi-purpose robots that operate independently and interact with humans and facilitates and speeds up training them to perform different tasks. By means of machine learning, production and maintenance can be optimised and made more efficient while improving the systems' energy efficiency, reducing incidents and minimising the carbon footprint. On the other hand, applying AI in export products (including machinery) will create a supreme competitive advantage. To increase AI use, not only more research but also investments and actions to facilitate AI deployment will be needed. They include sharing good examples, using test environments and marketplaces, and supporting co-design between small and large companies.

4. *The 5G test network will be updated and its use for companies' experimental projects will be increased by 30%*. 5G Test Network Finland (5GTNF) is a test environment for wireless telecommunication consisting of R&D environments operated by several different actors. It enables the development of applications that combine AI and telecommunication. The test environment should be developed with the next stages of 5G technologies and the emerging standardisation of 6G technology in mind. The TNF operating model and service provision should also be updated.

KR 3.2. Data economy and data-based value creation will be more common in industry

Data-based value creation and business opportunities are an important incentive for developing AI applications. Key bottlenecks for advancing the data economy include the availability, quality and interoperability of data.

Initial actions and objectives recommended by the programme:

1. *Each year, 10 major projects on developing a Finnish industrial data space63 and 10 major EU projects on industrial data economy will be launched*. The EU Data Strategy aims for the creation of sector-specific but interoperable data spaces. A precondition for developing data spaces is the parallel development of enabling platform technology and applications in an ecosystem consisting of different actors. The value of major projects amounts to several million euros, and companies play a key role in them.
2. *Creating and testing an operating model for an industrial data accelerator*. The Finnish Age of Artificial Intelligence programme tested an AI accelerator operating model that drew on facilitated peer learning between companies. The results of this experiment were good, and the accelerator has continued to operate after project funding expired. This successful operating method could also be applied to accelerating the data economy in manufacturing industry. The accelerator activities would help companies map and efficiently deploy data found in their separate systems or modules. As a result of the accelerator work, companies' ability to move forward in the data economy, make better use of the available opportunities to develop data economy, and their participation in the data economy will be diversified and expanded.
3. *The activities of Finland's GAIA-X hub will bolstered, and it will have at least 100 participating companies*. GAIA-X is an initiative that reinforces the EU's AI and data strategies and strategic autonomy with the aim of creating an European cloud service environment and data space infrastructure. The

63 Data space refers to a logically defined and limited entity with shared principles and rules for data processing. It improves interoperability and supports the creation of new services and innovations based on sharing and using data.

development of GAIA-X will be guided by company-driven use cases, and its financing will be obtained from national and EU sources. Finland's GAIA-X hub, which will be set up and operated by Sitra, will promote the utilisation of Finnish use cases and the deployment of Finnish technology in the GAIA-X architecture. In Finland, company consortiums put together by the hub are emerging around GAIA-X in at least five sectors. The consortiums will be the starting point for significant investments and RDI projects on developing data spaces. They should include large companies, SMEs and technology sector start-ups alike.

KR 3.3. High-performance computing will be used more widely in industry

Efficient development and use of demanding AI applications require large computing capacity, the costs of which may be significant. The rapidly advancing quantum computing is opening up completely new possibilities for AI use in increasingly demanding applications.

Initial actions and objectives recommended by the programme:

1. *Increasing the number of company users of EURO-HPC by 100% annually*. One of the supercomputers of the EuroHPC, Europe's high-performance computing network, is located in Kajaani, and the new Lumi computer adds to its services. The ability of Finnish companies and particularly SMEs to use the available high-performance computing resources has been modest. To activate companies and to increase EuroHPC use, the AI Business Finland programme offers AI computing support[64].
2. *Taking up the quantum challenge, with a minimum of 100 companies participating in the campaign*. Finland's aim is to be one of EU's key centres of excellence of quantum computing and an attractive investment environment in this field. To attain this goal, VTT will build a quantum computer in cooperation with the Finnish quantum computing start-up, IQM, by 2025. The quantum computer will be a major boost to the Finnish expertise and ecosystem in this field. Quantum computing is expected to revolutionise data processing in the future, but so far, companies have little or no awareness of its concrete use cases and possibilities. Following the example of the AI ethics challenge included in the Finnish Age of Artificial Intelligence programme and through the Artificial Intelligence 4.0 programme's challenge campaign, Finnish companies will be involved in developing new technology, and the company-centeredness of technology development will be enhanced.

64 Support can be granted to companies' significant computing-intensive AI research projects in which the computing costs exceed EUR 20,000 and which are applying for, or have been granted, Business Finland's RDI funding.

Extensive and diverse participation of companies in creating use scenarios for new technology will boost development cooperation and reinforce Finland's positive country image.

3. *Creating a shared use environment for quantum technologies*. Quantum computers, and quantum computing resources and environments, are being developed in a number of projects in Europe and globally. Supercomputers, including the EuroHPC, will be essential development and test environments of quantum computing in the next few years. To speed up and expand the development, a shared environment that combines different resources across the Internet should be created. Finnish actors could be essentially involved in this environment with their expertise and resources.

KR 3.4. Start-up activities based on top technological expertise will grow

The interfaces between entrepreneur/start-up ecosystems and innovation ecosystems are challenging junctures in the innovation process. The innovation ecosystem focuses on creating new knowledge and inventions. The ecosystems usually have universities, research institutes and companies as members in their networks. A successful innovation ecosystem combines globally valued special expertise and business based on it.[65]

Initial actions and objectives recommended by the programme:

1. *Mapping Finnish and international business incubator activities specialising in industrial applications of digitalisation and VC funding for promoting sustainability*. Pre-incubators and early-stage entrepreneurship programmes are typically implemented by universities, higher education institutions or other educational institutions. The incubator activities concentrate on initial and early-stage companies with growth potential which have access to a centralised offer of know-how, competence, networks and funding.[66] New accelerator operating models capitalise on large companies' growing interest in start-up cooperation. Mapping the situation of know-how and expertise revolving around industrial applications of digitalisation and start-up entrepreneurship will provide a knowledge base for support and development actions.

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65 Ministry of Economic Affairs and Employment: Hautomot ja kiihdyttämöt suomalaisissa innovaatioekosysteemeissä 2019: FINAC 2019: Terveys- ja hyvinvointisektorin innovaatiotoiminnan kehittämistyöpaja: Hautomoiden ja kiihdyttämöiden rooli innovaatioekosysteemissä. Ministry of Economic Affairs and Employment 11 February 2019. https://finac.fi/wp-content/uploads/2019/02/Marit-esitys-11022019-jakoon.pdf

66 Ministry of Economic Affairs and Employment: Hautomot ja kiihdyttämöt suomalaisissa innovaatioekosysteemeissä 2019: FINAC 2019: Terveys- ja hyvinvointisektorin innovaatiotoiminnan kehittämistyöpaja: Hautomoiden ja kiihdyttämöiden rooli innovaatioekosysteemissä. Ministry of Economic Affairs and Employment 11 February 2019. https://finac.fi/wp-content/uploads/2019/02/Marit-esitys-11022019-jakoon.pdf

2. *Intensifying cooperation between research, start-up activities and industry*. Choices are needed regarding growth accelerators: the activities must be focused on and resources must be allocated to areas in which Finland can have a global competitive advantage. Closer cooperation must also be developed between research, start-up activities and industry. After the start-up stage, the growth accelerators to be used should, as a rule, be specific to a certain sector or similar.67 From companies' perspective, supporting growth is at best a cost-effective comprehensive service process, even if it were produced by several parties.

04 Advanced digital technologies will serve Sustainable Development Goals and a transition to a carbon neutral Finland in 2035

The goal set in Prime Minister Marin's Government Programme is that Finland will be carbon neutral by 2035 and the world's first fossil-free welfare society. To achieve this goal, emissions reductions must be speeded up in all sectors, and the carbon sinks must be built up.

The market is being divided in new ways, and in this process, companies that have transitioned to sustainable manufacturing and business early will do well. Market-driven change will often be based on consumer behaviour rather than regulation. Consumers are increasingly demanding more responsibility and sustainability and also changing b-to-b activities.

Sustainable development creates many business opportunities for Finnish companies. For example, the forest industry, chemical industry and technology industry have produced roadmaps (with Technology Industries of Finland as an example68) which help companies reduce their greenhouse gas emissions significantly while offering Finland export potential amounting to tens of billions. Companies increasingly base their strategies on sustainable development. Many Finnish export products and services can be considered

67 Ministry of Economic Affairs and Employment: Hautomot ja kiihdyttämöt suomalaisissa innovaatioekosysteemeissä 2019: FINAC 2019: Terveys- ja hyvinvointisektorin innovaatiotoiminnan kehittämistyöpaja: Hautomoiden ja kiihdyttämöiden rooli innovaatioekosysteemissä. Ministry of Economic Affairs and Employment 11 February 2019. https://finac.fi/wp-content/uploads/2019/02/Marit-esitys-11022019-jakoon.pdf

68 Technology Industries of Finland 2020: Technology Industries of Finland's low-carbon roadmap: solutions to the climate challenge. https://teknologiateollisuus.fi/en/focus/environment-and-sustainability/technology-industries-finlands-low-carbon-roadmap-solutions

exemplary measured by their carbon handprint69, as the companies manufacture products that help customers reduce their carbon footprint and other environmental loading. The green transition is also seen as a business opportunity in many SMEs.70

Digitalisation is frequently a precondition for achieving Sustainable Development Goals and climate objectives, creating a circular economy, improving resource efficiency and addressing environmental issues. For instance, data and AI are needed for the traceability and exchanges required by the circular economy. The impacts of digitalisation on the environment are not always exclusively positive, however. They may also lead to new environmental loading and wasteful use of natural resources71.

In the Artificial Intelligence 4.0 programme, industry's climate objectives and the circular economy are examined from the perspectives of digitalisation, data and AI use. This programme does not address other important means of implementing the green transition, such as energy production. Ethical digitalisation will play a central part in attaining the Sustainable Development Goals.

Programme objective 4 primarily supports the achievement of Sustainable Development Goals 9 (Industry, innovation and infrastructure), 11 (Sustainable cities and communities) and 13 (Climate action). In second place, the programme promotes the attainment of goals 7 (Affordable and clean energy), 12 (Responsible consumption and production) as well as 14 and 15 (Life below water & and Life on land).

Key results for promoting the attainment of Sustainable Development Goals:

1. *Data-based circular economy promotes ecologically sustainable business*
2. *Green and ethical digitalisation will be an important asset for Finnish exports*

KR 4.1 Data-based circular economy promotes ecologically sustainable business

The twin transition aimed for, or the circular economy associated with it, will not be achieved without data and data sharing between different platforms. The operation of AI and similar advanced computing technologies requires big data curated to a high

69 Pelkonen, Jaana 2016: Hiilikädenjäljestä uuden kasvun kimmoke. Sitra 25 May 2016. https://www.sitra.fi/uutiset/hiilikadenjaljesta-uuden-kasvun-kimmoke

70 Kivikoski, Jouni - Kauppinen, Tatu 2021: Pk-yritysten opit digitalisaatiosta 2020: Miten digitalisointi on auttanut pk-yrityksiä menestymään? Priot Konsultointi Oy. https://www.yrittajat.fi/sites/default/files/tutkimus_pk_yritysten_digitalisaatiosta_2020.pdf

71 Climate and Environmental Strategy for the ICT Sector. https://julkaisut.valtioneuvosto.fi/handle/10024/162912

standard; innovations are enabled by combinations of data sets. The data economy means more to circular economy than merely advanced digitalisation – it is an essential precondition.

Initial actions and objectives recommended by the programme:

1. *New data platforms of the circular economy and globally interesting examples of green business based on data sharing will emerge*. The projects aiming to develop Finnish data spaces (OK 3.2) will systematically serve environmentally sustainable business.
2. *We will be strongly profiled as promoters of circular economy in the manufacturing industry*. We will reinforce cooperation on developing European data spaces and platforms, in particular to promote the circular economy. We will participate in producing specifications and ensure that Finnish actors' expertise, products and data-based business will be compatible with key future requirements. We will create rules and tools for building sustainable data-based business. We will support communities and experiments in which data sharing is fair and transparent and serves sustainable growth in industry.

KR 4.2 Green and ethical digitalisation will be an important asset for Finnish exports

We are profiled in the global market by assisting our customers to operate sustainably and responsibly. The aim will be to develop solutions that increase the carbon handprint as well as new export products and services based on them.

Promoting ethical AI use was highlighted as one of the most important actions of the Finnish Age of Artificial Intelligence programme. The Artificial Intelligence 4.0 programme strives to promote ethical and sustainable data use in business.

Initial actions and objectives recommended by the programme:

1. *Identifying and supporting growth ecosystems* which develop globally competitive export products and services based on AI technologies that help customers reduce their carbon footprint and environmental loading.
2. *Together with Finnish companies, focusing on assessing the carbon handprint of products and services*, communicating about the handprint and developing an assessment method.
3. *Participating and influencing European and international AI legislation and research* regarding ethical and secure AI use.
4. *Promoting the deployment of computing principles and technologies of environmentally sustainable AI* ('Green AI') instead of AI focusing on efficiency ('Red AI').

4 Next steps

Artificial Intelligence 4.0 is a programme with a wide scope which aims to speed up a systemic change in business by using AI and other advanced digital technologies associated with it as instruments of change. By accelerating the deployment of these technologies in industrial business, we can achieve important societal goals concerning the green and digital transition, recovery from the COVID-19 pandemic as well as companies' competitiveness, productivity growth and preconditions for creating jobs in a changing world.

The programme's vision of global leadership in the sustainable digitalisation of industrial business is extremely ambitious. The objectives it sets are demanding, and the key results leading to them will be challenging to achieve. It is obvious that while we can give the desired change a nudge forward in the three years covered by this programme (2021–2023), the final impacts of the activities will be seen over a time span of five to ten years.

The Artificial Intelligence 4.0 programme is not striving for its goals alone. Not only plenty of concrete work and pulling together over the long term but also orchestration of change projects and actions with similar impacts as well as the creation of shared knowledge, visibility and awareness will be needed to bring about the projected change. This is why achieving the objectives and key results of the Artificial Intelligence 4.0 programme will, above all, be the result of excellent cooperation.

At the strategic and policy planning level, the objectives of the Artificial Intelligence 4.0 programme and others, especially policy programmes implementing Prime Minister Marin's Government Programme and promoting recovery from the COVID-19 crisis will need to be coordinated. Key ones of these are the Sustainable Growth Programme for Finland, a strategy for industrial renewal, the Circular Economy Programme, the National Roadmap for Research, Development and Innovation and the Government's entrepreneurship strategy. Clear synergies have also been identified with the drafting and monitoring of Finland's technology policy as well as many sector-specific development strategies and roadmaps. Ministerial cooperation in different forums, especially between the Ministry of Economic Affairs and Employment, the Ministry of Transport

and Communications, the Ministry of Education and Culture, the Ministry of Finance and the Ministry for the Environment will be vital. In EU level policies, key synergies and cooperation needs are associated with Europe's Digital Decade initiative and the Digital Compass as well as the industrial, AI and data strategies that speed up the twin transition. The steering group, and especially its chairs and secretariat, will be responsible for this cooperation.

Facilitated by the Artificial Intelligence 4.0 programme, a national overall strategy for the fourth industrial revolution will be prepared, which will be influential both in Finland and internationally. The goal is that industrial sectors, business ecosystems, companies, research institutes and higher education institutions, regions and advocacy organisations can link their roadmaps and actions plans to the implementation of the national agenda.

At the implementation level, putting together versatile and comprehensive networks and ecosystems which will add detail to the action plans and implement them will be important. The sub-groups to be set up will ensure that, in order to promote sustainable digitalisation in industrial business, a national network of networks will emerge, which will make it possible to gather the recommended measures together and implement them in a decentralised manner through the networks. Development communities and projects, often local ones, formed by companies, higher education institutions and research institutes as well as public organisations including cities and counties will play a crucial role in programme implementation. The sub-group chairs, members of the Artificial Intelligence 4.0 programme's steering group and representatives of the secretariat will be responsible for this cooperation.

Promoting the financing and investments necessary for implementing the programme will be an essential part of the activities. Essential funding sources and partners for the actions will be Business Finland and its Quantum leap mission, the Academy of Finland, the EU's Horizon Europe and Digital Europe programmes, SITRA's fair data economy theme and, in particular, the Centres for Economic Development, Transport and the Environment and regional councils for the part of Finland's Structural Funds programme 2021–2027. In addition to programme-based funding, the Ministry of Economic Affairs and Employment, VTT and Business Finland will invest their funding in the coordination and implementation of the programme. Resource allocation and promotion of investments will be coordinated by the Ministry of Economic Affairs and Employment.

At the level of monitoring and evaluating the programme's effectiveness, the cooperation will mean continuously updating the situation picture of business digitalisation. The programme will continue national cooperation, for example under the auspices of the Digital Barometer project, and strengthen support for work on thematic and regional situation pictures. Coordinated by VTT, international comparison data related to the

programme's objectives will be collected, in addition to participating in the development of the DESI index and the EU's Digital Compass in cooperation with other ministries, the Prime Minister's Office and the European Commission.

Doing things together also means making things visible together. This is why communication, ensuring the customer-centeredness and comprehensibility of policy actions, and knowledge-based steering will play an essential part in the programme's success. Investments will be made in communication both in Finland and the international context.

The table has been set for sustainable digitalisation and the next step towards AI use. Now is the time for action.

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Artificial Intelligence 4.0 programme's first interim report: from launch to implementation stage

This document is the first interim report of the Artificial Intelligence 4.0 programme. It describes the current state and outlook of the fourth industrial revolution and advanced digitalisation associated with it in Finland and globally by analysing survey and statistical data on digitalisation in companies as well as, in particular, the European Commission's digitalisation policy framework.

The report also contains a proposal for the overall target state Finland should strive for in the development and use of digitalisation that promotes the fourth industrial revolution in cooperation between companies, research institutes and educational institutions and public organisations. The development objectives, initial key results and a plan for sub-groups that will add detail to and implement them are presented in the report using the OKR method.

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