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The role of industrial digitalisation in post-Covid-19 manufacturing recovery, diversification and resilience

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Key Messages

- In simple terms, Industry 4.0 describes the widespread digitalisation of the manufacturing sector. In the past decade the shift to industrial digitalisation has largely been motivated by the desire to boost productivity and growth in an increasingly competitive manufacturing landscape.

- Evidence from around the world shows that digitalisation can play a key role in the post-Covid-19 manufacturing recovery (i.e. resuming operations), diversification (i.e. exploring new products and new markets) and resilience (i.e. preparing for supply/demand shocks and operational risks).

- Alongside previous drivers for industrial digitalisation, the Covid-19 pandemic has highlighted several new drivers for accelerating the adoption of Industry 4.0 in the UK and the world, including:

  Supply chain transparency, predictability and flexibillity

  Efficient workspace reconfiguration and staff tracking

  Increased remote working and training

  Flexibility to repurpose production

- In general, the international response to Covid-19 has been to accelerate industrial digitalisation across the entire manufacturing sector through existing or new horizontal measures.

- We find that countries are both reaffirming their previous commitments to Industry 4.0 technologies and creating new funding programmes and initiatives. For example:

  Japan is doubling down on support for automation in a bid to reshore manufacturing and support greater supply chain resilience.

  South Korea has pledged to roll out AI and 5G services, echoing previous commitments to expand AI and telecommunications infrastructure.

  Singapore's existing "Go Digital" programme is being promoted to help businesses embrace digitalisation to overcome the challenges posed by the Covid-19 pandemic.

  Germany has established a €2 billion fund for start-ups and a €130 billion stimulus package, including additional loans and support for SMEs.

  China has announced a new plan to leverage digital technologies to resume production and support recovery focused on the development of remote working solutions and virus prevention and control solutions.

Emerging drivers of industrial digitalisation post-Covid-19

- Some national governments see industrial digitalisation as a potential source of social and employment safety net enhancements. For example, Korea's "Digital New Deal" involves a $48 billion investment targeted at creating 903,000 jobs.

- Key emerging messages, with implications for the UK Industrial Strategy, include the following:

  The UK is in a good position to follow the global trend towards industrial digitalisation. Further support is required to foster digital technology adoption to: employ workforce and visitor management solutions to ensure health and safety; enable digital workflows for remote working; implement intelligent supply chain forecasting to flexibly adjust production according to changes in demand; facilitate Project Defend reshoring through increased automation; and support green recovery and more sustainable forms of production in line with net zero directives.

  A wider roll-out of the Made Smarter programme could be considered as a key policy priority for the UK in the short term. However, national rollout is a challenge because of the UK's current institutional landscape. When analysing similar digital adoption initiatives internationally, it is clear that the institutional set-up of countries facilitates the national rollout of digital technology support programmes. A future UK industrial Strategy could help to the development of long-term regional structures to support digital technology adoption and innovation.

Supply chain transparency, predictability and flexibillity

Efficient workspace reconfiguration and staff tracking

Increased remote working and training

Flexibility to repurpose production

1. Background

Since the outbreak of the novel coronavirus was first declared in December 2019, there have been more than 16 million confirmed cases worldwide.[1] The rapid spread and scale of Covid-19 has caused widespread disruption to the manufacturing sector.[2] Restrictions on movement, factory closures and supply chain disruption have led to a sharp global downturn in manufacturing.[3] Covid-19 has also exposed the weakness of global value chains in responding to demand shocks and dealing with operational risks.[4]

In the UK almost a third of manufacturers have seen their orders decline by up to 50 per cent. Nearly 40 per cent of companies believe that it could take more than 12 months to return to normal trading conditions.[5] Nonetheless, the manufacturing sector has played a key role in the UK's response to the pandemic. Whether by scaling up the production of critical supplies for the health-care sector or maintaining food production, manufacturing firms have shown their importance in a time of national crisis.

As the UK moves towards the next stage in dealing with Covid-19, it is time to start thinking about manufacturing recovery (i.e. resuming operations prior to Covid-19), diversification (i.e. exploring new products and new markets) and resilience (i.e. preparing for supply/demand shocks and operational risks), particularly for hard-hit industries such as aerospace and automotive.

In light of this sudden change to the manufacturing landscape, it is necessary to consider what role digital technologies might play in the recovery of the sector. Made Smarter, which was launched at the end of 2018, has been the UK's flagship project for advancing Industry 4.0 in domestic manufacturing firms. Although the UK has been lagging behind other nations in the adoption of industrial digitalisation technologies (IDTs), Made Smarter aims to position the UK as a centre of excellence for Industry 4.0 to "recapture the UK's industrial spirit as a nation of creators and makers".[6]

Against this backdrop, this policy brief begins by identifying the key drivers of industrial digitalisation before and after Covid-19. It suggests how different IDTs could support recovery, diversification and resilience of manufacturing in the UK. It then looks at how other countries have adjusted their digitalisation strategies in response to Covid-19. Finally, it puts forward several emerging policy themes for industrial digitalisation.

2. Drivers of Industrial Digitalisation

It is nearly ten years since Industry 4.0 was first hailed as the next revolution in manufacturing.[7] In simple terms, Industry 4.0 describes the widespread digitalisation of the manufacturing sector. Big data, artificial intelligence (AI), the Internet of things (IoT), virtual reality (VR) and automation are among some of the key IDTs enabling this transformation.

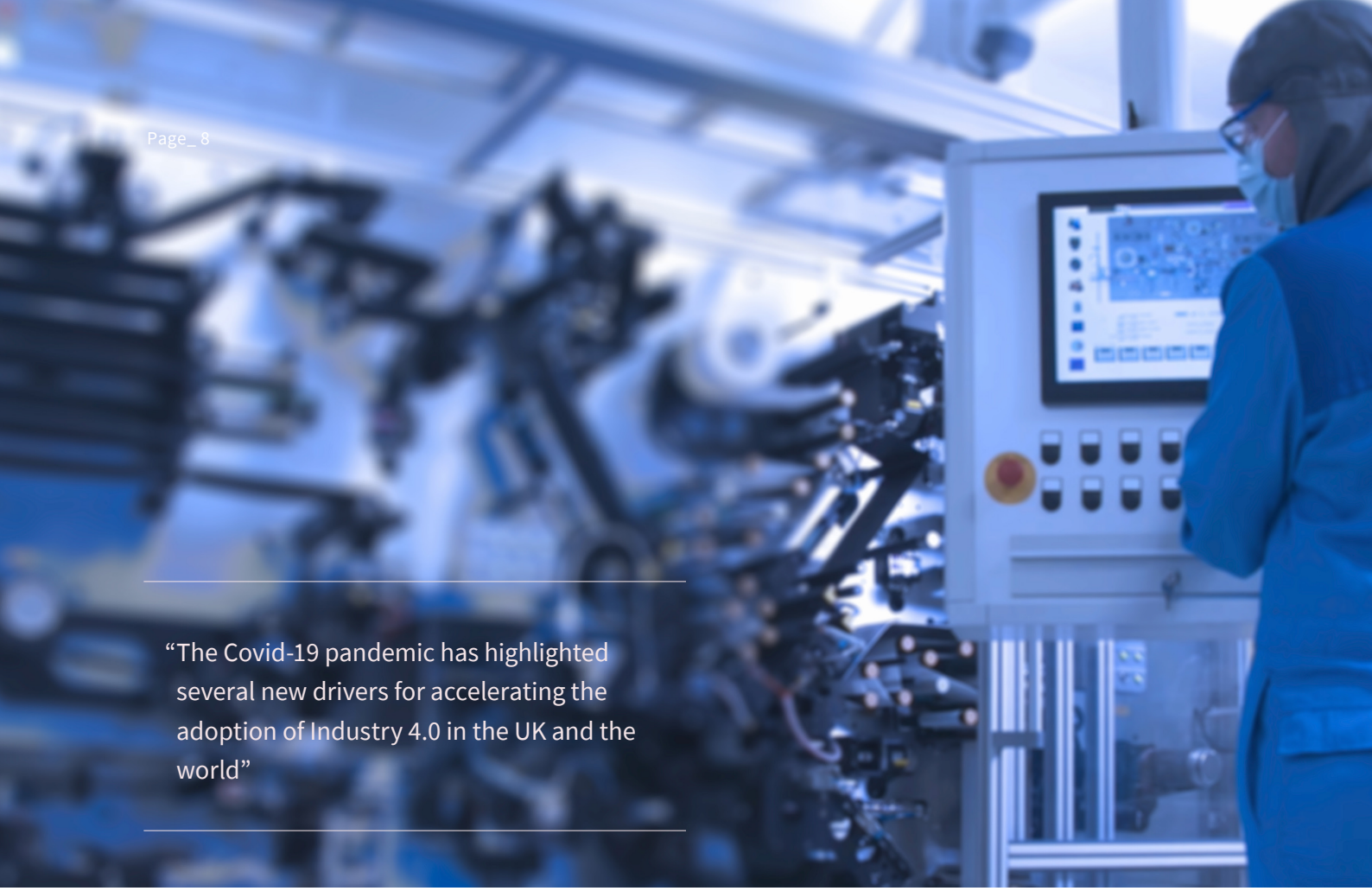
In the past decade the shift to industrial digitalisation has largely been motivated by the desire to boost productivity and growth in an increasingly competitive manufacturing landscape. The Made Smarter Review, an industry-led study exploring how UK manufacturing can maximise benefits from increasing adoption of digital technology through a strong industry and government partnership, found that Industry 4.0 can:

- Raise UK productivity and international competitiveness (leading to increased manufacturing sector growth of between 1.5 and 3 per cent per annum);
- Create new, higher-paid, higher-skilled jobs that add value to society and positively offset the displacement of poor productivity and poorly paid jobs (with a conservative estimated net gain of 175,000 jobs throughout the economy);
- Strengthen UK supply chains and create new value streams;
- Address regional economic disparities;
- Increase exports through competitiveness;
- Create a new vibrant technology market serving UK industry and attracting FDI;
- Improve the resource efficiency of the UK's industrial base, making it more resilient to global resource supply disruptions and reducing its environmental impact through more efficient manufacturing and industrial processes and more optimised supply chains (potentially reducing CO2 emissions by 4.5 per cent).

Box 1. How has industrial digitalisation already improved productivity in manufacturing in the UK?

Rolls-Royce business unit, Power System, are already using digital twin technologies to model real-time operational data and to improve decision-making. Their project, Customer Service 4.0, allows them to remotely monitor the performance of engines, track their inventory, schedule maintenance and analyse performance data. For customers, they have developed a Go!Act app, which uses data from connected devices to identify the sources of any faults in their systems. These technologies facilitate data-rich communication between operators, service providers and experts, and they help Rolls-Royce to fulfil their long-term service responsibilities under the Value Care Agreement.

Source: Rolls-Royce, "'Customer Service 4.0' at Rolls-Royce Power Systems – A New Service and Digital Strategy to Transform MTU's Global Customer Support", 2018, https://www.rolls-royce.com/media/press-releases.aspx.



"The Covid-19 pandemic has highlighted several new drivers for accelerating the adoption of Industry 4.0 in the UK and the world"

Post-Covid-19 emerging drivers of industrial digitalisation

On the question of whether industrial digitalisation will be accelerated by the Covid-19 disaster, emerging evidence suggests that experts around the world are convinced of the importance of digital technologies to promote manufacturing recovery, diversification and resilience. For example, a joint statement from Japanese and German experts representing their nations' official Industry 4.0 programmes (i.e. the Robot Revolution & Industrial IoT Initiative, and the Research Council of Plattform Industrie 4.0, respectively) states that "Japan and Germany agree that the future development will enhance digitalisation in general in both countries".[8] In particular, Germany's policy approach is to pursue the idea of digital tools to support human activities (i.e. more human-centred manufacturing processes rather than replacing human work with machines).

In this regard, a survey of "Mittelstand" enterprises in Germany (i.e. SMEs) conducted by McKinsey confirms that digitisation remains a priority for 89 per cent of respondents, with 34 per cent reporting that it increased in significance during the crisis.[9] Although the Covid-19 crisis is increasing the need to digitalise, it is also forcing companies to pause some ongoing digital projects to manage costs while they navigate the worst part of the crisis. This is where government action could be effective in supporting firms to build resilience by facilitating digital technology adoption.

In the case of the UK a survey carried out by Make UK indicates that local firms also perceive industrial digitalisation technologies as a key tool for building resilience and recovering from the crisis:[10]

- 46 per cent of surveyed firms agree that past investments in industrial digitalisation technologies (IDTs) have helped them to survive the Covid-19 crisis, whereas only 20 per cent disagree.
- 44 per cent of firms agree with the idea that IDTs would have made a difference to their resilience during the recent crisis, whereas only 27 per cent disagree.
- 60 per cent of respondents believe that achieving the full potential of IDTs requires government support.

- 71 per cent of surveyed firms are planning to increase their investment in IDTs over the next 2 years, despite the Covid-19 crisis.

In summary, the business case for supporting industrial digitalisation has become more evident during the crisis. Alongside previous drivers for industrial digitalisation, the Covid-19 pandemic has highlighted several new drivers for accelerating the adoption of Industry 4.0 in the UK and the world, including:

- **Supply chain transparency, predictability and flexibility.** Covid-19 has demonstrated how fragile existing value chains are, and also that transparency is still missing. Manufacturers need more granular and frequent data to deal with increased uncertainty. Real-time inventory data and intelligent processes for modelling demand provide more accurate forecasting. Algorithms can be used to detect purchase pattern changes in real time. Synthetic data sets and advanced machine learning techniques can be used to train new predictive demand models, even when historical data is insufficient.[11]

- **Efficient work space re-configuration and staff tracking.** Manufacturing line space is at a premium, so operators are normally positioned at 0.6m intervals. New requirements for personal protective equipment and social distancing rules mean increased costs for human assembly teams. This increased cost creates a new impetus for machine line automation, which can help organisations to comply with guidelines to reduce virus transmission.[12] Furthermore, digital technologies can facilitate the real-time tracking of people to ensure compliance with social distancing rules.

- **Increased remote working and training**. Remote working requires digital ways to model production workflows. Digital twins can help to validate the production and assembly line against virtual facility layouts. Industrial digitalisation can also help to identify the optimal process layout for operators and machinery, help to develop online workshop instructions, and enable the digital management of process changes.[13]

- **Flexibility to repurpose production.** During the peak of the Covid-19 crisis governments around the world encouraged manufacturing firms to repurpose their operations to address shortages of critical items, including personal protective equipment (PPE) and medical ventilators. Digital technologies can help firms to adapt production processes to those goods in high demand through the use of modelling tools to re-design production lines and 3D printing for rapid prototyping, among others.

Box 2. How has industrial digitalisation helped with the recovery and diversification after past crises?

The cascading earthquake, tsunami and nuclear disaster in Fukushima on 11 March 2011 created widespread damage in the region. Prior to the disaster, Fukushima had the largest manufacturing output of the region, with significant expertise in electronic component design and production. Following the disaster, the manufacturing sector shrunk by nearly 15 per cent. In response, the Business and Industrial Promotion Basic Plan – Shinsukue Fukushima Industrial Planning was announced. This strategy aimed to support new areas of manufacturing, including renewable energy and robot-related manufacturing industries. The Innovation Coast Framework of Fukushima specifically focused on integrating Industry 4.0 technologies into manufacturing. A robotics facility was established in Nahara to support robot production and testing for decommissioning practices, as well as a robot development and demonstration centre in Minamisoma City. Fukushima is now being cultivated as a centre of excellence for robotics and automation in Japan. In the long term it aims to be a world leader in medical support and assistive devices, through the application of robotic solutions.

Source: Hui Zhang et al., "Bounce Forward: Economic Recovery in Post-Disaster Fukushima", Sustainability 11, no. 23 (January 2019): 6736, https://doi.org/10.3390/su11236736.

Table 1 identifies some of the key digital technologies in Industry 4.0. Based on the current capabilities of these technologies, it provides a speculative view of how they could be applied to help with manufacturing recovery and diversification post-Covid.

Table 1. Key digital technologies and their relevance to post-Covid recovery and diversification

Example technologies	Driver 1 Supply chain transparency, predictability and flexibility	Driver 2 Efficient work space re-configuration and staff tracking	Driver 3 Increased remote working and training	Driver 4 Flexibility to repurpose production	How can it help recovery, diversification and resilience of manufacturing?
Artificial intelligence (AI) - AI describes a collection of techniques, including machine learning, that enable systems to interpret and learn from data in order to achieve flexible goals.	✓				AI can help to build more resilient supply chains through advanced supply forecasting to predict demand and accurately plan manufacturing activities.[11] Predictive analysis can help with revenue stability through dynamic pricing optimisation and identifying areas for diversification.[14]
Big data - handles high information density and uses mathematical analysis to measure trends, identify relationships and dependencies.	✓	✓	✓		Enables remote working solutions and better supply chain visibility.[15] Real-time data can be monitored against key performance indicators (KPIs) on people, assets, work in progress, finished goods.
Digital twins - integrate several digital technologies to create living digital replicas of physical entities. These simulations can include people, places, processes and systems.			✓	✓	Real-time modelling of production and assembly lines can support remote workforces to make informed decisions. End-to-end visibility of inventory, machines and processes supports seamless integration between increased digital and physical working.[13]
Internet of things (IoT) - refers to a system of connected devices that can collect, transfer, analyse and store data via sensors.	✓	✓			IoT-enabled inventory can help with waste reduction and maintenance improvements, further boosting productivity.[16] Workforce tracking can manage the risk of virus transmissions.[17]
Virtual reality (VR)/ Augmented reality (AR) - an artificial environment that presents itself as a real environment. AR is a hybrid of a real–artificial environment. The real environment is enhanced through computer-generated information to create an interactive experience.			✓		Upskilling and re-training the workforce helps to mitigate against skills shortages due to self-isolation or repurposing/diversification of manufacturing.
Automation and robotics - Autonomous robots can carry out tasks without any human interaction. Collaborative robots, or cobots, can work alongside human employees to boost production.		✓			Reduces the demands on workforce labour and helps compliance with social distancing.[18] Supports reshoring costs, advancing supply chain resilience. Increases machine operation hours, boosting productivity.[19]
Additive manufacturing - A set of technologies that enable the layer-by-layer production of a three-dimensional object from a digital 3D computer aided design model.				✓	Supports flexible production and agile response to demand fluctuations. Helps to build future crisis preparedness and solve supply chain gaps.[20]

3. International Policy Responses

Having understood some of the key emerging drivers for digital industrialisation, we now consider international policy response changes as a result of Covid-19. Table 2 summarises the industrial digitalisation policy response changes from Germany, Singapore, Japan, South Korea and China. The US was also initially reviewed but removed from further analysis because no specific digitalisation strategy was identified.

In general, the international response to Covid-19 has been to accelerate industrial digitalisation across the entire manufacturing sector through existing or new horizontal measures. We find that countries are reaffirming their previous commitments to Industry 4.0 technologies. For example, Japan is doubling down on support for automation in a bid to reshore manufacturing and support greater supply chain resilience.[21] South Korea has pledged to roll out AI and 5G services, echoing previous commitments to expand AI and telecommunications infrastructure.[22] Singapore's existing "Go Digital" programme is being promoted to help businesses embrace digitalisation to overcome the challenges posed by the Covid-19 pandemic.[23] Additional programmes, funds and stimulus packages have also been created to support manufacturers. For example, Germany has established a €2 billion fund for start-ups and a €130 billion stimulus package, including additional loans and support for SMEs.[24] China has announced a new plan to leverage digital technologies to resume production and support recovery focused on the development of remote working solutions and virus prevention and control solutions.[25]

National governments see digitalisation not only as key to manufacturing recovery, diversification and resilience, but also as a potential source of social and employment safety net enhancement. For example, Korea's "Digital New Deal" involves a $48 billion investment targeted at creating 903,000 jobs by setting the conditions to stimulate growth

of the data, network and artificial intelligence industries supporting the manufacturing sector.[26] Singapore's Infocomm Media and Development Authority (IMDA) are partnering with industry leaders to train and place 3,000 Singaporeans in jobs to support a digital recovery.[27] The European Union has also recently announced support for green and digitalisation infrastructure to stimulate job creation and "smart, sustainable and inclusive growth".[28]

It is clear that industrial digitalisation is a key strategy for manufacturing recovery and diversification. If the UK is to maintain its commitment to world excellence in Industry 4.0, it could consider increasing its investments in digitalisation as a key strategy for manufacturing in a post-Covid landscape.

Table 2. International industrial digitalisation commitments since the Covid-19 pandemic

Country	Reinforcement of existing initiatives	Additional programmes and funds
Germany 	• **"Go Digital"** – Promotion of digitalisation measures and digital training for remote working via the Go Digital funding programme.[29] • **Digital Policy Agenda for the Environment** – Aims to make full use of digitalisation's potential to support climate action.[30]	• **€2 billion fund for start-up ecosystem and €130 billion stimulus package** – Includes additional loans and support for SMEs, with €50 billion targeted at R&D in low-carbon industries as part of the "Future Package".[31] • **"Digital Now"** – New funding for the digitisation of medium-sized businesses under the existing Mittelstand 4.0 Digitalisation Strategy.[32]
Singapore 	• **"Go Digital"** – The 2017 programme is being promoted to help businesses embrace digitalisation to overcome the challenges posed by the Covid-19 pandemic.[23] Its scope has been expanded to include remote working, workforce management and visitor management solutions.	• **Digital Resilience Bonus (DRB)** – Launched to uplift digital capabilities, with the initial target of the retail and food services sectors.[33] Includes training and placement of 3,000 graduates and mid-career professionals in digital and technology jobs.
Japan 	• **Robot Revolution Initiative (RRI)** – Open innovation platform established in 2015 with 226 members.[34] Focus on pursuing the replacement of human work with machines such as robots in response to the Covid-19 crisis.[8]	• **$9 billion subsidies** – Announced by the Development Bank of Japan to assist reshoring of production over the long term.[21] In an effort to mitigate increases in labour costs, subsidies will be offered for industrial robots and automation. New subsidies announced for IT and remote working solutions, as well as capital investments to improve manufacturing and services.[35]
South Korea 	• **Korea Smart Manufacturing Programme** – In 2019 the government pledged $9.3 billion of the 2020 budget to focus on AI, 5G services, digital twins and big data platforms.[36] There are plans to establish an AI research and development complex in Gwangju, and to offer vouchers to SMEs to buy AI solutions and set up big data platforms.	• **"Digital New Deal"** – Building on the existing "Korea Smart Manufacturing Programme", an additional $48 billion investment has been announced to create 903,000 job places.[26] There is a significant focus on AI and wireless telecommunications (5G) technology for post-Covid recovery.[37]
China 	• **Made in China 2025** – Launched in 2015, plans to continue the upgrade of China's manufacturing sector to higher-value products.[38] Inspired by Germany's Industry 4.0, the programme is focused on enabling smart manufacturing capabilities.	• **Digital Transformation Partnership Action Plan 2020** – Announced by the National Development and Reform Commission (NDRC) on 13 May to accelerate cross-sector digital transformation and support SMEs with access to research, digital tools, networking opportunities and training programmes.[39] • **Ministry of Science and Technology** – New plan announced to leverage digital technologies to resume production and support recovery.[25] Focused on remote working solutions (e.g. cloud manufacturing) and virus prevention and control solutions (e.g. health checks). Includes increased technical support and training to support SME recovery. Encouraging innovation hubs and technology incubators to share solutions with SMEs and accelerate new business models to support digitalisation and remote working.

4. Summary of Emerging Priorities for UK Digitalisation

This policy brief has highlighted several areas in which industrial digitalisation can help smooth the transition to the new normal. We summarise the following emerging priorities that are key to the short-term and long-term recovery, diversification and resilience of the manufacturing sector in the UK.

Workforce health and safety

Virus control and prevention is a priority area for manufacturing recovery. Since a relaxation in restrictions, multiple manufacturers have already faced closures as a result of outbreaks of Covid-19.[40] Workforce and visitor management solutions should be integrated swiftly to avoid disruption.

Digital workflows

In the coming months, remote working and physical–virtual mapping solutions need to be prioritised to accommodate a reduced physical workforce. Investing early in these solutions provides an opportunity to boost productivity.

Intelligent supply chain forecasting

Data-driven demand forecasting is needed to ensure better transparency across the value chain. Concerns about the prospect of a global recession could have significant ramifications for the manufacturing sector.[41] In the short term, manufacturers must flexibly adjust their production according to changes in demand. In the long term, it is clear that increased resilience and agility is a priority for UK manufacturing to deal with future crises or potential “second waves” of Covid-19.

Automation and reshoring

As the UK recently announced plans for greater reshoring as part of Project Defend,[42] digital technologies can help to smooth this transition, through training new workforces and managing increased labour costs through automation.

Green recovery and circular production

There is an increasing emphasis on using digitalisation to support a green recovery and more sustainable forms of production. We already know that Industry 4.0 can help to track resource and energy efficiency. There is a need to allocate funding for digital technologies to advance decarbonisation, in alignment with the UK’s target to be net zero by 2050.[43]

5. Implications for the UK Industrial Strategy

Covid-19 has dramatically changed the manufacturing landscape. While it is difficult to predict the lasting impact of this pandemic, it is clear that digitalisation has an important role to play in the recovery and diversification of manufacturing in both the short and long term.

1. In other countries industrial digitalisation has already been at the forefront of plans for the transformation of the manufacturing sector for many years. In recent times we have seen that other countries are not only maintaining their commitments but also reinforcing them with additional investment and support in an effort to accelerate Industry 4.0.

2. The UK is in a good position to follow the global trend towards industrial digitalisation. However, the evidence shows that early movers have an advantage. The UK could act swiftly to adopt industrial digitalisation in order to support the recovery and diversification of manufacturing. This additional support and investment are expected to further smooth the manufacturing sector after the Brexit transition period comes to an end.

3. A wider roll-out of the Made Smarter programme could be considered as a key policy priority for the UK in the short term. Any future amendments to the UK Industrial Strategy could help to ensure that the model developed during the Made Smarter regional adoption pilot for SMEs in North West England is transferred to the rest of the country. However, national rollout is a challenge because of the UK's current institutional landscape. When analysing similar digital adoption initiatives internationally, it is clear that the institutional set-up of countries facilitates the national rollout of digital technology support programmes. Other countries are using existing institutions to deliver digital support nationally (e.g. Japan through prefectural advisory centres and Germany through Steinbeis and Fraunhofer regional bases). A future UK Industrial Strategy could help to the development of long-term regional structures to support digital technology adoption and innovation.

About this policy brief

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