TRADE & INDUSTRIAL POLICY STRATEGIES

POLICY BRIEF: 5/2022

Adoption of frontier technologies in six manufacturing subsectors

OVERVIEW

This policy brief highlights the level of adoption of frontier technologies in six manufacturing subsectors: metal and engineering; retail motor and aftercare; plastics; manufacturing; automotive components; automotive manufacturing; and new tyre manufacturing. This is an important undertaking because, while there is a solid understanding of the importance of frontier technologies especially for the manufacturing sector, there has not been a comprehensive investigation of the level of adoption of these technologies across the different manufacturing subsectors. Previous research has either zoned into one sector, such as metal, or looked at the level of adoption at the continental level (Rasool, 2020; Deloitte 2020). To address the gap, this policy brief highlights the aggregated survey results from companies from the six subsectors. The survey analysis is supplemented by interview data with key stakeholders in the industry.

INTRODUCTION

Technological change is central to inclusive industrialisation. The key drivers of technological change are frontier technologies, defined, albeit with no consensus, as technologies that can profoundly disrupt existing production processes and products. Frontier technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), and 3D printing can help businesses improve their productivity and competitiveness, and move up the value chain in their respective sector (UNCTAD, 2021). By driving new products and transforming production processes, frontier technologies can help firms become more knowledge-intensive and generate higher value add. At the country level, frontier technologies can improve global competitiveness and foster industrialisation and sustainable development.

In essence, frontier technology presents an opportunity to leapfrog to a more equal and sustainable future.

Despite the stated benefits of frontier technologies, results from a survey conducted on industries that fall under merSETA indicate a worryingly low uptake of these technologies accompanied by a low level of research and development (R&D) around them. The universal applicability of these technologies means that manufacturing companies cannot simply ignore them. The consequences of non-engagement are enormous. For example, companies will eventually be uncompetitive, and the concerted effort to industrialise the country will move at a snail pace, if not backward. Further to that, the triple development challenges of unemployment, inequality and poverty will remain.

This policy brief is based on a TIPS survey conducted on behalf of merSETA* to collate baseline information on key trends around technological change and the direction the manufacturing companies are taking. In terms of sample size, the survey was sent to 10 721 merSETA stakeholders, including non-levy paying members (accredited training providers, NGOs, and industry associations), and it ran for three weeks from 6 September 2021 to 26 September 2021. The survey received 544 responses, accounting for about 5.1% of the sample size. However, to understand the manufacturing companies response to technological change, responses from the non-levy paying constituents were excluded. This brought the tally of responses to 319 manufacturing companies that fall under merSETA.

The Manufacturing, Engineering and Related Services Sector Education and Training Authority (merSETA) is one of the 21 Sector Education and Training Authorities (SETAs).

Trade & Industrial Policy Strategies (TIPS) is a research organisation that facilitates policy development and dialogue across three focus areas: trade and industrial policy, inequality and economic inclusion, and sustainable growth

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There is no consensus on the meaning of frontier technology. A widely used definition is that these technologies have "the potential to disrupt the status quo, alter the way people live and work, rearrange value pools, and lead to entirely new products and services" – ESCAP, 2018.

Table 1: Frontier technologies that are relevant to the manufacturing sector

TECHNOLOGY GROUP	BRIEF DESCRIPTION
Additive manufacturing, 3D and 4D printing	Additive layer manufacturing describes a manufacturing/production where a computer-controlled head deposits or sinters (via laser) a fine layer of raw material to construct a three-dimensional object, based on digital instructions.
Advanced materials and nanotechnology	New materials are lighter, stronger and more environmentally friendly. It is about the creation of new materials and nanostructures for the development of beneficial material properties.
Clean energy generation, energy storage and transmission	Breakthroughs in battery and fuel cell efficiency; renewable energy through solar, wind, and tidal technologies; energy distribution through smart grid systems; wireless energy transfer; and more.
Information processing, artificial intelligence, big data, virtual reality, augmented reality	Next-step interfaces between humans and computers involving immersive environments, holographic readouts, and digitally produced overlays for mixed-reality experiences. The availability of cloud based processing and data storage is reducing the costs of complex processing tasks and making data processing capabilities that were once extremely capital intensive affordable.
Cloud computing and the Internet of Things	Cloud computing, the IoT and connected devices describe cluster of related technologies that is about the use of networked sensors to remotely connect, track and manage products, systems and grids. The IoT) refers to networks of physical objects (devices, vehicles, buildings, equipment) containing electronic hardware, software and sensors, that enable them to be connected to the Internet. This allows objects to collect and exchange data. The internet-of-things is facilitated by the convergence of a wide range of digital technologies – particularly cyber– physical systems, wireless networks, cloud computing, big data, artificial intelligence and machine learning – and is expected to find important applications in industry and other sectors such as consumer and home services, energy, transport systems, healthcare, entertainment and public services.
Encryption and cyber security	Encryption is about making information unreadable by anyone who is not explicitly authorised to view the data, while cyber security is about advances in defending computers, sensors and devices against malicious users.
Robots (air, factory, land, underwater)	This broad area is about the development of machines that can complement or substitute human capabilities. While industrial robots are focused on production, drones (air, land, underground and water) extends human observation to new dimensions.
Smart and energy-efficient transport	While electric or battery powered vehicles are important, this domain also explores improvements in public transport, transport planning, traffic management, transport safety and reductions of the negative effects of transport on the environment
E-commerce and digital trade	Digital trade and e-commerce is making rapid advances, accelerated by the global pandemic. This area is about improving electronic transactions, international payments, digitalising customs, improving contracting and dispute mechanisms, improving traceability and data exchange. Key issues include rules about intellectual property, global taxes, the rapid increases in trade in services and also protection of data.
Distributed ledger technology and blockchain	Distributed ledger technology based on cryptographic systems that manage, verify and publicly record transaction data; the basis of "cryptocurrencies" such as bitcoin. It enables greater trust and transparency through decentralisation and cryptography.

Source: Compiled by Shawn Cunningham for merSETA survey report (2021).

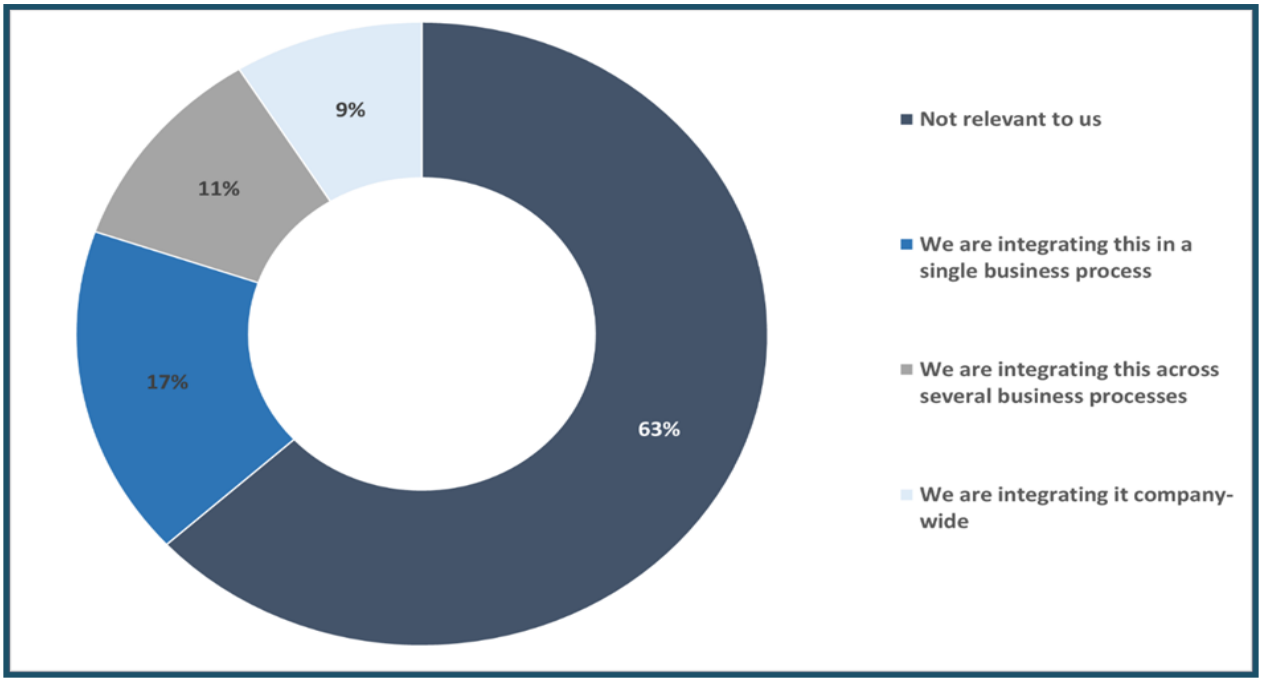
WHAT ARE FRONTIER TECHNOLOGIES?

There is no consensus on the meaning of frontier technology. A widely used definition is that these technologies have "the potential to disrupt the status quo, alter the way people live and work, rearrange value pools, and lead to entirely new products and services" (ESCAP, 2018). These technologies are often seen as central to achieving the Sustainable Development Goals (SDGs). However, if they are not well managed, they can displace jobs and exacerbate the existing inequalities (UNCTAD, 2021). Table 1 details examples of frontier technologies that may affect the manufacturing sector. It provides a detailed description of each group of frontier technology. The TIPS survey was based on the frontier technologies outlined in the table.

ADOPTION OF FRONTIER TECHNOLOGIES IN MANUFACTURING SUBSECTORS INCLUDED IN THE STUDY

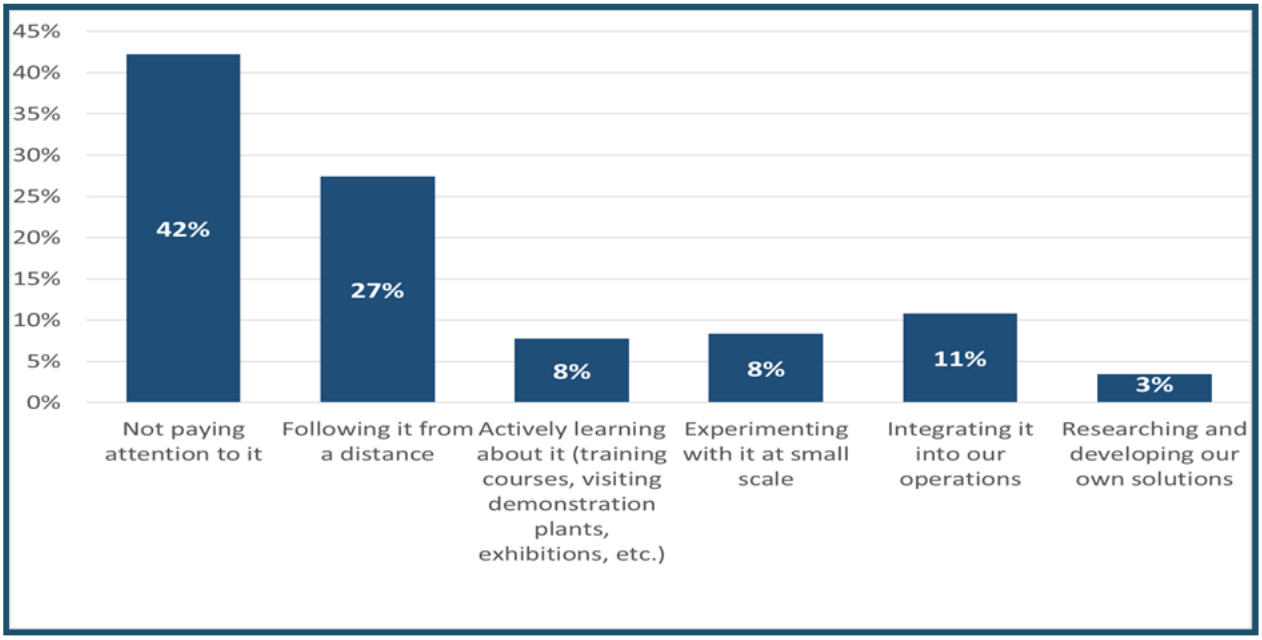
The TIPS survey found that the adoption of frontier technologies in companies across six subsectors – metal and engineering; retail motor and aftercare; plastics manufacturing; automotive components; automotive manufacturing; and new tyre manufacturing – is low. Graph 1 shows that about 63% of companies in the subsectors indicate that the frontier technologies are not relevant to their business. When asked about their engagement with these technologies, 42% of companies indicated they are not paying attention to them at all (see Graph 2).

Graph 1: Integration of frontier technologies in business processes



Source: merSETA survey results (2021), compiled by the author.

Graph 2: Engagement with frontier technologies in subsectors included in the study, 2021



Source: merSETA survey results (2021), compiled by the author.

Furthermore, as shown in Graph 2, 27% of companies are following these technologies from a distance, without any active engagement. Last, the level of learning about these technologies is relatively low, with only 8% of companies indicating that they are learning about them. This evidence shows that frontier technologies are neither integrated nor actively engaged in these subsectors.

Besides low levels of adoption, many companies in the subsectors are not involved in R&D around these technologies. Graph 2 shows that only 3% of companies actively research and develop their own solutions on frontier technologies. The low level of R&D is compounded by declining investment in innovation in the manufacturing sector. R&D expenditure by the business sector as share of Business Enterprise Expenditure on R&D (BERD) has declined in manufacturing from 38.8% in 2008/9 to 28.2% in 2017/18. Overall, the business sector's share of Gross Domestic Expenditure on R&D (GERD) has also declined from 58% in 2008/09 to 41% in 2017/18 (NACI, 2020).

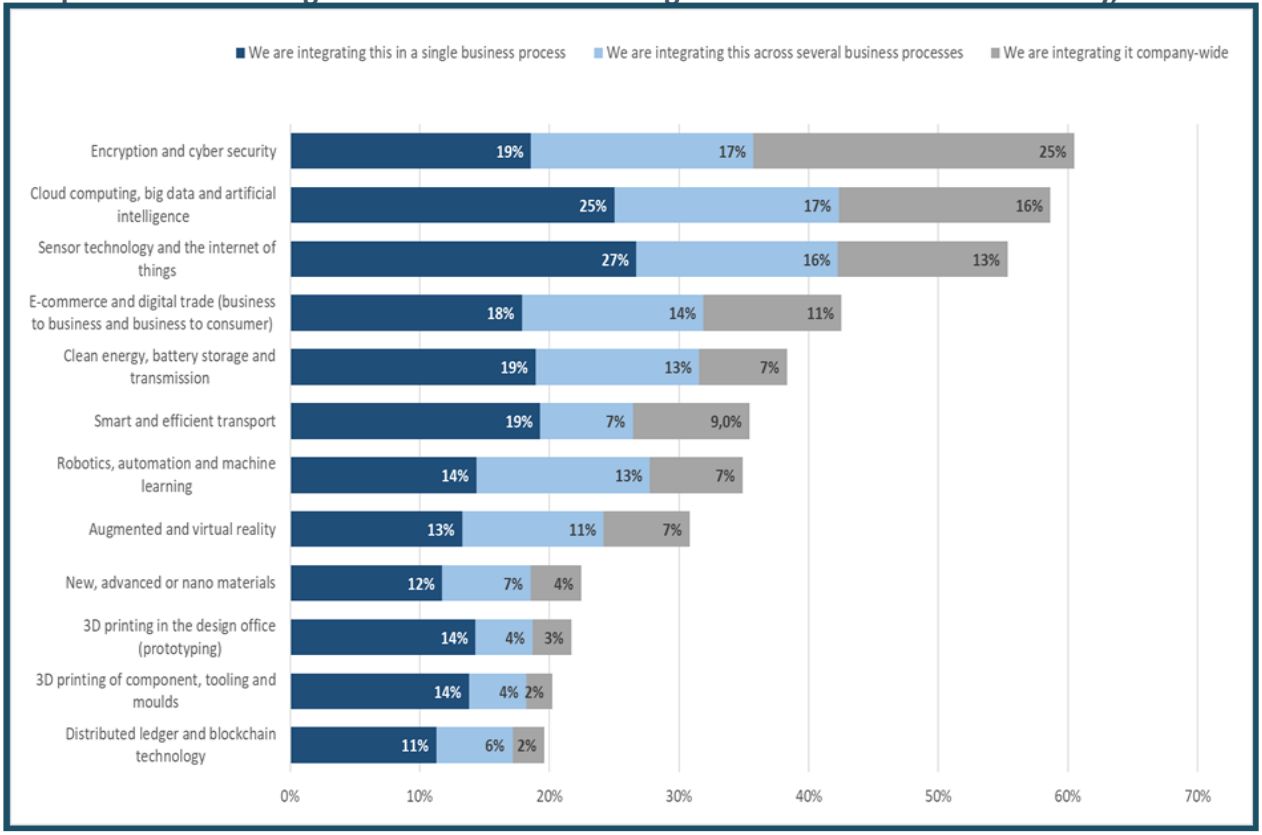
In addition, government funding for private-sector R&D has followed in tandem, declining from R2.6 billion in 2008/9 to R371.2 million in 2017/18 (NACI, 2020). The decline in government funding for innovation stands at odds with its policy priorities. In the National Development Plan, the government highlighted the importance of innovation in unlocking South Africa's global competitiveness. Furthermore, innovation has been prioritised in the Economic Reconstruction and Recovery Plan.

Notably, companies that are adopting these technologies in business processes are doing so incrementally. Graph 1 shows that many companies start by adopting the technology into a single business unit before integrating them company-wide, with 17% of companies indicating they have integrated at least one frontier technology in a single business process.

Encryption and cyber security are widely integrated frontier technologies in the subsectors, followed by cloud computing, big data and artificial intelligence, and sensor technology and the IoT (see Graph 3). The uptake of cloud computing has increased over the years, mainly because of implementing better mobile infrastructure in South Africa (Deloitte, 2020). Furthermore, as these technologies are older, wide integration is expected (Rasool and Rasool, 2020). Distributed ledger and blockchain technology is the least integrated technology in the sector, followed by 3D components, tooling and mould, and 3D printing in the design office.

Well-adopted technologies in the subsectors are distributed across all business processes. Graph 3 shows the level of integration across three processes: single business processes, several business processes, and company-wide. About 27% of companies indicated that they are integrating sensor technology and the IoT into a single business process, and 13% indicated that they are integrating the same technology company-wide. Albeit with variation, the same trend applies to encryption and cyber security. With the least adopted technologies, integration is mainly limited into a single business unit.

Graph 3: Level of integration of frontier technologies in the subsectors in the study, 2021



Source: merSETA survey results (2021), compiled by the author.

The most important source of information manufacturing companies use to learn about frontier technologies is electronic newsletters … however, while good for flagging trends, they are not adequate sources of information on their own.

STRATEGIES COMPANIES USE TO LEARN ABOUT FRONTEIR TECHNOLOGIES

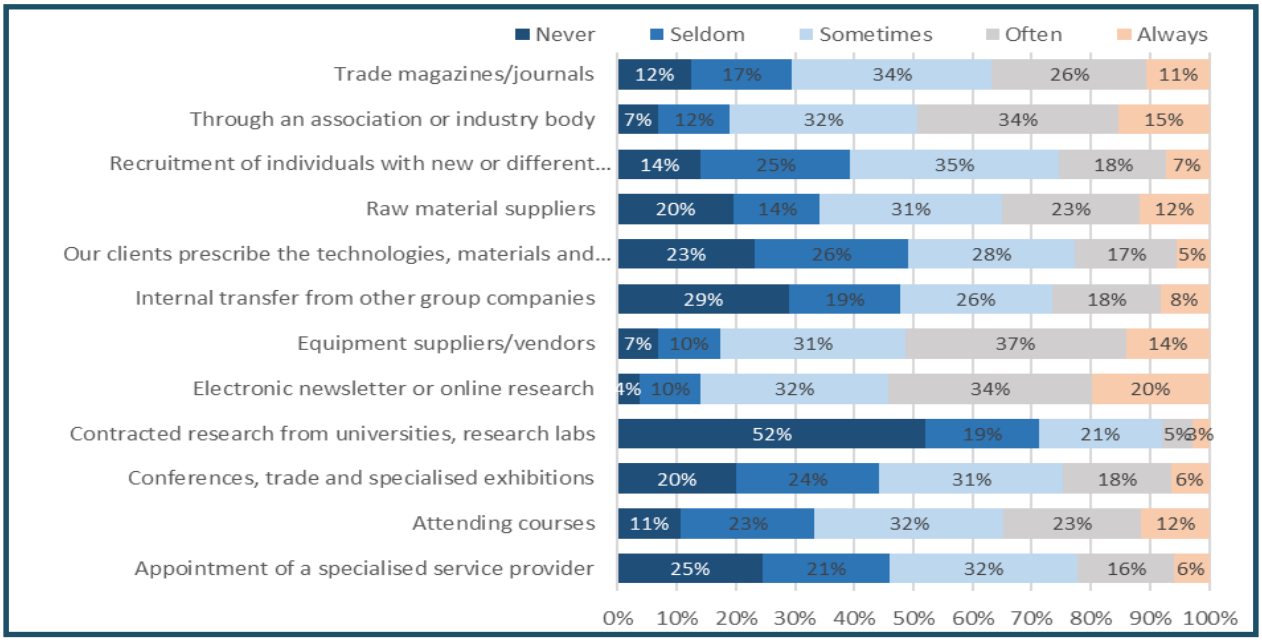
The most important source of information manufacturing companies use to learn about frontier technologies is electronic newsletters. Graph 4 shows that 74% of companies learn about frontier technologies from electronic newsletters and online research. While electronic newsletters can be good for flagging new technologies and more broadly technological change trends, they are not adequate sources of information on their own. Rigorous and scientific research is needed to understand the impact of these technologies on production process, business models and human capital. This kind of research can be done at the research centres and universities.

However, surprisingly, universities and research centres are ineffective sources for learning about new technologies in the subsectors. Graph 4 shows that more than half of the manufacturing companies that responded to the survey did not learn from research from universities and research centres. These findings are corroborated by the South African Science, Technology and Innovation Indicators report, which indicates that only 1.2% of the industrial sector received the information they needed about innovation from universities between 2014 and 2016 (NACI, 2020). In contrast, the service sector received 11.9% of the information they needed about innovation from universities in the same period (NACI,2020). As it stands, universities are a significant source of learning for the service sector compared to the industrial sector.

REASONS FOR LOW ADOPTION OF FRONTIER TECHNOLOGIES

While the survey did not investigate reasons for the reluctance of manufacturers to adopt frontier technologies, anecdotal evidence from the interviews with key industry stakeholders points to a few reasons. First, companies in the subsectors included in the study are backwards-looking instead of forward -looking. That is, most companies' current focus is on keeping their businesses open and retaining jobs instead of actively tracking technology change. In fact, when companies were asked about their strategic priorities over the next decade, many indicated that they are focusing on reducing cost, increasing output and becoming environmentally sensitive. Second, the cost of replacing old equipment is high, which many smaller manufacturers cannot afford. For example, 3D printing is not well adopted mainly because affordability is an issue, especially in developing countries However, once the cost of printers and material decreases, it is expected that the manufacturers will adopt the technology given its exponential benefits (Deloitte, 2020). Third, closely related to the second reason, is that companies are hesitant to upgrade their equipment because they are unsure about future volumes given the current economic conditions. To justify their hesitation, industry stakeholders gave examples of companies that collapsed after upgrading to new equipment and then failed to recover costs due to insufficient demand. In this case, companies tend to wait for new technologies to be established before they can adopt them.

Graph 4: Platforms where companies learn about new technologies



Source: merSETA survey results (2021), compiled by the author.

Adoption of frontier technologies is relatively low, with little R&D in the subsectors included in the study. The main reason behind this is that tough economic conditions have forced companies to focus mainly on survival and retaining jobs.

CONCLUSION: KEY POLICY AREAS

To effectively harness frontier technologies for industrial development, key barriers that prevent their mass adoption should be addressed. Adoption of frontier technologies is relatively low, with little R&D around these technologies in the manufacturing subsectors included in the study. The main reason behind this is that tough economic conditions have forced companies to focus mainly on survival and retaining jobs. Furthermore, the cost of upgrading equipment is high, and many small businesses cannot afford to undertake expensive equipment upgrades when they are not sure of demand. This in turn has made companies reactionary as they wait for technologies to become established before adopting them into their own business. In terms of learning strategies, companies mainly learn about new technologies from electronic newsletters, which are often not sufficient on its own. If these issues are not adequately addressed, the South African manufacturing sector will not be competitive.

To increase the adoption of frontier technologies, three propositions are made:

1. Given that the survey was only meant to highlight the level of adoption of frontier technologies in the six manufacturing subsectors, further research must be conducted to understand issues facing companies from adopting these technologies, especially for small to medium businesses. This must be followed by a clear programme to promote the adoption of the technologies. Master Plans are a possible avenue to carry out such promotion and advancement. Frontier technologies can induce rapid industrialisation and structural transformation, and Master Plans are the new instrument of industrial policy. Therefore, the interwoven nature of industrial policy and technological change requires Master Plans to address the level of adoption of frontier technologies. Notably, some Master Plans already speak to technological change, a key example being the Automotive Master Plan. However, other Master Plans, such as the Plastics Master Plan do not address the issue of technological change in a substantive manner.

2. Government should increase its R&D funding for private sector businesses. The most significant barrier to adopting frontier technologies is that small to medium-sized firms cannot afford to have their own R&D departments, so they wait to adopt well-established technologies. This can cause companies to lose their competitive advantage. Being at the fore-front of technological change is a key differentiator in gaining and maintaining a competitive advantage.

3. Universities should be incentivised to conduct and disseminate research that is relevant to the manufacturing sector. Over half of surveyed companies indicated that they do not learn from universities, mainly because they never receive the information they need from these institutions. A strong partnership with the sector should accompany the incentive in order to have a feedback loop on research being conducted.

REFERENCES

Deloitte Africa. 2020. Industry 4.0: Is Africa ready for digital transformation? Available at: https://www2.deloitte.com/za/en/pages/manufacturing/articles/africa-industry-4-0.html. (Accessed 26 January 2021).

ESCAP. 2018. Frontier technologies for sustainable development in Asia and the Pacific. Economic and Social Commission for Asia and the Pacific Available at: Frontier technologies for sustainable development in Asia and the Pacific | ESCAP (unescap.org). (Accessed 27 January 2021).

NACI. 2020. South African Science, Technology and Innovation Indicators. National Advisory Council on Innovation. Available at: http://www.naci.org.za/index.php/south-african-science-technology-and-innovation-indicators-report-2019-2/. (Accessed 26 January 2021).

Rasool, H. and Rasool, F. 2020. Readiness of the South African Metal Industry for the Fourth Industrial Revolution. Available at: (PDF) Readiness of the South African Metal Industry for the Fourth Industrial Revolution (researchgate.net). (Accessed 26 January 2021).

UNCTAD. 2021. Technology and Innovation Report 2021. United Nations Conference on Trade and Development. Available at Technology and Innovation Report 2021 | UNCTAD. (Accessed 25 January 2021).

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