# MANUFACTURING TRENDS AND DRIVERS OVER THE NEXT 5 YEARS AND BEYOND

UNIVERSITY OF CAMBRIDGE
Department of Engineering

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## CONTRIBUTORS

The contributors to this report are: Imoh Ilevbare, Diana Khripko, Theresa McKeon, Shayma Salih and Nicky Athanassopoulou, IfM Engage, Institute for Manufacturing, University of Cambridge.

For further details please contact ifm-enquiries@eng.cam.ac.uk.

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## INTRODUCTION

Manufacturing remains an integral part of UK economic output, and in 2023 the manufacturing industry contributed 9% to UK GDP.[1] The same year the UK manufacturing sector ranked eighth globally by the value of output, with the industry generating a Gross Value Added figure of £224 billion, contributing 41% of all business R&D and employing 2.6 million people.[2]

World largest manufacturing economies[3]:

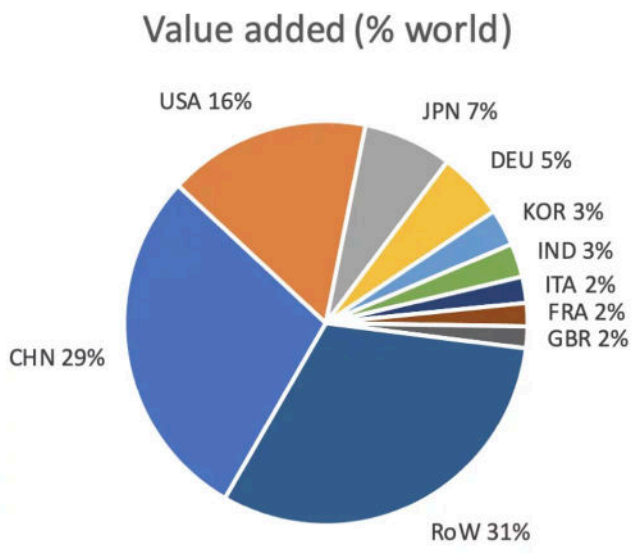


Figure 1: Gross production basis of global manufacturing.
Source: CEPR, The world's big players in manufacturing, data from the OECD TiVA database 2023

The global manufacturing sector is facing numerous challenges related to climate change, geopolitical shifts, new technology adoption and demographic changes. Understanding the most important external factors, and how they can impact manufacturing operations, now and in the future, is imperative for ensuring business resilience and longevity.

In 2023 IfM Engage conducted consultations with more than 50 manufacturing companies to assess industry trends and drivers for the next 5 years and beyond. These companies operated across various sectors, offering products, services, design, distribution and logistics. The contributors to this study were from the UK and around the world, representing diverse backgrounds, experiences and tenure in the manufacturing industry. The data has been collected, analysed and presented in this report.

The themes that arose surpassed the geographical boundaries and varying career lengths of the participants. Nevertheless, a quick demographic breakdown highlighted the differences and similarities in the profiles of the specialists who took part in the project. Much of their work was globally oriented. Only 13 people worked exclusively in domestic markets, with 20 internationally facing and 19 covering both areas. There were slightly more people with less than 20 years' experience in the sector than those who had spent more than 30 years in it. Just over half of the respondents worked in manufacturing, compared to services, design, distribution and logistics and "other" industries, including energy, procurement, basic and detail engineering and automotive.

1 World Bank Group, 'Value Added of Manufacturing' (% of GDP) - UK
2 MAKE UK, 'UK Manufacturing the facts: 2023'
3 Centre for Economic Policy Research (CEPR), 'China is the World's Sole Manufacturing Superpower', data from the OECD TiVA Database 2023

## Profile of the manufacturing specialists who took part in the project

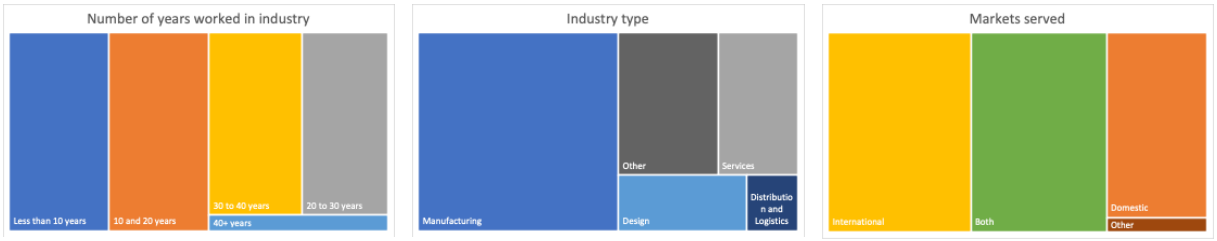


Figure 2: Visualisation of demographics of survey respondents

## Top trends and drivers over and beyond the next 5 years[4]

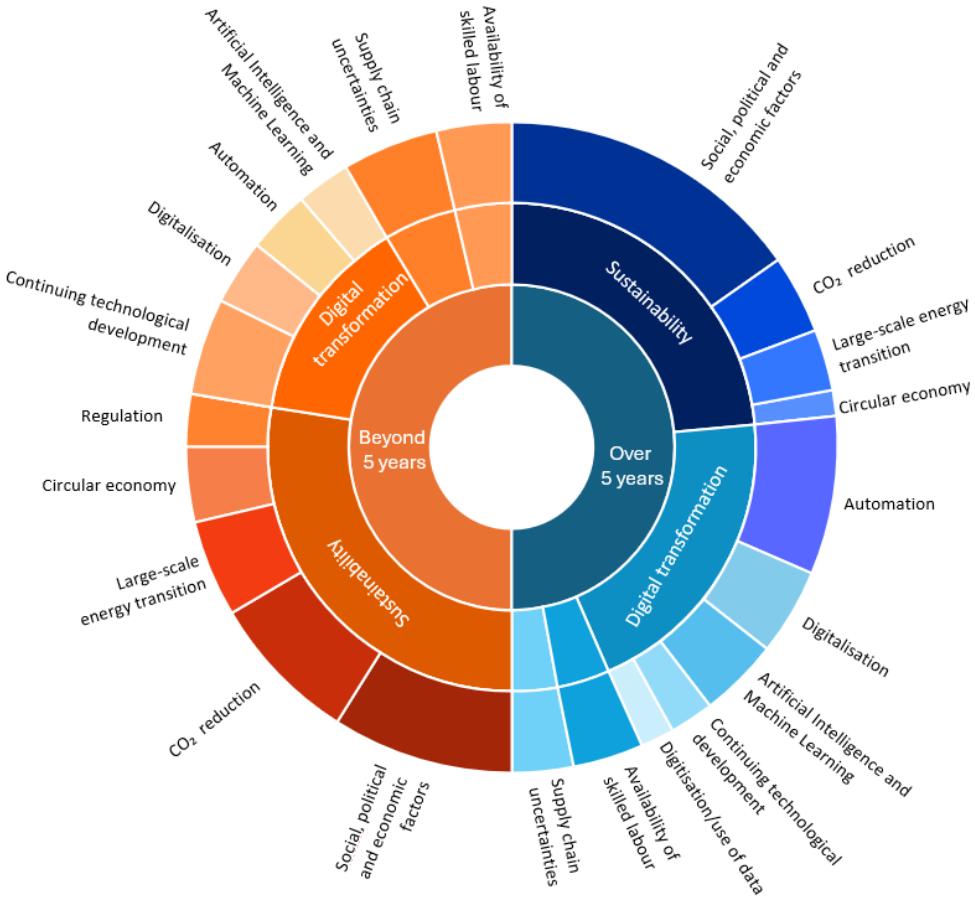


Figure 3: Visualisation of the top five most common responses from survey participants pertaining to both over and beyond the next five years

4 The responses can be categorised into four key themes across both time periods (the next 5 years and beyond), with specific trends and drivers comprising different aspects of each theme. The colours on each side of the figure represent this (the middle layer is the four themes and the outer components that will contribute to each theme). By using the same colour for each theme and trend on either side, we can show where experts perceived there will be more or less focus over time. For example, digital transformation is expected to have a slightly greater impact over the next 5 years, compared to the 5 years beyond that. Respondents indicated that the use of data and digitisation in manufacturing would feature more prominently over the next 5 years, so it is not reflected explicitly on the side of the graphic portraying trends beyond the next 5 years. Nevertheless, digitisation and other aspects of digital transformation are complex and entwined, as will be seen further down.

## KEY FINDINGS

The responses identified four main themes regarding trends and drivers of significant impact over and beyond the next 5 years. Industry specialists further broke down each theme into individual elements that they consider to be key components or causes influencing the overall trends. These shared themes underscore diverse industry and specialist recognition of the importance of addressing future challenges, emphasising their ongoing relevance and multifaceted nature. Furthermore, the validity of the survey results is underpinned by their alignment with analysis of nearly 2,000 scientific sources conducted by artificial intelligence. The overarching themes are as follows.

## 1. DIGITAL TRANSFORMATION (P5):

a. Increasing industrial automation
b. Artificial intelligence/machine learning
c. Digitalisation
d. Digitisation

## 2. SUSTAINABILITY (P10):

a. Customer demand for sustainable product and industry accountability for environmental impacts
b. The need for increasing energy and resource efficiency
c. Energy transition and alternative energy sources
d. Designing for sustainability and a circular economy
e. Rethinking and redesigning supply chains
f. Regulation to implement net zero

## 3. SUPPLY CHAIN UNCERTAINTIES AND TRANSITIONS (P16)

## 4. AVAILABILITY OF SKILLED LABOUR (P18)

## 1. DIGITAL TRANSFORMATION

Four trends identified from our industry survey are grouped under the digital transformation category: "increasing industrial automation"; "artificial intelligence/machine learning"; "digitalisation"; and "digitisation". Digital transformation is not a new topic; it has become a deeply embedded concept and remains top of the agenda of many boardroom meetings. This fundamental change process involves and is enabled by the innovative deployment, integration and use of digital (i.e. computer-based) technologies and the associated capabilities and skills.

The aim of digital transformation is to radically improve a business in how it operates and its ability to compete, and how it creates and delivers value to its customers and stakeholders. Digital transformation is a long-term and continuous effort whereby businesses continue to challenge the status quo, experiment with and integrate new technologies that could confer competitive advantage, and build the culture, capabilities and skills required to be successful.[5] One example of digital transformation is found in cyber–human systems and their potential to bolster, rather than replace, human abilities and performance.[6] The global digital transformation market size is worth approximately $850 billion and expected to reach around $4.2 trillion by 2032. Rapid advancements associated with the four technology trends are contributing to this significant growth.

### 1a. Increasing industrial automation

Automation is the use of technology to perform tasks with reduced human input or intervention. Automation (or "industrial automation" in the context of manufacturing) involves the use of computers and robots, and information technologies for handling process flows. Automation helps humans to shift their focus away from standard, repetitive and mundane tasks to value-adding tasks, as required in creativity and relationship-building. The primary benefits for industry are increased productivity and efficiency, resulting in a competitive market position. Indeed, such aspects of digital transformation align with the views of companies that responded to our survey. In their words, they believed that industrial automation will:

- Save time, improve quality, reduce cost, increase output and help offset the labour shortage by reducing reliance on operators
- Enable improved tracking and tracing
- Offer opportunities for optimisation and greater competitiveness.

Automation therefore aligns with other trends. For example, current and impending labour shortages will affect the manufacturing sector. Although there is already a lack of talent entering the workforce at a sustainable rate to replace those leaving and/or retiring, persistent staff shortfalls could have a calamitous impact on developed economies. In the UK this shortage is evident in the 36% of vacancies the sector is having difficulty filling. A gap of this magnitude could cripple the country's manufacturing industries.[7] Likewise, by 2030 over 2 million manufacturing jobs (roughly 53 out of 100) are expected to go unfilled in the US.[8] The changing nature of the required skill sets in factories undergoing digital transformation and technological advancement is one factor affecting jobs in manufacturing, with industrial automation mainly impacting and resulting in the loss of lower-skilled jobs.[9]

5 McKinsey and Company, 'What is Digital Transformation?', 2024; Gong, C. and Ribiere, V. (2021). Developing a Unified Definition of Digital Transformation. Technovation, 2021, pp. 1-17
6 R&D Today, 'Could Cyber-human Technology Improve Productivity?'
7 MAKE uk, 'The Labour Shortage Challenge for UK Manufacturers'; Production Engineering Solutions, 'UK Manufacturing Skills Reaching Crisis Point: WorldSkills UK Report Issues Wake-up Call', 2023
8 Vention, 'Five Rising Industrial Automation Trends to Expect in 2024', 2023; Deloitte Insights, 'The Problem Defined: Manufacturing Faces a Workface Shortage', 2021
9 MIT Industrial Performance Center, 'MIT Work of the Future: New Technologies, Better Jobs'

Another key driver in automation is global competition, especially from lower-wage economies, which have increased the cost pressure for most Western manufacturers. In response, manufacturing companies in developed economies seek to scale up their production while reducing the effort needed to integrate new equipment and tools, and to minimise start-up and maintenance times.

Automating manufacturing processes and systems is a critical part of the sector. Automation creates new possibilities and can provide innovative ways to solve many manufacturing challenges and approach a changing manufacturing footprint. It can increase production output, and product and service customisation, while addressing rising labour costs, quality issues and safety concerns. At the same time, automation is allowing emerging models of operation to be trialled, for example manufacturing as a service (MaaS). This trend is expected to continue with the incorporation of existing and new digital technologies into manufacturing systems and processes.[10]

Opportunities for automation in manufacturing span a range of industries. Pharmaceutical companies have been implementing automation solutions to enable them to use "just-in-time" manufacturing principles for drug production and dispensing. Semiconductor companies have automated processes and equipment to help them minimise manual handling, thus reducing impurities and contaminants while simultaneously improving the quality of semiconductor chips. Other engineering companies have adopted robotic solutions to increase production output without significantly expanding their labour forces. And smaller food companies have used automation to integrate several process steps, improving production speeds and product quality (by reducing the risk of contamination) and minimising food waste from product waiting times between processes.[11]

Traditionally, automation has been considered a predominantly large company activity as they have greater access to resources (capital, labour and expertise), enabling them to automate more easily.'[12] But in recent years skills shortages and increasing operating costs have led to small and medium-sized enterprises (SMEs) starting to automate their operations, with the goal of remaining competitive. Innovative, smaller organisations are therefore gaining experience in do-it-yourself automation by leveraging modular, low-cost digital solutions and off-the-shelf hardware and intuitive software.[13]

The evolution and increasing uptake of industrial automation are driven by multiple factors. From a technology advancement standpoint, these include artificial intelligence (AI), advanced robotics, the Internet of Things (IoT), 5G, edge and cloud computing, additive manufacturing, immersive technologies and wearables. Artificial intelligence, advanced robotics and industrial IoT are seen to have some of the highest impacts on industrial automation,[14] which organisations will continue to adopt as these technologies improve and become more affordable. As noted by our survey respondents, this adoption will "change the way industry works". Automation will be seen not as "nice-to-have" but as a necessity. The modularisation of automation systems and the increased affordability of relevant off-the-shelf technologies means they will become ever more accessible to smaller businesses.

10 Road4FAME, 'Deliverables 3.4 and 3.5: Final Consolidated Roadmap and Final Recommendations, pp. 8, 12-14, 32-34
11 Interreg North-West Europe COTEMACO, 'Food Manufacture 4.0 – Automation and Robotics at the Service of Food Manufacturing', 2020
12 MAKE uk and infor, 'Manufacturing and Automation: Opening the Gates for Productive and Efficient Growth', p. 17
13 Shoestring Digital Manufacturing, 'Easy Digitalisation'; International Federation of Robotics, 'Labour Shortage: How to Automate Small and Midsized Enterprises', 2023; Shoestring Digital Manufacturing, 'Industry Case Studies'
14 StartUs insights, 'Top 10 Industrial Automation Trends in 2025'

## 1b. Artificial intelligence (AI) and machine learning (ML)

Artificial intelligence refers to the technologies and algorithms that enable systems to identify patterns, make decisions and improve themselves through experience and data.[15] Machine learning is an aspect of AI that is often used in manufacturing to identify and use patterns in large data sets to make predictions. Accordingly, ML is much more focused in scope and application.

AI in manufacturing is expected to grow in significance and impact in the coming years. Indeed, organisations are increasing their funding allocations for it: the manufacturing industry spend on AI and other cognitive technologies was estimated at 34% in 2022.[16] The following year, the majority of manufacturing companies (63%) were planning to increase their AI budgets, while only a very small proportion of companies (3%) intended to spend less.[17] The global market size of artificial intelligence in manufacturing is estimated to reach $20.8 by 2028.[18],[19]

AI is an enabler of digital transformation and can support industrial automation by optimising complex industrial processes. For example, ML solutions are applied to manufacturing processes, which produce improved data analysis and decision-making. Another common use of AI is in maintenance, whereby companies can better predict and prevent machine failure. Similarly, there are demands for AI in areas of quality assurance and control, when faults that are not perceptible to the human eye can be identified via computer vision.

Inventory management and logistics is another example of a field that has come to rely on artificial intelligence. Implementation of AI-assisted ordering and real-time inventory-management systems can optimise and often reduce inventories without compromising productivity or the ability of the business to serve its customers on time. In the UK, Ocado's Smart Platform uses a combination of AI tools (computer vision, deep reinforcement learning and advanced sensing) and robotics to efficiently pick and pack customer grocery orders in fulfilment centres.[20] This technology has been deployed to other grocery retailers worldwide, including Kroger, the largest grocery retailer in the US. Kroger has also partnered with Nvidia to improve shipping logistics, to create a better shopping experience in stores through digital twin models designed to accurately reflect store layouts and operations, and to ensure groceries reach customers while still fresh.[21]

Artificial intelligence, together with other digital technologies such as IoT and cloud computing, are increasingly used to coordinate and optimise a business's whole value chain, including customers, suppliers and logistics. Capturing and analysing customer experiences through mobile platforms and apps, for example, has given businesses immediate visibility regarding customer preferences and choices. This in turn has allowed for customer-led reconfigurations of products and services.

15 Columbia Engineering, 'Artificial Intelligence (AI) vs. Machine Learning'
16 University of Cambridge and IBM, 'Targeting the Full Value of Digital Disruption: Innovating Business Models for Capturing Value from new Technologies' , p. 4
17 The Foundation for Science and Technology, 'AI and Manufacturing are Becoming Inseparable and its Changing Smart Factories', 2023
18 Markets and Markets, 'Artificial Intelligence in Manufacturing Market'
19 Augury, 'On the Journey to Industry 4.0, Where are the Manufacturers?', 2023
20 Ocado Group, 'Our Technology'
21 Chain Store Age, 'Kroger Launches Ambitious AI Transformation Program', 2022

AI applications offer additional benefits across whole value chains, including the implementation of AI to optimise large and complex logistic systems that improve the customer experience and service while maintaining cost effectiveness. Investment in AI also has internal benefits for companies, allowing them to upskill their workforces. In practice this means that as simpler processes are increasingly carried out by AI, workers will need to acquire the skills and knowledge needed to address more complex tasks and processes. For example, an increasing number of digital technologies emerging into the manufacturing sector resulted in a proliferation of large data sets produced from multiple sources. These data sets need to be manipulated and analysed by a trained workforce, which renders them useful to a business. Understanding how AI tools affect their business can offer substantial advantages to an organisation and change the economics of the existing industry value chains.

AI could, for example, enhance or replace human customer-service tasks, extending the service to a 24/7 cycle. The quality of service would improve, with AI helping to reduce errors without significantly impacting operating costs. Machine learning, in particular, could help to predict potential equipment failures and alert production staff to equipment maintenance needs in advance. These measures would minimise production disruptions while ensuring robustness, resilience and quality of outputs.

### 1c. Digitalisation

Among specialists, the term "digitalisation" mostly refers to the wider context of "socio-technical phenomenon, the use of digital technologies, and their influence on societies, businesses and personal lives".[22] Open to different means of technical and social evaluation, digitalisation can be further analysed through the scale for which it is devised and deployed: individually; by single platforms; organisationally; or across entire socio-technical ecosystems.[23] A consensus needs to be reached on the meaning of "digitalisation", and its implications, in order to facilitate connections between academia, industry and start-ups.[24]

Siemens began digitalising its manufacturing plant over a period of 10 years, growing from a ratio of 25% to 75% digital. It was reported that, prior to digitalisation, the plant was able to manufacture five different products; after digitalisation it was able to manufacture up to 1,300 different products.[25]

Even with the significant up-front expenses often associated with digitalisation, an increasing number of organisations are taking the initiative to digitally transform their factories and manufacturing operations and reaping the associated benefits. Digital transformation of manufacturing is expected to continue growing. According to some market reports, the size of the market could more than double from approximately $300 billion in 2023 to over $800 billion by 2029.[26]

22 Frenzel-Piasentin, A. et al, 'Digitization or Digitalization? – Toward an Understanding of Definitions, use and Application in IS Research', AMCIS Conference 2021, p. 7
23 Frenzel- Piasentin, A., et al, 'Digitization or Digitalization? – Toward an Understanding of Definitions, use and Application in IS Research', AMCIS Conference 2021, pp. 5-6
24 MIT Sloan Management Review, 'Don't Confuse Digital with Digitization', 2017
25 The Manufacturer, 'What is Digital Manufacturing?', 2020
26 Mordor Intelligence, 'Digital Transformation in Manufacturing Industry Size and Share Analysis – Growth Trends and Forecasts (2024-2029)

## 1d. Digitisation

Data and digitisation were identified by survey respondents as a trend over the next 5 years, but not beyond. This disparity could reflect ambiguity around the phrasing used to describe contemporary technological processes. For example, in a discussion paper the Fraunhofer Institute highlighted the lack of clarity for industries using terminology that may indicate "a generic societal trend" but which "conveys comparatively little about the actual (catalogue of) technologies that we mean by it".[27] Alternatively, for some specialists the terms are less open-ended. The process of "digitisation" can be seen as relatively finite, a "technical process of converting analogue signals into digital form"[28] or "the fully digital creation of information and data without a physical or analogue counterpart".[29] In general, definitions of digitisation tend towards the explanation of a "technical process of data conversion, generation, storage, or processing".[30] As with "digitalisation", the characteristics of "digitisation" may be furthered evaluated by the level at which they are deployed – individual, platform, organisational or across the socio-technical ecosystem.[31]

When approaching digitisation, it is necessary for companies to improve efficiency through improved computing power, more integrated software and better analytics. Through sustained digitisation, companies will have new methods of data and information oversight to analyse and optimise processes and outcomes. Survey respondents perceived the application of data to be necessary to drive productivity and efficiency, which would be enabled by improved computing power, more integrated software and better analytics. For instance, an SME that implemented digital job tracking saw cost benefits, saved time and improved efficiencies.[32] Across diverse manufacturing industries, digitisation offers similar advantages to the above example, as well as opportunities for optimisation, including data collection providing visibility of machine usage and bottlenecks.[33] Alongside such benefits, manufacturers need to consider how to reduce cyber-security and privacy risks, align or update their existing infrastructure to help them achieve tangible benefits, and educate and train their staff in the new technologies.[34]

27 Kroll, H. et al, 'Effects of Automatisation and Digitalisation on Manufacturing Companies' Production Efficiency and Innovation Performance', Fraunhofer ISI Discussion Papers – Innovation Systems and Policy Analysis, no. 58, p. 1
28 Legner, C. et al, 'Digitalization: Opportunity and Challenge for the Business and Information Systems Engineering Community', Business & Information Systems Engineering, 2017, p. 301
29 Clarke, R., 'Risks Inherent in the Digital Surveillance Economy: A Research Agenda', Journal of Information Technology, 2019, pp. 59-80
30 Frenzel-Piasentin, A. et al, 'Digitization or Digitalization? – Toward an Understanding of Definitions, use and Application in IS Research', AMCIS Conference 2021, p. 6
31 Frenzel-Piasentin, A. et al, 'Digitization or Digitalization? – Toward an Understanding of Definitions, use and Application in IS Research', AMCIS Conference 2021, pp. 5-6
32 Shoestring Digital Manufacturing, 'Job Tracking at Buchanan Orthotics'
33 pwc Advisory Outlook, 'Why Digitisation is Reshaping the Manufacturing Industry', 2019
34 National Institute of Standards and Technology (NIST), '7 Manufacturing Digitization Challenges – and how to Overcome them', 2020

## 2. SUSTAINABILITY

The United Nations has defined "sustainability" as the societal intention to "meet the needs of the present without compromising the ability of future generations to meet their own needs".[35] Human activities cause environmental pollution, which is driving climate change, loss of biodiversity, shortages of water and resource scarcity. The IPCC last year warned that "global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2000 years", and the likely range of human-caused global-surface-temperature increase (from the 19th century until now) lies between 0.8°C and 1.3°C, with a best estimate of 1.07°C.[36] If humanity does not take meaningful action, the continued release of greenhouse-gas emissions "will intensify multiple and concurrent hazards".[37]

Biodiversity, water supply and a growing population affected by climate change are aspects of life and the natural environment that will be affected by climate change. Around the world, flora and fauna have suffered from local population extinction due to climate change. Rising temperatures in particular were identified as the cause of extinction in 47% of 976 species examined.[38] Water supply is also at risk. The IPCC estimates that for "each degree of global warming, approximately 7% of the global population is projected to be exposed to a decrease of renewable water resources of at least 20%".[39] Beyond that, approximately 3.3 to 3.6 billion people are highly vulnerable to climate change based on where they live, the complex interplay between socio-economic development, ocean and land use, and the historical and continuing patterns of inequity and marginalisation.[40]

For the manufacturing sector, the consequences of climate change and the need to address them are twofold. First, there is a growing need to mitigate the impact of industrial practices by integrating environmental, social and economic factors into manufacturing and the distribution of goods, with the aim of limiting damage to ecosystems, thereby reducing resource depletion and the negative impacts on human health and societal inequalities stemming from these issues. Second, businesses are increasingly exposed to risks stemming from the impact of climate change, such as infrastructure damage, supply chain disruptions, reduced ecosystem services, implications for insurability, and threats to employee safety and wellbeing.  In the EU, for instance, industrial emissions of pollutants and greenhouse gases incurred an external, societal cost (via damage to human welfare and the economy) of between €2.7 and €4.3 trillion from 2012 to 2021.[41] From another perspective, the UK's emissions carry a global cost estimated at a loss of £39.5 billion per year, equivalent to 1.9% of UK GDP.[42]

Increased awareness of the importance of sustainability was reflected in the survey responses. According to the industrial leaders, sustainability is expected to significantly influence and shape manufacturing over and beyond the next 5 years. The survey findings indicate that sustainability in manufacturing is influenced by growing new market value opportunities, technological advancements and innovation, as well as customer/market requirements and economic and regulatory pressures. To mitigate climate change, protect natural resources and address social inequalities, the need to develop and implement sustainable practices in manufacturing will remain crucial in the foreseeable future. The synthesis of survey responses resulted in six primary clusters of trends and drivers.

35 United Nations, 'Sustainability'
36 Intergovernmental Panel on Climate Change (IPCC), 'Climate Change 2023 Synthesis Report', p. 4
37 IPCC, 'AR6 Synthesis Report, 'Headline Statements – Future Climate Change, Risks, and Long-term responses', 2023
38 IPCC, 'Sixth Assessment Report, 'Fact Sheet – Biodiversity', 2022, p. 2
39 IPCC, 'Sixth Assessment Report: Impacts, Adaptation and Vulnerability', 4.1.1 Points of Departure and Advancements since AR5
40 IPCC, Sixth Assessment Report: Impacts, Adaptation and Vulnerability', 2022, B.2 Observed and Project Impacts and Risks
41 European Environment Agency (EEA), 'The Costs to Health and the Environment from Industrial Air Pollution in Europe – 2024 Update'
42 LSE Grantham Research Institute on Climate Change and the Environment, 'Policy Brief: What will Climate Change cost the UK?', 2022, p. 6

## 2a. Customer demand for sustainable products and industry accountability for environmental impacts

Consumer expectations have started to shift. Demand has increased for businesses to be held accountable for their impacts on the environment, ecosystems and societies, which is demonstrated through shoppers' preferences for more sustainable products.[43] Customers now seek not just ethically sourced and environmentally friendly manufactured products but also a commitment from companies to address climate change through implementing sustainable practices across their supply chain and providing transparent evidence and data about their activities.[44] Consequently, sustainability has become a pivotal selling point and a distinguishing factor in the competitive landscape.

## 2b. The need for increasing energy and resource efficiency

The costs of resources and energy are continuously growing as a result of increasing fluctuations in fuel prices and raw materials. Global supply chains are more and more vulnerable to disruptive shocks, as shown by events such as the COVID-19 pandemic and geopolitical conflicts such as the Russian war in Ukraine and the terrorist attacks on transportation ships in the Red Sea. The direct impacts of climate change on infrastructure, production and workforce, as well as growing competition for critical resources, are reinforcing the constraints. Industry's concerns about the stability and security of energy and material supply are prompting businesses to develop and implement more efficient processes and waste-reduction practices.

The evolution of digital and automation technologies provides an important capability for monitoring resource and energy utilisation, imparting onto users a deeper understanding of opportunities for improvement. Efficiency measures differ significantly across various industries and may encompass material selection, changes in operational and maintenance practices, and updates to existing equipment, machinery and supporting systems. Firms are strongly advised to prioritise efficiency improvements before considering investments in new equipment or systems. In doing so, economies will cut energy consumption, which is necessary to meet climate-protection goals.[45] The benefits of greater efficiency extend beyond mere savings on energy and material expenses; they are also closely tied to the direct reduction of emissions and waste.

Resource efficiency optimises use so that a given level of final consumption can be met with fewer resources (by reducing the weight of products, incorporating recycled materials, improving lifespan and sharing schemes) and can occur at the point of production or consumption or at the end of a product's life.[46] Efficiency also encompasses optimising the use of water and other materials, and minimising waste and pollution during production. Improving on costly and wasteful resource inefficacy does not necessarily require an equipment overhaul or capital investment. Insights shared from the experiences of a sustainability expert at the IfM demonstrated that in the UK three cement factories achieved a better performance through data analysis and computer modelling to ascertain the impact of fuel mix on performance. Implementing a new metric into the production process revealed variations in fuel-derived carbon emissions and the benefits of standardising performance through an improved fuel mix. One factory discovered its potential to reduce its emissions by as much as 16% and to lower fuel consumption by around 6%; this was achievable through operating within the plant's existing capabilities.[47]

43 Harvard Business Review, 'Research: Consumers' Sustainability Demands are Rising', 2023
44 MIT Sloan Management Review, 'How Supply Chain Transparency Boosts Business Value', 2021
45 Hechelmann, RH. Et al, 'Preparing the Ground with Energy Efficiency', Sustainable and Smart Energy Systems for Europe's Cities and Rural Areas, 2022, p. 101
46 Department for Energy Security and Net Zero (DESNZ), 'Unlocking Resource Efficiency', 2023, pp. 6, 35, 41, 43, 52
47 IfM, 'Resource Efficiency: Can Sustainability and Improved Profit go Hand-in-Hand?; An Example from the Cement Industry'

Alongside the need to better utilise resources, energy efficiency is integral to the transition to alternative energy sources. It is the first step towards developing climate-neutral organisations, buildings and cities, ultimately leading to accomplishing large-scale climate-protection goals. Examples abound of manufacturing companies exploring and achieving energy efficiency. One case study demonstrated how a medium-sized polymer-processing factory producing plastic lids via injection moulding introduced hybrid machinery and renewable materials, resulting in a decrease in its energy demand and a reduction in greenhouse-gas emissions.[48] Energy efficiency was also improved at an electroplating plant through utilising an energy monitoring system, establishing suitable targets and optimising cross-cutting technologies. In this example, waste heat volumes were recovered and integrated back into the process. Targeted analysis maximised heat recovery to tap 95% of its potential, resulting in reductions of 24% in heating and 34% in cooling effort.[49]

Notable progress towards energy efficiency has also been made by Toyota in the UK. For 14 years the company has been detecting areas in which it can reduce the energy used to manufacture a car by at least 8% every year. This has resulted in a total reduction of over 70%.[50] Put another way, Toyota can now produce four cars using the same amount of energy that used to be required to produce just one. Their strategy did not require an overhaul of resources or technology; rather, it called for an improvement to existing processes to make them more sustainable. As the above examples show, industries in pursuit of sustainability must first achieve energy efficiency, which goes hand in hand with the reduction of GHG emissions.[51]

## 2c. Energy transition and alternative energy sources

Because of industry's continuing reliance on fossil fuels, energy accounts for around 73.2% of the total global emissions, 29.4% for industry and 24% for the transport sector, with around half that figure coming from commercial applications.[52] Manufacturing industries are also vulnerable to price shocks, as seen in the energy crisis in 2022. For example, between January 2021 and January 2023 the average EU industrial producer's energy price increased from 106.2 to 241.3, an increase of 127%.[53] Over the same period, the volume of imports (10.3%) rose at a greater rate than industrial production (2.3%).[54] Thus, it has become clear to industry that reliance on fossil fuels results in potential energy supply dependencies and associated supply security risks. Therefore, the transition to alternative clean energy sources and technologies is a key pillar in businesses strategic considerations. In the manufacturing sector, light industries have made progress in lowering their emissions.[55] However, more effort is needed, and the current outlook for the overall global industrial sector is not promising. Although policy frameworks exist and emissions have declined, industry is not currently on track to align with the goals of net-zero emissions by 2050.[56]

Rethinking energy supply systems in manufacturing will require a detailed understanding of the actual energy demand of the processes, leading to considerations about alternative energy sources and the conversion of technologies and solutions. The companies surveyed considered a broad portfolio of potential solutions for de-fossilisation of their energy systems. However, two key technology clusters were identified: electrification including energy storage and alternative fuels.

48 Khripko, D. et al, 'Product Carbon Footprint in Polymer Processing – A Practical Application', 11th Global Conference on Sustainable Manufacturing, 2013, pp. 285-287
49 Hechelmann, RH. Et al, 'Preparing the Ground with Energy Efficiency', Sustainable and Smart Energy Systems for Europe's Cities and Rural Areas, 2022, p. 123
50 IfM, 'Resource Efficiency: Can Sustainability and Improved Profit go Hand-in-Hand; Improving Efficiency Without Reinventing the Wheel'
51 Khripko, D. et al, 'Product Carbon Footprint in Polymer Processing – A Practical Application', 11th Global Conference on Sustainable Manufacturing, 2013, pp. 284, 288
52 Our World in Data, 'Sector by Sector: Where do Global Greenhouse Gas Emissions Come From?', 2020; Our World in Data, 'Cars, Planes, Trains: Where do $CO_2$ Emissions from Transport Come From?', 2020
53 European Council, 'Energy Price Rise Since 2021'
54 Import volumes exclude energy. European Central Bank, 'How have Higher Energy Prices Affected Industrial Production and Imports, 2023
55 International Energy Agency (IEA), 'Light Industry'
56 IEA, 'Industry'

Electrification converts electricity generated from renewable sources to the relevant energy form needed to operate various processes. Examples are varied and include the use of electric heat pumps and boilers instead of natural gas boilers to provide thermal energy, or electric vehicles replacing combustion vehicles in logistics. Although electrification is broadly recognised as one of the key pathways to replacing fossil fuels, its environmental performance depends on the types of source used to generate electricity. Furthermore, electric power generation from two important renewable energy sources – solar and wind – is intermittent, meaning integrating electricity storage solutions, such as battery technologies, and approaches to demand flexibility/load shifting are key enablers for electrification.

Companies are also investigating the potential of alternative fuels such as green hydrogen and biogenic gaseous, fluid and solid fuels to devise another group of technologies. Hydrogen is a versatile technology that can be used as a feedstock or as a fuel for high-temperature industrial processes, such as those in the cement and chemical industries or for heavy-duty vehicles. Green hydrogen can also be used as electricity storage, when it is produced from surplus wind and power generation.

While electrification and alternative fuels offer great potential for emission reduction, there are various challenges – including further research and development, infrastructure, economic viability and regulation – that currently present significant barriers to widespread adoption. It is expected that sustainable energy systems will need to comprise a balanced portfolio of multiple energy technologies.

### 2d. Designing for sustainability and a circular economy

Climate change and resource scarcity require a complete change in the way products are designed, manufactured and treated at the end of their lifetime. Humans devour 70% more resources than the Earth's ecosystems can regenerate, and only 7.2% of materials that enter production processes originate from circular sources.[57] The businesses surveyed highlighted the importance of integrating the criterion of sustainability into the material selection processes for new product development and, in the future, prioritising environmentally, bio-based and recycled materials. This approach would not only reduce the emissions and pollution associated with their products but also potentially contribute to carbon dioxide capture. Tying the survey results into the literature analysis, the emerging trend of "design for sustainability" is closely connected to goals to reduce carbon footprint; it encompasses the logic of environmental and social responsibility into product development.[58] The aim is to enhance resource and energy efficiency throughout the entire life cycle of a product, including design, manufacturing and usage, while also facilitating easier reuse and material recovery at the end of its life. Design for sustainability is also a key enforcement factor for the circularity of processes and value chains. Although interpretations differ on the meaning of circular economy, research has been conducted to propose as a unifying definition: "an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes [...] with the aim to accomplish sustainable development, thus simultaneously creating environmental quality, economic prosperity and social equity".[59] With nearly one-fifth of respondents specifically mentioning the circular economy, the survey results confirm the need to raise awareness on the transformation of manufacturing ecosystems and supply chains away from a linear to a circular economy.

57 IfM, 'IfM/World Economic Forum Paper Explores role of Partnerships in Circular Transformation, 2024
58 Birkeland, J., 'Design for Sustainability: A Sourcebook of Integrated Ecological Solutions', 2002, pp. 26-27. doi:10.4324/9781849770958
59 Kirchherr, J. et al, 'Conceptualizing the Circular Economy: An Analysis of 114 Definitions', Resources, Conservation and Recycling, 2017, p. 229. DOI: 10.1016/j.resconrec.2017.09.005

## 2e. Rethinking and redesigning supply chains

Several of the companies surveyed reported that, to be able to address market requirements on sustainability, to comply with policy and regulation, and to deliver on their own environmental business objectives, they see an increased need to rethink and redesign their supply chains. Different concepts and approaches were mentioned by the survey participants. Diversification, adaptability and rapid adoption of new processes are pivotal for navigating through recurring supply chain shocks while maintaining the transition towards greater sustainability. Additionally, participants recognised the need to engage with customers more proactively and integrate them into supply chains to meet the market demands for greater transparency of information on material sources and practices deployed. However, attempts to do this are not always straightforward. For example, in a survey of UK food companies, 79% found it difficult to measure and report their environmental performance at different points in the supply chain due to a lack of information on carbon emissions relating to materials they had purchased, transportation used and product distribution.[60]

Another approach that is receiving increasing attention from our survey respondents, as well as the wider manufacturing industry, is the design of supply chains with a focus on value creation. This approach considers the scarcity of resources, including strategic evaluations of resources that are already critical and the potential issues linked to their origins, as well as resources expected to become increasingly scarce because of continuing depletion and increasing global demand. Furthermore, some companies advocate establishing smaller, more diversified production centres to minimise the footprint of their logistics. To sustain competitiveness, companies regard increased investment in transitioning industries and supply chains to zero emissions as indispensable.[61] One method is distributed manufacturing. In this model goods are produced near to the customer in small factories and with shorter supply chains, enabling the delivery of personalised products and services at a lower cost to the environment.[62]

Sustainability improvements can develop alongside approaches to supply chain traceability and transparency. For AMT Fresh (a British fresh fruit and vegetable supplier with stakeholders across Europe, Asia, Africa and South America), the data generated through transparency requirements also helped to address the challenges of supplying fresh produce. As the company improved forecasting and pricing accuracy, the better understanding of supply levels resulted in a significant 35% (or 200 tonne) waste reduction over 4 years.[63]

## 2f. Regulation to implement net zero

A commitment to the Paris Agreement requires governments to revise their national strategies, policies and regulatory frameworks to align with the objectives of reducing emissions that drive climate change and to collaborate on adapting to the impacts of climate change.[64] Many countries have initiated, or are in the process of developing, net-zero strategies, typically supported by sector-specific goals. A common imperative is to address climate change caused by manufacturing and its environmental impacts. Such strategies are implemented through policies and regulations encompassing a wide range of incentive mechanisms, including subsidies, financial support, taxation on fossil fuels, carbon pricing and penalties, as well as obligations such as Scope 3 emissions reporting and tighter environmental regulations.

60 Harvard Business Review, 'How Food Companies can Better Measure their Sustainability', 2023
61 The Manufacturer, 'Does a new Globalisation mean Rethinking our Supply Chains?', 2017
62 IfM Engage, 'Insights: The new Globalisation and Rethinking our Supply Chains'
63 IfM Engage, 'Insights: Supply Chain Transparency – Do you really know what you are Eating?'
64 UN Climate Action, 'The Paris Agreement'

The businesses who responded to our survey perceive themselves to be facing significant and ongoing changes in the growing complexity of a policy and regulatory landscape that imposes new obligations and an elevated risk of non-compliance. Around the world, courts, tribunals and other adjudicatory bodies are hearing cases focused on climate change law, policy or science.[65] The number of actions taken increased from 884 in 2017 to more than 2,570 in 2024 (with over half of these litigated in the United States).[66] These numbers, combined with the aforementioned examples, underline how manufacturers are facing pressure to improve sustainability from a number of internal and external, local, national and international bodies and consumers.

65 UN Environment Programme, 'Climate Litigation more than Doubles in Five Years, now a key Tool in Delivering Climate Justice', 2023
66 Climate Change Litigation Databases, 'About'

## 3. SUPPLY CHAIN UNCERTAINTIES AND TRANSITIONS

Analysis of our survey responses indicated concerns that companies will be challenged to make location trade-offs in a highly sophisticated, agile way. They will need to weigh proximity to markets and sources of customer insights against the costs and risks in each region or country. As one respondent said, "The recent [supply chain] disruptions have resulted in significant changes to long-standing relationships. Those changes are driving new relationships, new business models, and many innovative realisations." Several other respondents mentioned localised manufacturing, highlighting the shared understanding that the global landscape is undergoing transformative changes that businesses need to be able to operate within. Alongside growing acknowledgement of increasing disruption, there is an overarching call to develop the manufacturing industry's capacity, skills and expertise to effectively navigate these challenges.

Supply chain uncertainties have increased the business risk for manufacturing companies, particularly the ones that maintain production and operations in geographical areas considered to be socio-politically at risk. The companies that responded to our survey mentioned several factors that are raising their concerns over supply chain resilience. The most frequently stated ones related to Brexit challenges, the US–China tension and the recent disruptions due to the COVID pandemic. Despite the fact that manufacturing operations are typically expensive and time-consuming to relocate, some companies have pursued mitigation through onshoring, to address their perceived supply chain exposure. Organisations have also sought to shorten and assure supply chains wherever possible. These actions are expected to result in significant changes to long-standing relationships, as well as establishing new relationships, new business models and supply chain innovations in the medium to long term. Establishing new, resilient supply chains that ensure companies can meet customer demand and not run out of stock will remain a significant challenge for manufacturing companies in the future.

Over the past 50 years the majority of manufacturing companies have gradually shifted from full vertical integration – having complete ownership of all the required manufacturing steps, from design to transportation – to outsourcing parts of their operations to external suppliers. As globalisation has opened up new markets and offered the opportunity to reduce the cost of certain operations, many businesses have moved production, or entire company units, to other countries. For certain sectors, for example automotive and electronics, this relocation has created diverse, complex and disperse supply chains with many interdependencies.

A number of vulnerabilities are inherent within such globally interconnected supply networks, many of which were exposed during the COVID pandemic. Increased delays in manufacturing or shipping goods severely impacted manufacturing industries, including the automotive and industrial product sectors.[67] The current geopolitical and trade tensions have also increased supply chain risks for certain materials, components and technologies. In response, companies have started to reconsider their offshoring strategies, relocating their operations onshore when possible, or "friendshoring" – moving their operations away from geopolitical rivals to friendly powers.[68] A number of companies are investigating the possibility of shifting manufacturing out of China to India and countries in Southeast Asia. For example, Hasbro, the toy manufacturer, has relocated some of its production to India, while Apple is considering moving its assembly and production to Vietnam and India.[69] Vietnam is a country of choice for several other multinational technology companies such as Samsung and Dell.[70] Outside Asia, Volvo, the large Swedish car manufacturer, has announced that it will open a manufacturing site in Slovakia,[71] the first new European manufacturing site for Volvo Cars for almost 60 years.

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67 EY, 'How COVID-19 Impacted Supply Chains and what comes next', 2023
68 Banaszyk, P., 'Reshoring and Friendshoring as Factors in Changing the Geography of International Supply Chains', 2023, pp. 30-32. https://doi.org/10.2478/emj-2023-0026
69 World Economic Forum, 'Supply Chains and Transportation: What's the Difference Between "Friendshoring" and other Global Trade Buzzwords?', 2023; Reuters, 'Toy Manufacturers' Shift from China is no Child's Play, 2024; The Financial Times (FT), 'Apple Suppliers: Bets on Vietnam will pay off', 2023; FT, 'Vietnam Becomes Vital Link in Supply Chain as Business Pivots from China', 2023
70 FT, 'Vietnam Pushes for High Tech as Investors Pivot from China, 2024; FT, 'Vietnam's Economic Moment has Arrived', 2023
71 FT, 'Volvo to Open Dedicated Electric Car Plant in Slovakia', 2022

Western governments have introduced policies to support onshoring or friendshoring that prioritises free but secure trade (at the potential expense of economic efficiency) for critical raw materials, as well as finished goods and technologies.[72] One such critical technology is semiconductors. Ubiquitous and essential for many consumer and industrial products, semiconductors are also vital to defence, energy, space, finance and numerous other sectors. As much of the world's manufacturing production is concentrated in Asia, Western governments have sought to reduce supply chain risks by onshoring or friendshoring semiconductor manufacturing. The US CHIPS Act,[73] for example, was established to "revitalize domestic manufacturing, create good-paying American jobs, strengthen American supply chains, and accelerate the industries of the future"; and the European Chip Act[74] seeks to "bolster Europe's competitiveness and resilience in semiconductor technologies and applications". Other countries (the UK,[75] Spain,[76] and Japan[77]) have followed with their own national semiconductor strategies.

The practices of onshoring or friendshoring are expected to continue for critical materials, components and technologies. However, it is not yet certain which new supply chains will emerge or the long-term trade implications for costs, competitiveness and geopolitical power shift.

72 The International Institute for Strategic Studies, 'The "Friend-shoring" of Supply Chains', 2022, p.1-2
73 The White House, 'Fact Sheet: CHIPS and Science Act will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China', 2022
74 European Commission, 'European Chips Act'
75 Department for Science, Innovation & Technology (DSIT), 'Policy Paper: National Semiconductor Strategy', 2023
76 La Moncloa, 'Government of Spain Approves the Strategic Project for Microelectronics and Semiconductors', 2022
77 FT, 'Japan Seeks Revival as a Semiconductor Powerhouse', 2023

## 4. AVAILABILITY OF SKILLED LABOUR

Labour supply and employment are below pre-pandemic levels because of a rise in economic inactivity. Reasons for this stagnation include long-term illness and retirement (including those taking early retirement), and the introduction of new immigration regulations post-Brexit, which are likely to have had a detrimental impact on skills and labour availability. This larger social trend encompasses the manufacturing sector; the companies that participated in our survey indicated that the reduced availability of skilled labour was a significant restriction for their companies and was expected to persist. According to a 2024 ONS survey, 20% of UK manufacturing businesses with 10 or more employees reported a worker shortage.[78] And this percentage is likely to increase. One of the main reasons for the labour shortage is that fewer people, especially younger people, are entering the manufacturing profession at sufficient rates to replace those leaving – and particularly retiring from – the manufacturing sector. Similar labour shortages are affecting Europe and other countries around the world. A 2023 study of the EU reported a downward trajectory in the projected working-age population from 265 million in 2022 to 258 million by 2030.[79] A similar trend is present in the US, with reports from the Federal Reserve indicating that the labour force was 3.5 million people lower than pre-pandemic expectations, including those taking early retirement.[80] Although most employers are keen to retain older workers who have already been trained and instilled with their company ethos, organisations must plan for an ageing workforce and the need to train new people to fill the gap.

The implications of labour shortages have been felt across various sectors, including ICT, STEM (science technology, engineering and mathematics), construction and healthcare. But barriers to hiring sufficient numbers of staff extend beyond demographic change in Western society. Tough immigration protocols are contributing to the UK shortages. Indeed, a significant number of companies have indicated the lack of EU applicants as a specific reason for the inability to recruit into positions.[81] Other factors affecting European and British manufacturing industries include lower labour market participation of women, challenging working conditions, the selective nature of recruitment, and difficulties in human resource management, plus evolving skills and employment needs due to the green and digital transitions.[82]

The pace of digital transformation may suffer from the growing number of vacant manufacturing roles as factories lacking skilled staff face barriers to the adoption of automation solutions in production systems. Compounding the challenge is companies increasing adoption of complex technologies in the manufacturing sector.[83] The more sophisticated they are, the higher the skill level and training required to run and maintain equipment and processes. Therefore, the global industry faces a "growing scarcity of technical talent to develop and run manufacturing tools and systems" and the need to attract more people.[84]

78 Office for National Statistics (ONS), 'Business Insights and Impact on the UK Economy: February 2024'
79 European Commission, 'Commission Report finds Labour and Skills Shortages Persist and Looks at Possible ways to Tackle them', 2023
80 FT, 'Technology and Skills Shortage', 2023
81 House of Commons Library, 'Skills and Labour Shortage', 2023, pp. 11-12
82 European Commission, 'Commission Report finds Labour and Skills Shortages Persist and looks at Possible ways to Tackle them', 2023
83 Department for Business, Innovation and Skills, 'Manufacturing Metrics Review Report', 2016, p. 16; Federal Ministry for Economic Affairs and Climate Action, 'A Modern Industrial Policy'; Boston Consulting Group (BCG), 'Digital Transformation -Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries', 2015; Executive Office of the President, 'Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing', 2012, pp. x, 13, 27-36; MTI Business Budget Booklet, 'Singapore Economy 2030: Seizing Opportunities, Energising Enterprises', 2022, pp. 3,5; BCG, 'Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries, pp. 2-15
84 McKinsey, 'Manufacturing the Future: The next era of Global Growth and Innovation', 2012, p. 9

# FINAL INSIGHTS

## Cross-analysis of trends and drivers over the next 5 years

**Respondents with 10–20 years in manufacturing:** Respondents within this demographic made comparably more mentions of political issues or pressure on supply chains than respondents with less than 10 years or more than 20 years of experience in the manufacturing industry.

**Across all levels of industrial experience,** a general consensus emerged among respondents on the most important trends that will shape the manufacturing industry over the next 5 years.

**Within the services sector,** there was a difference in survey responses relative to the length of service within the field. Those who had less than 20 years of experience strongly emphasised environmental sustainability. However, sustainability was not perceived to be of immediate importance to participants who had spent over 20 years in the services industry. Although a couple of respondents acknowledged climate change, the overwhelming majority emphasised technological advancements as the primary driver over the next 5 years. Specific attention was given to the implementation of data digitisation for seamless data access and sharing across the supply chain, in addition to design automation to improve standardisation.

**Distribution and logistics sector:** In stark contrast to other sectors, there was no mention by respondents of a desire to work towards sustainability within the distribution and logistics sector in the next 5 years or beyond. Instead, emphasis was placed on automation and digitalisation in the short term, a view that was reinforced for the longer term.

Respondents from various sectors consistently emphasised similar trends concerning supply chain sustainability, focusing on addressing climate change and enhancing resilience. One notable recurring theme was energy security and the strong preference for clean energy solutions. These patterns were consistently observed beyond a 5-year horizon. Significantly, even though technological advancements were perceived by respondents to play a pivotal role in shaping strategies within the manufacturing, service, distribution and logistics sectors, these technological trends and drivers did not evoke an equal level of immediate or long-term concern across all sectors. This finding highlights a nuanced landscape where, despite a general trend towards technology-centric solutions, the widespread adoption of such measures may be less pervasive than anticipated.

## Cross-analysis of trends and drivers beyond 5 years

Consistent patterns are expected to persist beyond the upcoming 5 years, with perceptions remaining relatively uniform across professionals of varying industry experience levels. Consensus was reached among respondents that the trends deemed significant for the upcoming 5 years are likely to retain their relevance in the longer term but will gain a particular focus on sustainability and clean energy initiatives. To elaborate, respondents mentioned:

1. A focus on the transition towards social and environmental sustainability, with an emphasis on decarbonisation and waste reduction
2. A growing demand for accountability
3. An emphasis on technological advancements, digitalisation, AI use and automation for improved efficiency, productivity, cost reduction and to address the challenges posed by skills shortages
4. Localised manufacturing to protect against reliance on external resources
5. Supply chain adaptability and resilience – it was acknowledged that there is greater supply chain vulnerability due to geopolitical and environmental factors
6. Opportunities for niche UK businesses to thrive
7. Anticipated educational shifts – younger people turning away from university and traditional courses, prompting businesses to set up tailored training programmes to retain a strong skills base

**Services trends and drivers:** Beyond the next 5 years, irrespective of length of service, respondents generally agreed that environmental sustainability and digitalisation will be the main drivers shaping the industry.

**Design trends and drivers:** Beyond the next 5 years, sustainability continued to be emphasised, with respondents suggesting digitalisation and designing for sustainability, particularly implementing circular design, as solutions to overcome sustainability challenges and conform to sustainability regulations. In addition, the following trends are anticipated:

- An increase in hardware–software vertical integration – driven by the desire to have greater control, improved performance and differentiation in systems and hardware. In addition, vertical integration has been suggested as a solution to improve flexibility and responsiveness to changing market conditions
- An increase in model-based systems engineering, with the objective of improving efficiency, quality and collaboration between stakeholders
- The development of cyber–physical systems (CPS), which are expected to play a significant role in automating and optimising diverse industrial processes, including manufacturing, logistics and supply chain management

**Distribution and logistics trends and drivers:** Beyond the next 5 years, akin to other sectors, respondents recognised the need to improve flexibility and adaptability, with an overall view of building and strengthening resilience. In addition, optimising distribution processes to improve efficiency and reduce costs was emphasised.

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