SET SUPPORTING ECONOMIC TRANSFORMATION

HOW TO GROW MANUFACTURING AND CREATE JOBS IN A DIGITAL ECONOMY

10 policy priorities for Kenya

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Any errors or omissions are the responsibility of the authors.

CONTENTS

ACRONYMS

DFI	development finance institution
DVA	digital value-added
EAC	East African Community
EPZ	Export Processing Zone
FDI	foreign direct investment
GDP	gross domestic product
GVC	global value chain
HMNO	host mobile network operator
IoT	Internet of Things
IPR	intellectual property rights
KAM	Kenyan Association of Manufacturers
LDC	least-developed country
MNO	mobile network operator
MSME	micro, small and medium enterprises
MVNO	mobile virtual network operator
ODI	Overseas Development Institute
OEM	original equipment manufacturer
PPP	purchasing power parity
R&D	research and development
SGR	standard gauge railway
SMEs	small and medium-sized enterprises
SSA	sub-Saharan Africa
STEM	science, technology, engineering and mathematics
TVET	technical and vocational education and training
VA	value-added

FOREWORD BY KENYA ASSOCIATION OF MANUFACTURERS

As a key pillar of the Kenyan government's Big Four agenda, Manufacturing forms a priority sector for attracting investment, driving economic growth and creating jobs. The Kenya Association of Manufacturers (KAM) has been at the forefront of championing industrialisation for an inclusive and broad-based economic growth. We have been working on mounting an export push in Kenya, with the aim of transforming manufacturing and creating jobs.

With the onset of the Fourth Industrial Revolution, we need to be cognisant of the fact that the lines between the physical and digital lines are blurring, rapidly and globally changing the landscape of manufacturing. Digital technologies are being increasingly used at all points along the Global Value Chain, from designing using software, to automation in production, to use of e-commerce for retail. There is an urgent need to understand how global trajectories in digitalisation can affect domestic manufacturing in Kenya and inclusive growth in the country.

Increasing productivity gains from the use of digital technologies across the value-chain and maximising employment gains from the efficiencies generated is key for transforming the manufacturing sector and boosting productive employment. Evidence-based policy making is needed to put in place targeted and appropriate policies that can help Kenyan manufacturing to leverage the Fourth Industrial Revolution.

We are therefore excited to unveil this 10-point policy framework that underlines the gaps that need to be filled to ensure that the Kenyan local industry can capitalise on digital technologies. This 10-point plan addresses issues related to a) building digital infrastructure including through increasing access to digital services and updating policies on data, b) boosting competitiveness of Kenyan manufacturing in an increasingly digitalised economy and c) managing the digital change in an inclusive and sustainable manner. It is important to ensure that Kenya's digital industrial policy fits within the country's wider industrial policy.

This policy framework has been developed in partnership with ODI. KAM has supported this work through linking KAM members with ODI, helping identify what Kenyan firms need to do better and how public policies can help in achieving this, as well as by providing technical comments and feedback on the report.

Phyllis Wakiaga

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EXECUTIVE SUMMARY

The global manufacturing landscape is changing rapidly with the increasing use of **digital technologies** such as robotics and artificial intelligence, presenting both important **opportunities and challenges for Kenyan manufacturing and job creation**. While Kenya has emerged as the leader of digitalisation in the African context, there is still a significant digital divide within the country, when compared with developed countries and Asian economies, in terms of access to and use of such technologies. At the same time, there are growing fears that rapid digitalisation might hamper job creation efforts, particularly in the manufacturing sector. In a new digital context, this paper provides a policy framework and discusses what needs to be done in 10 policy areas to promote Kenyan manufacturing and jobs. Some policy areas are well-known, while others are new.

While there is a global urgency in gaining a better understanding of the impact of digitalisation on African manufacturing, **there is little analysis available at country level to guide policy-makers concerned with developing manufacturing in a digital economy**. To address this gap, this study interviewed a range of stakeholders to draft a 10-point policy agenda to promote Kenyan manufacturing and jobs through digital transformation – which we define as the shift from low-productivity non-digitalised manufacturing to high-productivity digitalised manufacturing. The policy priorities have been identified using (a) case studies on Kenyan manufacturing firms in the garments, furniture and automotive industries; (b) analysis of available sector and firm-level evidence, including previous analysis by the Kenyan Association of Manufacturers and the Overseas Development Institute (KAM–ODI analysis); and (c) a KAM–ODI bilateral meeting to identify what Kenyan firms need to do better.

Amid the many opportunities associated with the use of digital technologies in Kenyan manufacturing, one issue causing concern is the impact on labour. Since manufacturing forms part of Kenya's Big Four agenda, primarily due to its job-creating potential, the implications of growing digitalisation, both within Kenya and globally, bring into question the very role of manufacturing as a development pathway towards employment generation. Our analysis highlights that there are different ways through which the digital economy can affect Kenyan manufacturing and job creation. On the one hand, a persistent digital divide in Kenya in the context of growing digitalisation globally can lead to increasing re-shoring of manufacturing jobs and to concentration of future production of digitally enabled goods in developed countries. On the other hand, if Kenya manages to leverage digitalisation, it can successfully expand the manufacturing sector and create more productive jobs in the economy.

Firm-level interviews show that digital technologies and robotics help firms to create efficiencies in production, which can increase their total factor productivity, leading to higher output and exports as well as creation of new jobs linked to these exports. **Appropriate policies need to be developed to ensure that Kenya is able to maximise productivity gains from digitalisation and, through the efficiencies created, is able to realise large-scale employment gains**. In this sense, the fourth industrial revolution, spurred by digitalisation, is not very different from the other industrial revolutions; deployment of digital technologies and robotics in manufacturing will destroy some jobs and tasks but will also create new jobs and tasks in manufacturing sectors that produce and supply parts for these new machines, as well as in complementary services sectors. **Developing countries need to put in place policies to improve competitiveness of those domestic service sectors that will attract job growth in the future as well as increase employability of the youth in such sectors.**

A significant part of this policy agenda is well trodden, but there are also new elements which require urgent attention. Kenyan manufacturing firms face many well-known challenges to digitalisation, including (i) high cost of capital, (ii) high cost of electricity and unreliable power supply, (iii) lack of available credit, (iv) high prices of raw materials, (v) lack of relevant skills, and (vi) poor customs and logistics procedures. However, a major message of this paper is that **to**

achieve digital transformation, policies in Kenya need to not only address these challenges but also build digital capabilities and manage inclusive digital transformation in manufacturing through targeted actions.

The digital economy is characterised by fast-blurring lines between the physical and digital world, convergence in modern technologies, rapid speed of change and rapid diffusion of technology. Digital technologies are increasingly affecting not only manufacturing production but also re-ordering manufacturing through digital platforms and use of mobile currency such as M-Pesa. This highlights the urgent need for a targeted approach to digitalisation, whereby developing countries adopt specific policies to leverage the digital economy, even when it may not fit with their comparative advantage as of now. **Comparative advantage is a dynamic concept, which can be shaped by appropriate digital industrial policy.**

In this context, **the study provides new discussions on targeted interventions for building digital capabilities: improving access to information and communications technology (ICT) goods and services; encouraging innovation and research; updating laws on data localisation, protection, source-code sharing and intellectual property rights; and using global and regional approaches to digital trade.** Analysis of Kenyan manufacturing undertaken in this paper suggests that micro, small and medium enterprises (MSMEs) in are the least prepared in building digital capabilities; only 20-40% of MSMEs have an IT policy in place, compared 78% of large firms have an IT policy in place. Moreover, while 95-99% of small and medium firms have access to internet, less than 65% of the firms have a web presence and less than 25% of the firms are using cloud computing, indicating a significant digital divide in terms of 'use' of internet in such firms.

Digital change also needs to be managed in an inclusive manner, requiring complementary policies for skills development in the workforce, improvements in regulatory practices, better dialogue and effective collaborations between the public and private sectors.

Kenya therefore needs to engage with the digital economy actively by developing a well-informed digital industrial policy that aims to improve efficiencies of firms but that also boosts employment opportunities and inclusive development. For this to occur, the digital industrial policy needs to be embedded within the wider industrial policy of Kenya so that all segments of society can gain.

With this in mind, the paper develops a policy framework which covers 10 policy areas crucial for a successful digital transformation of Kenyan manufacturing and discusses the role of the government and the private sector under each policy area. The timing, sequencing and prioritisation of these policies are likely to differ in priority across countries and sectors, but also over time.

The policies are as follows:

A. Policies for building digital capabilities

1. Improve access to internet and digital technologies through infrastructure sharing. Kenya's internet coverage was only 26% in 2016, and internet tariffs are 15% higher than in Ghana and twice those in Ethiopia.
2. Build and improve data infrastructure through laws on data localisation, source-code sharing, and intellectual property rights.
3. Improve firm-level capabilities by encouraging innovation, research and development and efficient resource utilisation. Kenya and the East African Community (EAC) should create a register for digital-related trademarks.
4. Support a well-embedded manufacturing ecosystem of start-ups and technology hubs. Government should encourage public–private collaborations for digital hubs.
5. Use regional approaches to e-commerce and digital products and services.

B. Policies for fostering competitiveness for a digital economy

6. Lower the cost of capital by reducing interest rate spreads through cutting inefficiencies and lowering collateral requirements for investment in digital products. Establish windows in development banks dedicated to digital investment.
7. Lower the cost of electricity to 9 cents per kWh and secure reliable power supply through better e-governance and investing in renewable energy. Electricity is crucial for operating digital products.
8. Improve transport infrastructure (i.e. transport systems, roadways, ports), postal competence and trade logistics, all of which are important for the operation of digital platforms. The digitalisation of border procedures and blockchain transport corridors is important.

C. Policies for managing inclusive digital change in manufacturing

9. Target skills development to increase absorptive capacity and capabilities of the workforce. Showcase how firms have successfully acquired digital skills, especially for the young and women.
10. Focus on problem-driven governance to create a digitally enabling environment with flexible institutions, better dialogue and permissive regulatory practices. Targeted actions need to address investor problems.

1 INTRODUCTION

The global manufacturing landscape is changing rapidly with increasing use of digital technologies such as robotics and artificial intelligence, and this presents opportunities and challenges for Kenyan manufacturing. The Kenyan government is currently directing efforts towards leveraging the digital economy to promote and expand the manufacturing sector, included as one of the 'Big Four' agendas due to its job-creating potential. It is important to understand that digitalisation, if done right, can boost manufacturing and present important opportunities in terms of lowering the costs of production, trade, and entry into the export market – all of which can create new and more productive jobs. However, African countries are facing a two-pronged challenge in an increasingly digitalised manufacturing landscape: (i) current levels of digitalisation are low on the continent, and (ii) the impact of digitalisation on manufacturing labour productivity is also lower (Banga and te Velde, 2018a). If nothing is done to address the digital divide, in access and in use, then it is likely that re-shoring of manufacturing tasks will increase, and future digitally advanced manufacturing will be concentrated in developed countries. Growing digitalisation in the context of a persistent digital divide is therefore increasing concerns of further 'de-industrialisation' in Kenya, with falling shares of manufacturing in value-added and employment.

A persistent digital divide therefore affects the competitiveness of Kenyan manufacturing. Kenya has emerged as an African leader in digitalisation, with internet penetration increasing by roughly 25 percentage points in the period 2001–2016. This increasing trend of digitalisation can be tracked to improvements in telecommunications, customs and regulations, and combined and continued efforts by both the public and private sectors. While important developments such as M-Pesa and the rise of innovation and technological hubs have been driven by private sector initiatives, government support has also played a key role, for example by recognising ICT as a development pillar in the government's 2030 vision, setting up undersea fibre-optic cables, and introducing the National Broadband Strategy and the National Cybersecurity Strategy. However, while overall digitalisation has increased in Kenya, there is still a 40–50 percentage point difference between the percentage of firms having access to computers and internet and the percentage of firms engaging with it (by, for instance, having a web presence or buying and selling online), reflecting a digital gap in use of digital technologies.

With rising digitalisation of manufacturing global value chains (GVCs), UNCTAD's (2018) Trade and Development Report brings forth an important point: a persistent digital divide in the absence of corrective policies will lead to deepening of the value-chain 'smile curve'. This deepening reflects widening inequalities in rent distribution and value addition through GVC participation, which is a particular problem for African countries already 'locked in' at the very bottom of the smile curve, conducting low value-added manufacturing (UNCTAD, 2013). However, if corrective policies are put in place then the digital manufacturing value-chain smile curve will flatten, indicating opportunities for firms in developing countries to leapfrog into higher value-added activities. In line with this, the Pathways for Prosperity Commission's (2018) report identifies five pathways that are currently being unlocked by technological innovations in developing economies: (a) rising value from agriculture through improvements in yield and agricultural supply-chains (b) new GVCs through drastic reduction in the cost of information exchange and networking, allowing higher-skilled manufacturing tasks to be undertaken remotely – perhaps by developing economies, given the right infrastructure; (c) new global trade in services such as management advisory services, remote healthcare, etc.; (d) linking of the informal sector with the formal sector through digital platforms and productivity improvements; and (e) greater domestic integration of the economy, allowing laggard firms to catch up with the 'superstar' firms through reduction in ICT costs and innovation.

Through these pathways, digital technologies will change not only how an economy functions, both domestically and globally, and job prospects, but also the terms on which people will work. On the one hand, emerging evidence shows that the informal sector is consistently using electronic payment systems, virtual savings and virtual credit supply (Ndung'u, 2018). On the

other hand, digitalisation seems to be increasing short-term contractual work – often found through online platforms – which poses challenges to those working in the informal sector. Digital platforms have also enabled the expansion of Uber taxi and TaxiFY services in the transport industry, which have created new opportunities for self-employment in Kenya (Ndung'u, 2018).

With the changing nature of work and skills, World Bank's World Development Report 2019 calls for an immediate investment in human capital and targeted skills-development. In addition, governments need to enhance social protection and extend it to all people in society, irrespective of the terms on which they work. The International Labour Organization (ILO) (2018) further stresses improving lifelong learning for workers and finding innovative ways of financing such learning.

While there is a global urgency to gain a better understanding of the impact of digitalisation on African manufacturing, there is little analysis available at country level to guide policy-makers concerned with developing manufacturing and with creating jobs in a digital economy. Identifying a number of successful Kenyan manufacturing firms and gaining in-depth understanding of the impact of digital technologies, or of what is enabling or constraining their use, is an important first step in ensuring that these firms remain competitive and can act as champion firms for other – less digital – Kenyan firms. Manufacturing is a key pillar in the Big Four Agenda that Kenya's president is championing, and it is crucial that Kenya uses digitalisation to enable – not hamper – manufacturing.

This study draws policy insights for digital transformation in Kenyan manufacturing using (a) case studies on Kenyan manufacturing firms in the garments, furniture and automotive industries (see appendix for selected case studies), (b) available literature and evidence, including previous ODI-KAM analysis in Were et al. (2017) and (c) an ODI–KAM bilateral meeting to identify what Kenyan firms need to do better and how public policies can help in achieving this. Although developments such as M-Pesa have been crucial in financial inclusion and development, and they help consumers, the focus of this study is to examine digital technologies being used on the production side (even though M-Pesa may also have helped manufacturing) rather than the transaction side, as well as in government services.

The structure of this paper is as follows. Section 2 presents a value-chain approach towards understanding the different aspects of digitalisation in manufacturing, and discusses the current state of digitalisation in Kenya and the opportunities and challenges it presents. Section 3 discusses specifically the job-creating potential of digital technologies and how growing digitalisation, both nationally and globally, can affect the labour in Kenyan manufacturing. Section 4 puts forward 10 targeted policies that can promote manufacturing in Kenya in a new digital area and help the sector realise its employment-creating potential. Section 5 concludes.

2 DIGITALISATION AND KENYA'S MANUFACTURING SECTOR: CHALLENGES AND OPPORTUNITIES

In the next sections we map out the scope of digital technologies in the manufacturing sector and discuss the potential impact of digitalisation on the Kenyan economy and on manufacturing in particular. Section 2.1 provides a value-chain approach towards understanding digital technologies. Section 2.2 provides a brief introduction to how Kenya has emerged as a leader in digitalisation in sub-Saharan Africa (SSA) through public–private efforts, which is followed by Section 2.3 examining how digitalisation is faring across different Kenyan industries and firms. Section 2.4 provides an insight into the growth outcomes that firms have been able to realise through digitalisation, and the challenges they are facing in leveraging the digital technologies.

2.1 Digitalisation: a manufacturing value-chain perspective

The digital economy contains a range of technologies with an enormous potential to affect the organisation of production, as well as the efficiency of the production process. Broadly these technologies, and their impacts, can be categorised under two types: (a) technologies reducing per unit cost of production (such as robots, 3D printers, Internet of Things (IoT)); (b) technologies reducing per unit transaction and delivery costs (such as use of internet and smartphones for communications, use of artificial intelligence and cloud computing for data management and use of e-commerce for increased market access). The effective functioning of this digital economy requires both investments by the firms in *digital infrastructure* – such as routers, sensors, satellites and electricity – as well as *a digitally enabling environment in the country*, which includes a) access to digital skills such as programming, web development, digital design, product management, digital marketing and big data analytics; b) policies and regulations encouraging development of ICT, innovation and digital business models; and c) digital accelerators [1] such as government support, public–private collaborations, behavioural and cultural aspects of the economy.

Government action to leverage the digital economy is needed on three fronts: (i) building digital capabilities through investments in digital infrastructure and developing appropriate policies on data; (ii) increasing competitiveness of manufacturing in the digital economy by addressing existing challenges to traditional manufacturing such as the high cost of electricity and capita; and (iii) managing digital change in an inclusive manner through skills-development and the fostering of open dialogue. It is important to note that while government policies can help bring about digital transformation, digital technologies themselves can increase efficiency and viability of policy solutions through streamlining of administrative procedures and better execution of policies, amongst other things. For instance, digital technologies enable online registration of businesses, harmonisation of regional laws on intellectual property using online tracking and monitoring of patents and trademarks through a centralised database, provision of online training modules for skills-development, and automation of customs for faster clearance.

Figure 1 shows interdependencies between (i) digital technologies, (ii) government policies, and (iii) firm capabilities; these are as follows:

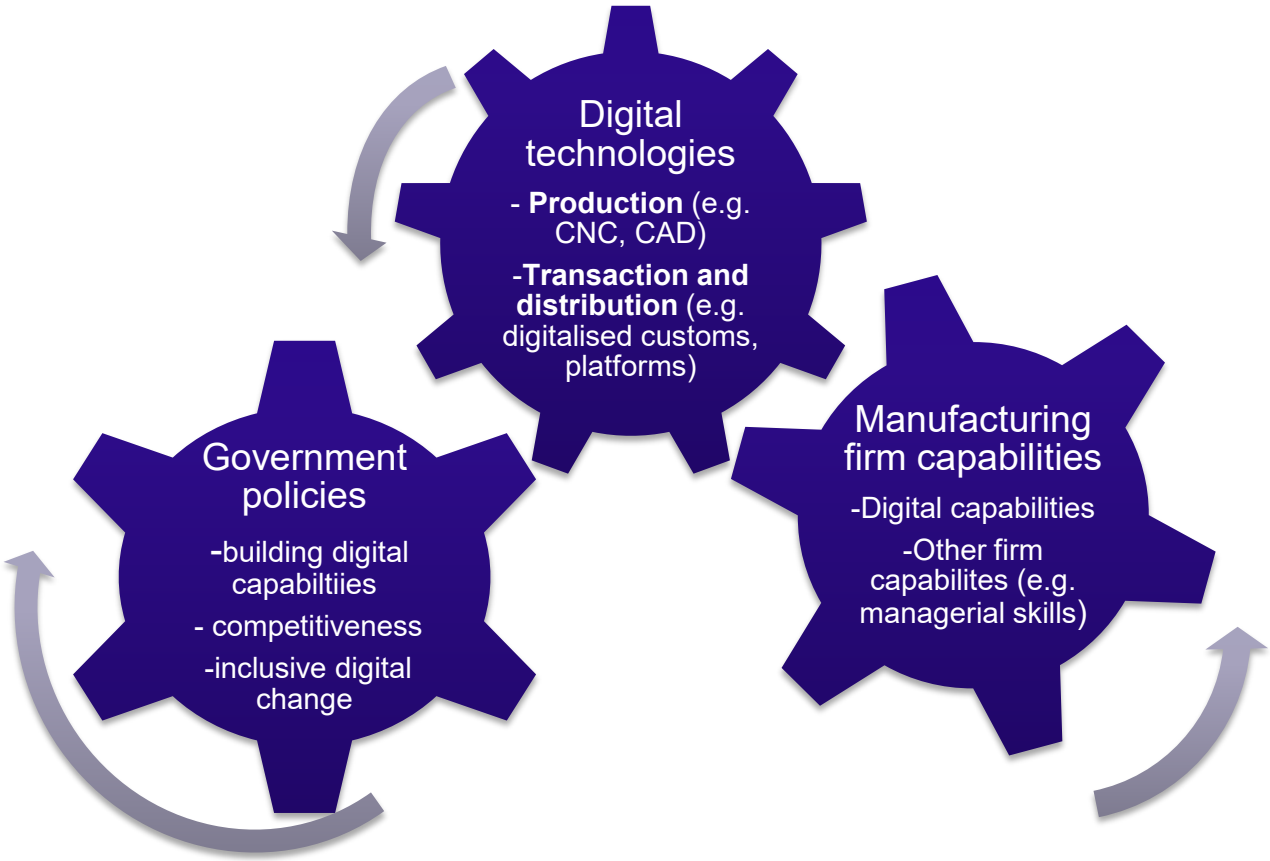
- *Digital technologies* which affect (i) efficiency of manufacturing production directly or (ii) indirectly through government policies

[1] The term 'Digital Accelerators' has been adapted from Accenture (2016) which uses it to refer to national communication infrastructure, government prioritisation of digital and digital business environment.

- *Government policies* for a digital industrial transformation are divided into those that aim to (i) build digital capabilities; (ii) foster competitiveness; and (iii) deliver an inclusive and accountable process

- *Manufacturing* firm capabilities are divided into (i) digital capabilities and (ii) other capabilities.

Figure 1: Linking government policies, digital technology and manufacturing capabilities

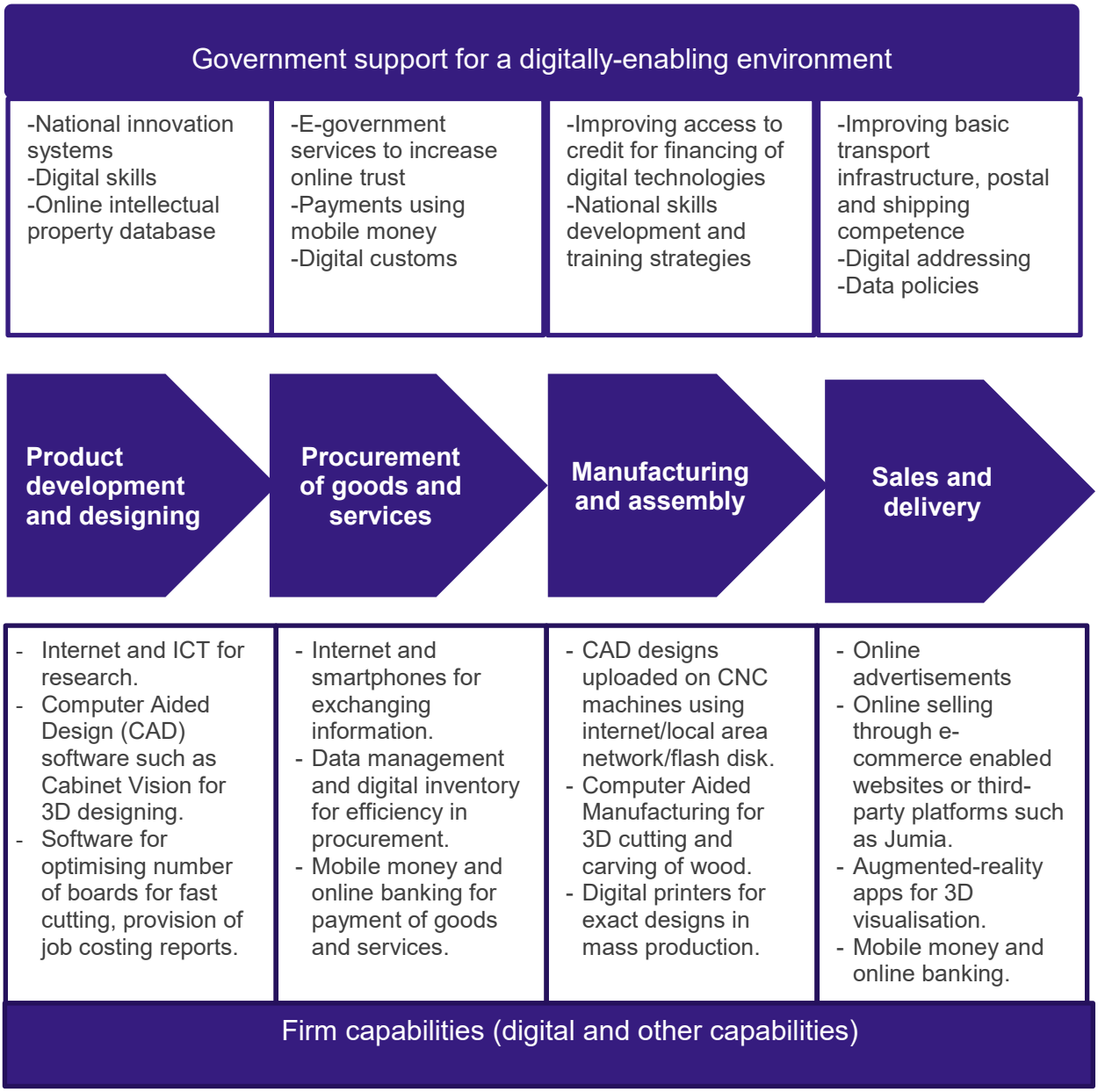


Source: Authors

The functioning of a digital economy can also be understood from a value-chain perspective. Figure 2 takes the example of furniture manufacturing and broadly maps out the use of different technologies, as well as support needed from the government at each stage. As a first step, designing of furniture requires internet and ICT technologies for research and development (R&D) and product development. Software programs such as Cabinet Vision are being used by some Kenyan firms for 3D visualisation of the cabinet and for easily changing specifications and designs. Some software also has features for optimising the number of panels in a piece of furniture for faster cutting as well as providing cost–benefit analysis. At the next stage, the furniture manufacturing firms need to procure raw materials, such as timber, either locally or by importing it from other countries. Here, digital technologies that reduce the cost of transaction and delivery are particularly important; firms can use the internet and smartphones to locate and engage with sellers, outsource tasks such as metalworking if needed, use digitalised inventory for stocktaking, and use artificial intelligence and cloud computing for data management. Mobile money and online payments can facilitate the exchange of goods and services. Once the material is procured, manufacturing of the cabinet is facilitated through computer aided manufacturing: computer numerical control (CNC) machines and digital printers are used for designing, 3D cutting, and woodcarving. Such technologies enable mass production of furniture with exact specifications and designs. For increasing market access and higher sales (which can be domestic, regional and international), firms can sell through their own e-commerce

enabled websites or through third-party platforms, such as Jumia, using online banking and mobile money. Electronic advertising as well as augmented reality apps for 3D visualisation are particularly useful for customers looking to purchase furniture.

Figure 2: Use of digital technologies in furniture manufacturing; a value-chain framework



Source: Authors

Government support at each stage of the value chain is crucial. First, developing a national innovation system, with sector-specific pro-innovation policies and reduced patent costs, can encourage R&D in firms, enabling them to undertake the higher value-added activity of designing in a value chain. Targeted strategies to build digital skills as well as expensing the use of software for small and medium-sized enterprises (SMEs) can facilitate inclusive use of technology at this stage of product development. Important steps the government can take for enabling the use of digital technologies in cabinet manufacturing include improving access to credit for financing digital technologies; making electricity more affordable and reliable (which is key in the use of CNC machines); and improving resilience of firms so that firms can leverage these converging technologies. Resilience can be improved by providing industry-specific training in repair and maintenance of digital machinery, which can create locally available skills to fix digital machines

if and when they break down. For procuring raw materials, for outsourcing of certain manufacturing tasks and for e-commerce sales, government support needs to facilitate both B2B and B2C e-commerce through improving access and affordability of internet; improving consumer's 'online' trust through digitalisation of key e-government services such as online payment of taxes; introducing digital addressing and digital identification systems, which can be the key in unlocking e-commerce growth; improving basic road and transport infrastructure as well as shipping and postal competence; digitalising customs to improve logistical efficiencies and reduce delays as well as counterfeit goods trade. Policies on data are also key for leveraging e-commerce.

2.2 Digitalisation and the Kenyan economy: a brief introduction.

Kenya has emerged as the leader of digitalisation in SSA, owing to continued and combined efforts by both the public and the private sector. The first significant development for Kenya's digital economy was in 2007, with the introduction of mobile money in Kenya through Safaricom's M-Pesa. Then, in 2008, ICT was incorporated as a key development pillar in the government's 2030 vision. Since then, significant efforts by the Ministry of ICT have been directed towards increasing the level of digitalisation in Kenya or creating a digitally enabling environment, including announcement of the Konza Technological City ('Silicon Savannah') as the vision's flagship project for business process outsourcing (BPO) and IT enabled services (ITeS). High-speed internet was brought into the country in 2010 through SEACOM, TEAMS, EASSY, and LION undersea fibre-optic cables, followed by the launch of the Kenya Open Data Initiative in 2011, making key government data freely available through a single online portal. In the year 2012, Kenya spent $3,178 million on ICT services, with a special focus on computer-related services in the budget, and in 2013 launched the National Broadband Strategy, with the aim of transforming Kenya through a nationwide high-capacity broadband network. Subsidised broadband was thus made available for all universities and technological hubs. Further efforts by the government saw the introduction of the National Cybersecurity Strategy (2014) to provide a secure online environment to conduct business, accompanied by the rolling out of 4G internet coverage by telecom providers. Since 2016, efforts have also been focused on preparing the Kenyan workforce for the digital economy. The Ministry of ICT's ongoing Digital Literacy project aims to bring about systemic change in basic and higher education through integrating technology in the learning programme.

Recent data from the International Telecommunications Union (ITU) on internet penetration show that the percentage of population accessing internet in Kenya has increased from 0.5% in 2001 to 26% in 2016. The data show that the internet penetration ratio doubled every five years (from 5% to 11% between 2007 and 2012, and from 11% to 25% between 2012 and 2016). The number of internet service providers increased from 171 in 2013 to 242 in 2016 but declined to 219 in 2017, partly due to non-renewal of licenses in some cases (KNBS, 2018). The total number of wireless internet subscriptions increased by 24.9% in the period 2016–2017. Similarly, total fixed wired internet subscriptions increased by 59.2%. Fixed fibre-optic subscriptions accounted for half of the total fixed wired subscriptions.

Kenya has also undertaken many steps to improve the investment climate, to become more attractive for investors. The World Bank Group's Doing Business 2017 ranks Kenya as the third most reformed country, with Kenya moving up 21 places to rank 92nd among the 190 economies on ease of doing business. Between 2013 and 2017, reforms were made in the following areas: starting a business, access to electricity, registration of property; and protecting minority investors. More recently, Kenya also launched the National ICT Master Plan (2017) to harness the power of ICT. It looks to further develop Kenya as 'an ICT hub and a globally competitive digital economy' with three foundations: (a) ICT human capital and workforce development; (b) integrated ICT infrastructure to enable cost-effective delivery of ICT products and services; and (c) integrated information infrastructure targeting e-government services. In line with this, President Kenyatta called for commissioning a taskforce on IoT and blockchain, in February 2018, focusing on how

the digital economy can be leveraged to achieve the 'Big Four' plan – expansion of manufacturing, affordable housing, food security and universal healthcare.

A combination of strategic public–private efforts has thus enabled Kenya to achieve higher connectivity, increased network capacity and more affordable internet (Waema and N'dungu, 2012). This has also helped to boost an entrepreneurial spirit in Kenya. While the government has supported development of infrastructure, incubators, small enterprises and small credit-providing facilities, the rise of privately driven tech hubs and networks, such as the iHUb or the Savannah Fund, have sparked innovation, collaboration and exchange of ideas. However, to make Kenya competitive, not just regionally but also globally in the growing digital economy, there is an urgent need to improve access to high-skill talent, financing opportunities for SMEs and regulatory environment for ICT services (Akamanzi, 2016). Khanna et al. (2016) also highlight the need to promote ICT-enabled manufacturing. To achieve digital structural transformation, it is important to: (1) promote the adoption of digital services-based productivity improvements in various manufacturing sectors in Kenya; and (2) develop effective private–public sector collaborations in different spheres of the digital economy, such as promotion of affordable internet, education and skills-development.

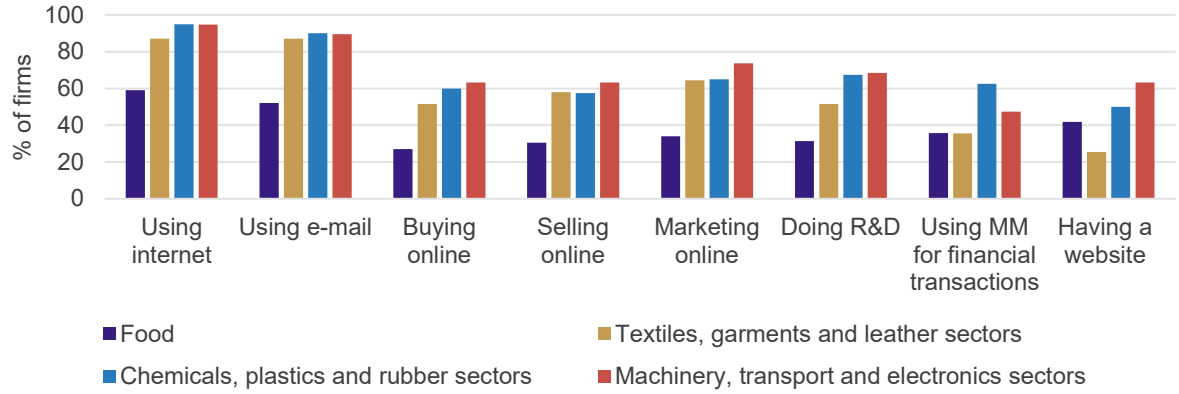
2.3 Digitalisation in Kenyan manufacturing

There are major developments in digital technologies across Kenyan manufacturing industries. Within the manufacturing sector, the rate of automation depends on both technological and economic feasibility. For instance, compared to the automotive sector, robots in the garments sector would need to have a lot more dexterity, since tasks in the garments sector such as stitching and embroidery are much nimbler. At the same time, average wages in the garments sector are lower than those in the automotive sector, indicating that automation may be inefficient. Banga and te Velde (2018b) show that while in developed countries such as the US and UK and in China, robot deployment is diversified across industries, it remains concentrated in developing economies (India, South Africa and Mexico), with over 60% of robots being deployed in the automotive sector.

Although data on robots are not available for Kenya, Figure 3 confirms that digitalisation also varies significantly across Kenyan manufacturing industries. On average, a higher proportion of firms in the machinery–electronics–transport sectors and the chemicals–plastics–rubber sectors use the internet, email clients, engage in e-commerce and online marketing, have a web presence, use mobile money (MM) and undertake R&D. While the textile–garments–leather sector fares well in terms of using internet and email, firms engaged in this sector are less likely to engage in online purchases, undertake R&D, use MM and have their own websites. The food sector is found to be the least digitalised.[2]

[2] The food sector globally has the least industrial robots installed (IFR, 2017)

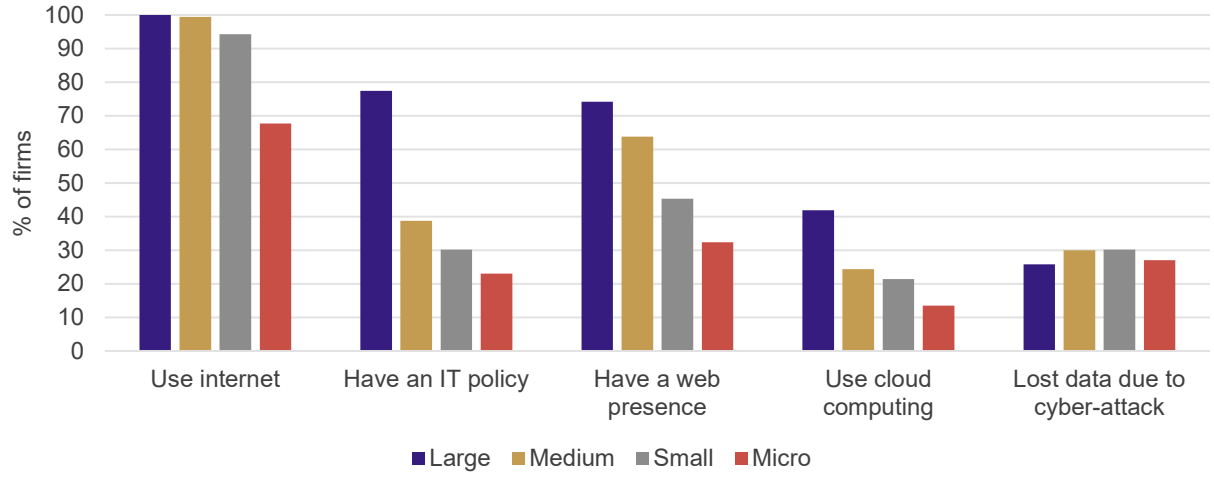
Figure 3: Dispersion of digitalisation across Kenyan manufacturing industries



Source: World Bank Enterprise Survey (manufacturing) Kenya 2013. Note: Number of firms interviewed in each sector are: 114 for the food sector, 31 for textiles–garments–leather, 40 for chemicals–plastics–rubber and 19 in machinery–transport–electronics sectors.

The use of internet and digital services also varies across manufacturing firms. Using data from Kenya ICT survey for 2016, Banga and te Velde (2018a) shows that there is a 40-50% difference between the percentage of firms having access to computers and internet and firms actually utilising it, i.e. having a web presence, engaging in e-commerce, and so on. While 97% of manufacturing firms in Kenya use computers and 93% have internet, only 54% have a web presence and 40% are engaged in e-commerce. Amongst the firms engaged in e-commerce, a higher percentage of firms are engaged in online buying (37%) compared to selling (27%). Figure 4 compares access and use of internet across Kenyan manufacturing firms of different sizes and finds that while 78% of the large firms have an IT policy in place, only 20-40% of micro, small and medium enterprises (MSMEs) in Kenya have such a policy. Moreover, while roughly 95-99% of small and medium firms have access to internet, less than 65% of these firms have a web presence and less than 25% are using cloud computing.

Figure 4: Digital divide in 'access' and 'use' in Kenyan manufacturing, by firm size



Source: KNBS (2016b)

Note: Large firms refer to firms employing 250 or more employees, medium firms between 50 to 249, small firms between 10 to 49 and micro firms between 1-9.

2.4 Digital transformation in Kenyan industries: evidence from textile and garments, furniture and automotive firms

In order to understand the challenges of digitalisation in Kenya, we conducted a series of interviews with manufacturing firms in Kenya from the garments, automotive and furniture industries. The purpose of the firm interviews was (a) to identify the types of technologies being commonly used across manufacturing industries and (b) to identify the shared challenges and constraints to digitalisation, as well as (c) to examine whether firms have been able to realise opportunities from digitalisation laid out in the previous sections.

Insights from the interviews are summarised in Table 1, with selected detailed case studies included in the appendix. Table 1 suggests that most firms are using CNC-based technologies, which is the automation of machine tools by means of computers. In modern CNC systems, there are two technologies at play: first, the mechanical dimensions of the furniture parts are defined using computer aided design (CAD) software and, second, they are translated into manufacturing instructions using computer aided manufacturing (CAM).

The case studies reveal that through digitalisation, manufacturing firms have indeed been able to achieve different growth outcomes: product diversification, expansion into regional markets, productivity improvements and lowered cost of production. Common challenges that still persist include skills shortages in relation to the use of digital machines, logistical and customs delays, access to credit, high cost of electricity, unreliable power supply, and high prices of raw material.

Taking a deep dive into manufacturing sectors, KAM (2018a) confirms that there is limited access to technology/ICT amongst Kenyan manufacturing industries. A major reason for this is the high cost of financing digital technologies, particularly in the textile and apparel industry, where the cost of financing manufacturing investments and trade financing is very high as compared to global rates. This highlights the need for competitive credit in the sector to facilitate investment, re-investments and trade expansions. In the case of automotives, there is little or no R&D in the sector due to high costs for innovations and the need to collaborate with the government. KAM further identifies lower skill levels of employees in the machine tools industry as an important problem, since this industry plays a big role in supplying machines, tools and equipment to other sectors. Training strategies are needed here to train the Kenyan workforce in manufacturing with quality and in finishing. The high cost of financing, poor access to credit and lack of institutes for formal training also limit the sector's access to new technology needed for machine tools manufactures. There is also a need to improve the engineering industry, which plays a crucial role as a service provider to the automotive sector.

In the case of the furniture sector, KAM (2018a) identifies key constraints to the growth of local industry: illicit trade, preference for imported furniture over locally manufactured products, limited labour skills, low investment in new technologies, and limited market access. There is also constrained input supply, since the Kenyan forestry sector is unable to meet local demands for timber, resulting in the country becoming a net importer of sawn timber. The problem of timber supply is exacerbated by a lack of transparency in obtaining import licenses.

While larger firms in Kenya are in a better position to leverage new technologies, micro, small and medium enterprises (MSMEs), which constitute 67% of manufacturing firms in Kenya, are unable to do so, largely due to the cost of deploying these technologies (Were, 2016). Numerous manufacturers end up using outdated technologies, running outdated systems and using obsolete machines. This has led to low processing capacity, less product diversification and low return on investment. Some Kenyan textile firms use obsolete machines that run at 200 rpm, whereas elsewhere firms use machines running at 18,000 rpm (Were, 2016).

Table 1: Constraints and opportunities for digitalisation in Kenyan manufacturing firms

Firm	Industry	Digital technologies used	Constraints to further digitalisation	Complementary strategies for digital transformation	Technology has contributed in
Megh Industries	Automotive	CNC-auto cut and laser, 3D scanning	Skills-gap and re-skilling investment, credit constraints, high cost of electricity, high prices of steel, delays due to customs and logistics, high cost of labour	Reverse engineering, 'glocalisation', on-the-job skills training, cellular manufacturing	Product diversification from supply of automotive components to transport seating
Funkidz	Furniture	CNC systems, CAD/CAM, augmented reality, 3D modelling.	Increase in prices of wood, credit constraints, lack of relevant skills	Customisation, partnership with Safaricom for developing curriculum focused on training in CNC, use of circular economy	Expansion to regional markets; Uganda and Rwanda
Panesar Interiors	Furniture	Five-axis CNC, CAD/CAM, 2D cutting and 3D carving.	Skills shortages, increase in price of wood	On the job training, innovative thinking, circular economy	Increase in efficiency, more than 60% exported internationally
New Wide garments	Garments	Auto-packing machines, CAD/CAM	Higher labour costs, retraining expenditure, high cost of electricity and capital, unreliable power supply, water shortages, high cost of permits, delays due to customs and poor logistics	In-house retraining of workers displaced from one task into other tasks	Lowered cost of production, meeting international standards, no negative impact on employment

Source: Firm-level interviews (see appendix for further details)

3 DIGITALISATION: IMPLICATIONS FOR KENYAN MANUFACTURING LABOUR

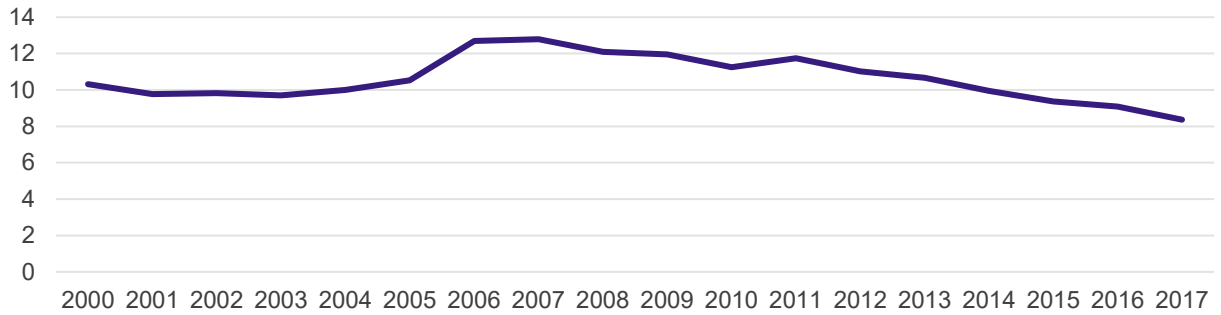
This section argues that digital technologies and robotics help firms to create efficiencies in production, which can increase their total factor productivity, leading to higher output and exports, and to creation of new jobs linked to these exports, but productivity gains realised will depend on whether countries are able to maximise productivity gains from digitalisation, and also on employment gains through the efficiencies created. The fourth industrial revolution is not very different from the other industrial revolutions; deployment of digital technologies and robotics in manufacturing will destroy some jobs but also create new jobs in manufacturing sectors that produce and supply parts for these new machines as well as in complementary services sectors. Developing countries need to put in place policies to improve competitiveness of those domestic service sectors that will attract job growth in the future as well as increase employability of the youth in such sectors.

3.1 The digital divide and Kenyan manufacturing jobs

A major concern associated with the use of digital technologies in the manufacturing sector is the impact on labour. Since manufacturing forms part of the Big Four agenda, primarily due to its job creating potential, the implications of growing digitalisation, both within Kenya and globally, brings into question the very role of manufacturing as development pathway towards employment generation. During the third industrial revolution (the ICT revolution) many developing economies (barring a small group of Asian economies) saw elements of 'pre-mature de-industrialisation' whereby these countries reached a peak of manufacturing in value-added and in employment at lower levels. As manufacturing becomes increasingly digitalised, there are growing fears of further de-industrialisation and further divides between capital-intensive and less capital-intensive countries (Rodrik, 2018).

Figure 5 shows that manufacturing value-added (VA) as a % of gross domestic product (GDP) in Kenya has been constantly declining since 2007, with a particularly fast decline since 2011. This indicates that, similar to many other developing countries, Kenya might be de-industrialising prematurely, while plans are for a rapid increase in the manufacturing to GDP share. As a whole, the manufacturing sector in Kenya grew by only 0.2% in 2017 compared to a revised growth of 2.7% in 2016 (KNBS, 2018). Food products and beverages (which is usually oriented towards the domestic market) is the dominant manufacturing sector, accounting for roughly 43% of the manufacturing value-added in GDP in 2015, followed by textile and apparel (8%), and chemicals and fabricated metals (7%) (KNBS, 2016a).

Figure 5: Manufacturing VA (% of GDP) in Kenya



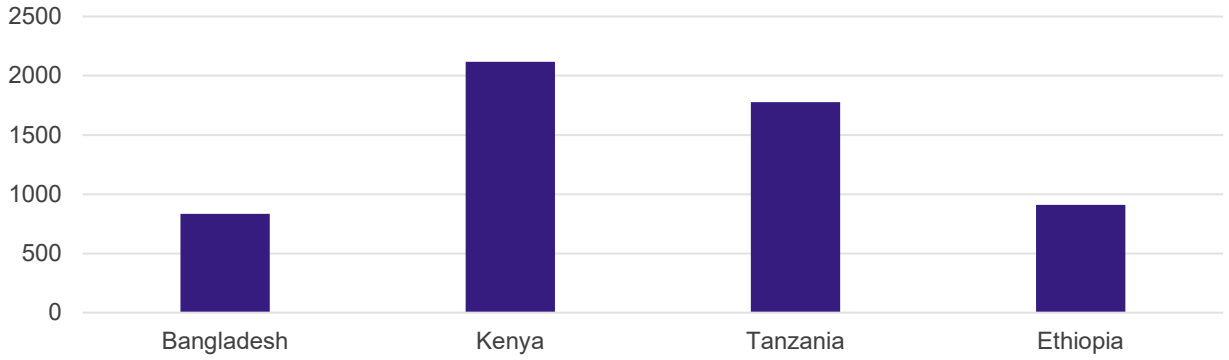
Source: World Development Indicators

It is important to note that firms will increase investment in automation only when the cost of employing labour is, by some margin, higher than the cost of automation/ operating robots. The

cost of labour is relatively higher in Kenya, compared to other African countries (see Figure 6), which may explain the faster adoption of technology in the manufacturing sector of Kenya[3] compared to other SSA countries. The rate of automation within Kenyan manufacturing will also differ across industries depending on technological and economic feasibility. For instance, Banga and te Velde (2018a) take the case of furniture manufacturing in Kenya and show that while US robots in the furniture manufacturing industry will become cheaper than US labour in 2022, robots in Kenya will become cheaper than Kenyan labour only a decade later, in 2034. For sectors where manufacturing wages are lower and where it is also technologically and economically more difficult to deploy robots as yet – such as garments – the inflection point will be a few years later.

There has been a slowdown in global trade since 2011, particularly in GVC-intensive sectors, such as computers, electronics and transport. These sectors are more intensive in the use of intermediate products such as parts and components, and are therefore being automated at a faster rate. In other sectors – for example food, beverage and tobacco products; basic metals; wood and wood products; paper and paper products and other non-metallic minerals – technological change has been slow until now, making them less susceptible to global trends (Hallward-Driemeier and Nayyar, 2017). These sectors can therefore act as a window of opportunity for African countries to undertake local production and regional trade. While several Asian countries are likely to see their preferences weakened (Bangladesh, Cambodia, and Nepal may all graduate out by 2024), African least-developed countries (LDCs) such as Ethiopia and Tanzania can still use their preferences.

Figure 6: Annual labour cost ($) per worker in manufacturing



Source: Gelb et al. (2017)

But how long will the window of opportunity last? This varies not only across the rate of automation in different sectors but also with the global competitiveness of countries, which is changing whether or not they participate in the digital economy. For instance, although the inflection point for Kenya in Banga and te Velde (2018a) is not before 2034, the authors show that Kenya's global competitiveness will be affected through the international pathways of digitalisation. One such international impact pathway is through re-shoring of manufacturing tasks from labour-intensive to capital-intensive regions; robots in the US, in the furniture industry, can become cheaper than Kenyan labour in the year 2033 (Banga and te Velde, 2018a). Although there are other factors to account for, such as transportation costs as well as time-to-market cost, the broader point is that 're-shoring' is not a myth. In fact, it presents an important and real challenge for African countries in an increasingly digital future. Even if developed-country 'lead' firms do not re-shore the production, they can automate their entire value chain as a way to remain competitive, cut waste and costs, adapt to fast-changing consumer demands and shorten the design and manufacturing process. Levi Strauss, for example, has already replaced its in-house design finishers with laser-wielding robots to produce and style its jeans (Donnan, 2018), and expects lasers to replace

[3] As per World Economic Forum (WEF) technology adoption index (using data on latest technologies in a country, extent of business adoption, technology transfer through FDI, % of individuals using the internet, internet bandwidth and broadband internet subscriptions), Kenya ranks 41st with a 4.9 score, ahead of South Africa and Nigeria.

almost all of its workers by 2020. It has also rolled out lasers in one of its factories in Hawassa Industrial Park in Ethiopia.

Clearly, the changing competitiveness of countries in the digital economy will lead to changes in the organisation of global value chains (see Rodrik, 2018). As manufacturing becomes increasingly based on a 'digital thread', i.e. a continuous flow of data between the different stages of production, it is likely that production will become concentrated in those countries that provide good infrastructure, R&D capabilities and skilled labour at all points along the value chain, hence developed countries. For instance, a recent survey by McKinsey and Germany's RWTH Aachen University reveals that roughly a quarter of the apparel-sourcing executives in the US and Europe interviewed expect that more than half of the clothes sources will come from 'nearshoring' in 2025. This indicates that much of the production for Western countries will move out of developing economies to these countries or to neighbouring countries (Bloomberg, 2018).

An argument can be made here that even though manufacturing tasks may get re-shored to developed countries, there is likely to be increased offshoring from China, as a response to rising wages. Lin (2012), for example, suggested that 85 million manufacturing jobs could potentially be relocated from China. Recent data suggest there were 103 million jobs in Chinese manufacturing in 2014, of which 25.4 million jobs were in consumer electronics, household appliances, toys, clothing, footwear, hats and leather goods. Xu et al (2017) surveyed more than 100 Chinese firms covering four sectors: home appliances, garments, footwear and toys, which together represent 16 million jobs. The survey suggests that 31% of firms ranked 'technology upgrading' as the preferred response to rising costs, rather than investing abroad in regions where labour is cheaper. And if they did invest abroad, South Asia was chosen over Africa as the preferred destination. Both lower- and middle-income African countries are, on average, found to have high manufacturing labour costs relative to GDP as well as high capital costs relative to their comparators, questioning the potential of Africa to emerge as an important manufacturing hub (Gelb et al., 2017).

The survey suggests that roughly 10% of firms are (considering) relocating as the first response to rising wages, which could lead to between 2.5 million and 10 million jobs relocating (to Asia and Africa). Even if only a quarter of the 10 million jobs end up in Africa (and the rest in Asia, for example) this would be 2.5 million jobs – significantly more than the 17.7 million formal and informal manufacturing jobs in SSA in 2013 (Balchin et al., 2016a). It is, however, still small (1%) in comparison to the 280 million additional jobs that Africa needs to create by 2030, simply to keep up with demographic challenges.

3.2 Closing the digital divide: potential for job creation in Kenya

While the digital divide presents certain challenges to employment in Kenya, by closing the digital divide, Kenya can benefit from a virtuous cycle of productivity and employment gains. Digitalisation presents important opportunities for Kenyan manufacturing, in terms of growth and employment creation. These pathways though which new employment opportunities can be created are explored below:

3.2.1 Digitalisation, efficiency gains and job creation in manufacturing

A positive relationship between digitalisation and productivity and growth has been confirmed by several macro-level studies. Booz and Company (2012) found that a 10% increase in a country's 'digitisation index' led to a 0.75% growth in its GDP per capita, with the impact of digitisation being the lowest for Africa and South Asia – regions which have a majority of digitally constrained economies. The result that digitalisation can boost growth is also confirmed in the study by Donou-Adonsou et al. (2016), which conducted analysis for 47 countries in the period 1993–2012, and finds that a 1% increase in the use of internet and mobile phones increases growth by 0.12 and 0.03 percentage points respectively. More recently, using data from 17 countries, Graetz and

Michaels (2015) find that in the period 1993–2007, robot densification led to an increase in annual GDP growth and labour productivity of 0.37 and 0.36 percentage points respectively.

In the case of Kenya, Ndung'u (2018) concludes that digitalisation has supported retail electronic payment systems and financial inclusion, and increased financial sector vibrancy. This has boosted GDP growth which can increase labour productivity, output and employment growth across diverse sectors of the economy. Using World Bank Enterprise Surveys, Banga and te Velde (2018a) confirm that compared to Kenyan manufacturing firms with no internet access, with-access firms (internet access is taken as a proxy for digital access) have significantly higher labour productivity, a higher share of permanent full-time workers as well as a higher share of skilled workers in total employment.

A good example of the productivity effect of digitalisation at the micro level in Africa is the case of A to Z Textile Mills of Tanzania, which introduced a modern laser fabric-cutting machine for garment manufacturing (Banga and te Velde, 2018a). This machine is used to cut fabric that is knitted on site (the factory is also one of the largest vertically integrated manufacturing plants in East Africa), and it produces 25,000–30,000 pieces in one shift. To produce a similar amount manually requires 25 to 35 people; the laser machine requires 17 people (2 people to operate the machine and 15 people to lay and sort the fabric). Whereas initially this appears to be a net job loss, the increased output rate has led to a higher volume of accurately cut fabric. This in turn has led to more input for the next stage of the production – stitching. The stitching stage at A to Z is manual, given the specialist skills required to operate sewing machines, and the owners have increased the labour employed in this more skilled area due to increased input. As per the firm's estimates, roughly 300 extra jobs were created. The productivity effect can be seen in this example as not only increasing and improving output by using technology but also generating more jobs for skilled labour downstream in the production process. This example shows that by seeking efficiencies without reducing manpower, and by becoming more efficient in some processes using technology, it is possible to create more jobs elsewhere.

However, it is entirely possible that digitalisation raises overall productivity but is not able to generate large-scale employment gains in developing countries. The productivity premium of deploying digital technologies has been found to be higher in the already digitally advanced developed countries compared to the less advanced developing countries. For instance, Booz and Company (2012) find that while a10% increase in digitisation leads to a 0.62% increase in GDP per capita in digitally advanced economies, the impact of the same is 0.5% in digitally constrained economies. Banga and te Velde (2018a) also find that while a doubling of the internet penetration rate can boost manufacturing labour productivity in middle-income countries by 11%, the impact of the same on low-income countries is just 3%; this difference in the impact of internet penetration is also noted for SSA countries versus other countries. Such differences in productivity gains can also translate into differences in employment gains across countries.

Berg et al. (2018) further show that while even a small increase in the level of robot productivity can increase output significantly (if the robots and humans are close substitutes), it will lower the wages in the short run (20 to 50 years or so). In the long run, large quantities of capital will have to be accumulated before a scarcity of human labour can reduce the returns to capital. Even in the long run, labour share declines substantially, and inequality rises.

The key to unlocking employment opportunities through digitalisation is to maximise employment gains from productivity effects of digital technologies. This can be achieved if cost savings from productivity gains are reinvested elsewhere in the economy, preferably in new-job-creating activities or building the absorptive capacity of the workforce. However, the employment gains realised through productivity benefits from digitalisation will ultimately depend on the relationship between employment and output growth, the strength of which varies across countries and time periods. When the labour market is very responsive (elastic to output growth), productivity gains through digitalisation are able to rapidly create new jobs in such economies. Workers who have

lost their jobs performing certain tasks can also move into other tasks where new opportunities are being created.

However, in some countries, the relationship between employment growth and output might be much weaker, such as in the case of India, with its stringent hiring and firing policies as well as other labour market rigidities that reduce labour market mobility. For the case of Africa, Afdb et al. (2018) show that during the 2000s, for every 1 percentage point of economic growth, employment in Africa on average grew by only 0.41 percentage points. The employment elasticity of Kenya is only a little bit over the average in Africa (around 0.48 percentage points). When growth in output is not accompanied by growth in employment, there are increasing concerns over 'jobless growth'. This is exacerbated in the case of the digital economy, since there are rising concerns over further de-industrialisation in developing economies, particularly African economies.

Banga and te Velde (2018a) highlight that low-income countries are not able to realise the same productivity (and possibly employment) gains from digitalisation as higher-income countries, largely due to poorer absorptive capacity of the workforce and increasing unemployability of workers in a digital era. Growing digitalisation has not only been characterised by declining prices in ICT and shifts in spending from digital assets to services, but also by changing demands from the workforce. For instance, in order to leverage Big Data analytics for manufacturing, there is a need for information technology (IT) and analytical skills in the workforce, organisational ability in the company, and data privacy laws in the country (Van Ark, 2016). In order to make the workforce more employable, there is a need to invest in knowledge-based assets, i.e. intangible capital resulting from firms' investments in R&D, intellectual property, firm-specific training, and so on.

By deploying digital technologies and robotics, firms can indeed create efficiencies in production, which can increase their total factor productivity, leading to higher output and exports, and creation of new jobs linked to these exports. However, these productivity gains are lower for developing countries, highlighting the need to set up policies in developing economies which maximise not only (a) productivity gains from digitalisation but also (b) employment gains through the efficiencies created.

3.2.2 Digitalisation and job creation in sectors complementary to manufacturing

While workers performing certain tasks may be displaced in sectors that introduce technology incorporated in the new machinery, additional workers will be needed in the industries producing the new machinery (WTO, 2017). Moreover, as manufacturing becomes more automated, it can create jobs in other sectors due to spillover effects. An important pathway of job creation is through the rise of 'digital' jobs. Growing digitalisation is expected to intensify 'servicification of manufacturing', which will create jobs not only in services sectors that repair and maintain these machines, but also in digital services such as data storage and information processing services (including cloud computing, computer systems design, programming, computer aided designing and digital cutting).

Banga and te Velde (2018b) argue that future job growth in developing economies is expected to be in services sectors such as accommodation, retail and sales, which are harder to automate since they require interpersonal communication, as well as in service sectors of computers, mathematics and sciences, architecture and engineering, which can complement the use of digital technologies.

While Figure 3 showed that the food sector is overall the least digitalised sector in Kenya, Figure 7 shows that the food sector has relatively higher value-addition by domestic digital services (communication and ICT and business services) in manufacturing production, followed by beverages and tobacco, chemicals, rubber and plastics, textiles, and machinery. There was also positive growth between 2004 and 2011 in the digital value-added (DVA) share of domestic

services in following sectors: beverages and tobacco, chemical, rubber and plastic products, leather, machinery and equipment, and mineral products (Figure 8).

Figure 7: DVA share of digital services in Kenyan manufacturing production (%)

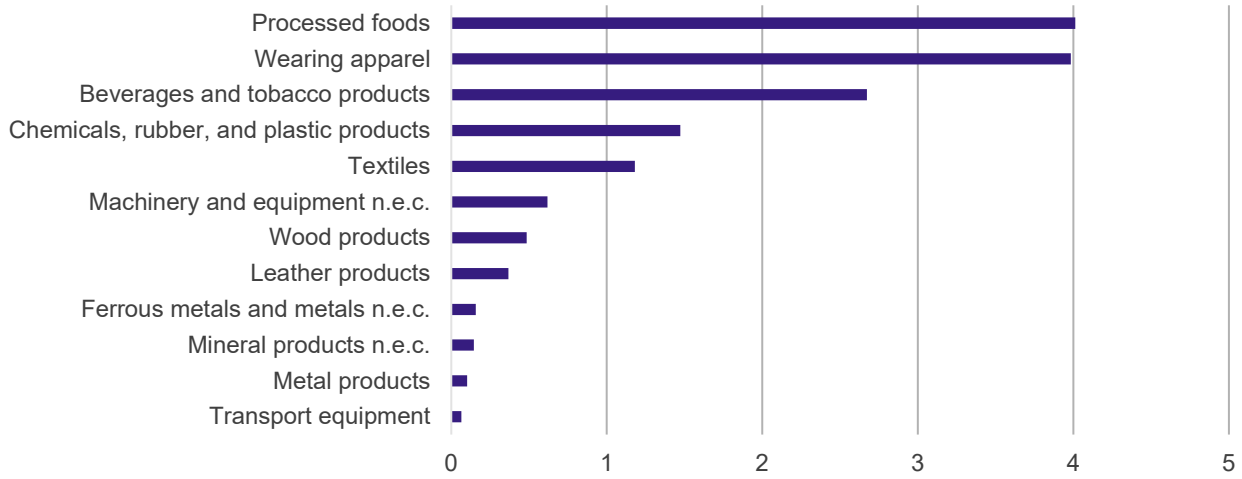
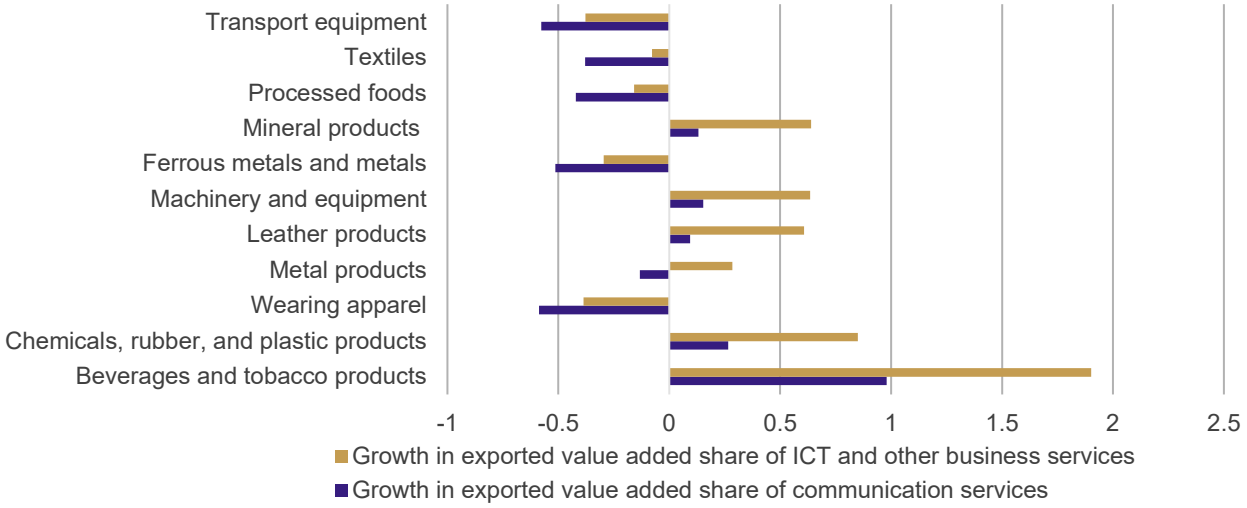


Figure 8: Annual growth in VA by domestic digital services in manufacturing exports, 2004–2011 (%)



Source: Export in value-added database (World Integrated Trade Solutions).
Note: Data are for the year 2011. VA share of domestic digital services is the average share of communications, ICT and other business services. The DVA (digital value added) of domestic services is lower in metal products, transports and mineral products, but these sectors have digitalised more overall, which may indicate the relatively higher use of foreign digital services in these sectors. Food and beverages have higher use of domestic digital services, and most of the processed food items in Kenya are also sold domestically and regionally.

3.3.3 Digitalisation, integration in production networks and job creation

The digital economy and its different facets – such as electronic commerce, blockchain, digital trade, robotics, fintech – have in many cases significantly reduced production and transaction costs, making trade and coordination across countries easier, faster and cheaper. Digitalisation not only lowers production costs, which can enable a lot more entrants, particularly women and SMEs, to enter into the export market, but it can also increase Kenya's GVC participation, which can be a driver of economic growth and employment creation in itself.

Some studies have argued for greater focus on regional integration in Africa. Africa's exports to the rest of the world are mainly in primary commodities that capture low value-addition and therefore generate fewer jobs. In contrast, intra-Africa trade (the percentage of trade African countries conduct among themselves as a share of their total trade) is more diversified, although very low – at about 18% (Sow, 2018). Export diversification is one of the long-standing challenges faced by many African countries in terms of upgrading in GVCs and has also been mentioned in KAM's Manufacturing Priority Agenda (2018). KAM proposes incentivising value-addition and diversification of exports through developing a policy framework for attracting foreign direct investment (FDI) in captive subsidiaries from those firms that are seeking product development in the region. Recently, Rodrik (2018) has also argued for greater focus on boosting regional integration and serving the domestic market in developing economies.

Digital technologies in production can help in export diversification, which can increase demand for new products, enabling Kenya to climb up the value-chain ladder, both regionally and globally, capturing higher rents and profits, which can be reinvested into output growth and employment creation. Our firm interviews reveal that digital technologies have indeed created opportunities for firms to venture into new exports and also to diversify their export markets. For instance, Funkidz – a furniture manufacturing firm in Kenya – has invested heavily in CAD and manufacturing technologies, and as a result it is able to produce mass quantities of good-quality, flat and packable furniture with exact specifications, which has also helped it to diversify into the Ugandan and Rwandan markets. Just this year, Funkidz has also started to export to the UK. Another firm, Megh Industries, invested heavily in multipurpose technologies such as CNC auto-cut and laser technology, and as a result was able to diversify from producing and supplying automotive parts in the '90s into transport seating in the early 2000s, which directly feeds into lines of big automotive assembly plans such as General Motors East Africa. Currently, the firm is preparing to re-enter the original equipment manufacturing (OEM) market with a full range of products for cars and motorcycles to service a large market that is opening up to 135 million people in comprising Kenya, Burundi, Rwanda, South Sudan, Tanzania, and Uganda. Banga and te Velde (2018a) also highlight the case of Klaks 3D printing, a Ghana based firm, which started 3D-printing parts it had previously imported from China.

E-commerce, another facet of the digital economy, can also enable export diversification. Recent research by International Trade Centre on five Asian LDCs – Bangladesh, Cambodia, Lao PDR, Myanmar and Nepal – finds that products in which these countries have comparative advantage, such as textiles and agriculture, feature prominently in online trade, but that new products are also emerging. For example, in Bangladesh, apparels dominate offline trade (accounting for 86% of total exports), but online demand is much lower (47%), and the country has diversified into agriculture, food and beverages and consumer electronic products. In Cambodia, e-commerce has enabled diversification into higher value-added segments; fresh mangoes and cashew nuts have replaced cereals as top-demanded agricultural products in online trade. In terms of markets, too, Suominen (2017) shows that on average, 63% of online sellers sell to two or more markets, compared to a third of offline sellers who export. The data from eBay suggests that 80% of online exporters 'survive' as exporters after their first year, compared to only one third of offline exporters. This is because online exporters are more diversified – they sell to multiple markets.

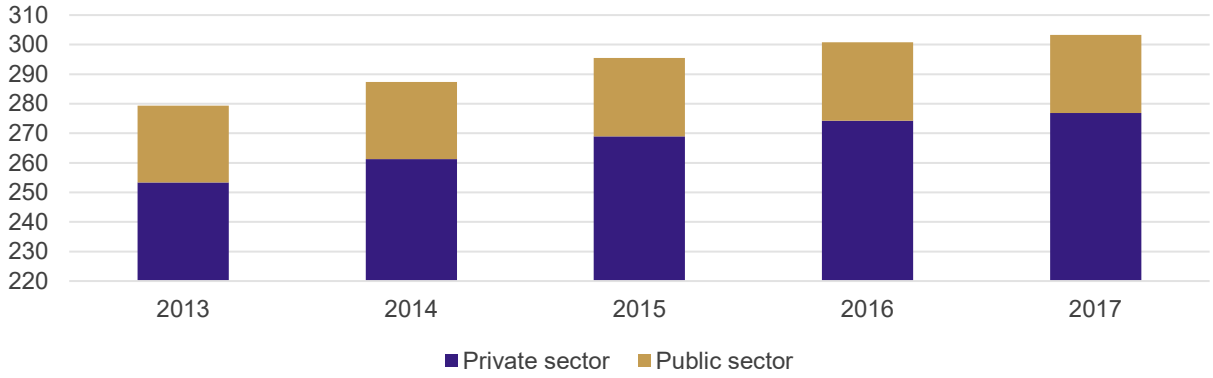
Rodrik (2018), however, argues that for realising large-scale employment gains, it is important to increase the focus on 'domestic integration' and dissemination of capabilities already in place in the most advanced productive sectors in developing countries. This bears resonance in Andrews et al.'s (2016) work on the global productivity slowdown within the Organisation for Economic Co-operation and Development (OECD) region. Using data for the period 1997–2014 for 24 OECD countries, Andrews et al. (2016) find that the global productivity slowdown in the OECD is not so much slowdown in productivity growth at the global level, but is reflective of an increasing labour productivity gap between firms at the global frontier (top 5% of OECD firms in terms of labour productivity) and laggard firms within the region, as a result of divergence in technology and diverging capacities of firms to technologically innovate and successfully combine intangibles (such as computer programmes) into the production process.

This suggests that along with pursuing a 'top-down' approach of higher GVC participation in Kenya, it is also important to focus on a bottom-up approach, which can link the laggard firms and suppliers with higher-productivity firms in Kenya. Krishnan et al. (2018) propose a similar approach for MSMEs in Kenya, some of which are productive and competent to stand alone, while others need to be linked with large firms in value chains. To maximise employment gains, policies in Kenya need to leverage digitalisation to not only boost higher value-added linkages in global and regional networks, but also boost domestic integration and diffusion of capabilities.

3.3.4 Digitalisation, employability and the changing demand for skills

Overall, wage employment in the modern manufacturing sector increased by 4% in 2017, higher than the 3% growth in 2016 (KNBS, 2018). Wage employment in manufacturing grew by 8.5% between 2013 and 2017, with the private sector accounting for about 91% of manufacturing employment in 2017 (see Figure 9).

Figure 9: Wage employment in Kenyan manufacturing, by sector ('000s)



Source: KNBS, 2018

Figure 10 further reveals that labour productivity in Kenyan manufacturing has increased steadily in the period 2002–2016, but growth has slowed since 2013. The share of labour compensation in manufacturing value-added in Kenya declined from 40% in 2000 to 27% in 2016.

Figure 10: Labour productivity and compensation share in Kenyan manufacturing

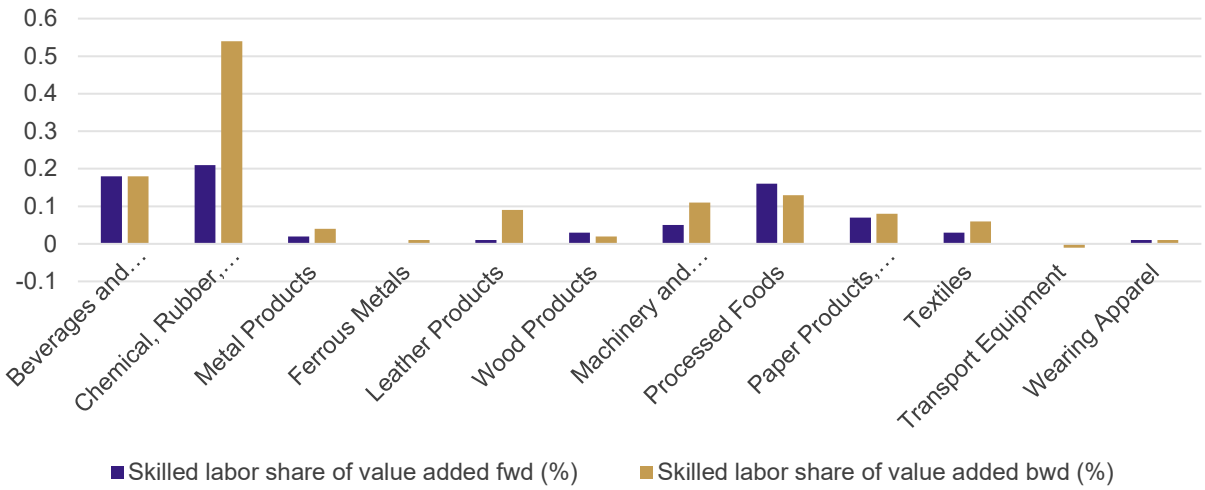
Source: Kenyan Economy Survey (various issues)
Notes: Labour productivity is real value added in manufacturing sectors (in KSh Million)/ number of employees. Data with 2001 and 2009 prices has been spliced.

While digitalisation will affect employment levels and wages, the effect is likely to manifest more deeply through changing occupational structures and demand for skills (Banga and te Velde, 2018b). Digital technologies tend to replace 'routine' tasks that follow a formal set of rules and guidelines, mainly performed by middle-skilled workers. As a result, developed countries are witnessing 'hollowing out' of the middle-skilled, whereby employment shares of middle-skilled workers are decreasing while those of high- and low-skilled workers are increasing (World Bank, 2016). High-skilled workers perform tasks complementary to technology while low-skilled workers perform services in occupations such as care work and nursing, which are not economically or technologically feasible to automate.

Although developing countries are polarising at a slower rate (World Bank, 2016), growing digitalisation is likely to increase the demand for skilled labour. Figure 11 shows that in the period 2004–2011, the demand for skilled labour increased in Kenya across almost all manufacturing sectors. The share of skilled labour in value-added, in both backward and forward linkages, has increased in the following sectors: beverage and tobacco, chemicals, processed food, machinery and equipment, paper products and textiles.

The demand for skilled labour is likely to increase in the future, as occupations that are intensive non-routine cognitive tasks are expected to experience growth (Banga and te Velde, 2018b). Such tasks will increasingly require workers with 'hard' skills such as digital and professional skills, as well as 'soft skills' of management, collaboration, communication and analytical thinking. The demand for workers performing low-skilled non-routine manual tasks such as driving industrial trucks, as well as low-skilled service occupations such as nursing and caring, is also likely to increase; this will require workers with physical and socio-emotional skills, respectively.

Figure 11: Growth in skilled labour value-added, by linkage in Kenya, 2004–2011



Source: Export in value-added dataset, WITS database.
Note: Purple bars indicated the share of skilled labour in forward linkages, i.e. in domestic value added in foreign exports, and mustard bars show share of skilled labour in backward linkages, i.e. in foreign value added in exports.

4 POLICY PRIORITIES FOR DIGITAL TRANSFORMATION IN KENYAN MANUFACTURING

Digital transformation requires a new, targeted approach, not the same-old general enabling policies. Rodrik (2018) correctly argues that a general development agenda is unlikely to be effective in preparing developing countries for the digital economy. Studies usually present a menu of policy options to create a digitally enabling environment – such as improvements in the regulatory framework, education and skills, R&D etc. – but these aren't particularly useful for developing-country governments, which are not capital-intensive to begin with and are often grappling with the issue of where to start from. Moreover, public–private collaborations are increasingly important in the digital economy, which needs clear demarcation in terms of what the government and firms can do and in which areas they should seek collaboration.

Targeted policies are thus needed to address the challenges to digitalisation mentioned in the previous section, as well as to capitalise on the new opportunities presented by the digital economy. Policy priorities identified below are based on (a) examining how existing capabilities of Kenyan manufacturing can be leveraged in the digital economy and (b) how these capabilities can be diffused through the economy. They have been drawn from existing evidence and literature, as well as firm interviews (see Appendix A for detailed case studies).

Policies are discussed under three subsections:

A. Policies for building 'hard' and 'soft' digital capabilities in Kenyan firms
B. Policies for increasing Kenya's competitiveness in the digital economy
C. Policies necessary for supporting inclusive and accountable digital transformation.

A. Building digital infrastructure

Policies to build digital infrastructure are a crucial first step. Several studies have looked at boosting competitiveness of ICT goods and building digital infrastructure. Digital infrastructure includes not only hard infrastructure such ICT goods and hardware (for example, computers, sensors, cable, routers) but also soft infrastructure including ICT and digital services – such as mobile and internet services, computer services and data storage – and processing services – such as cloud computing, Big Data – which are becoming increasingly key to unlocking growth in the digital economy. In the digital era, it is crucial for developing economies to put in policies and regulations to build soft infrastructure. More recently, the Center for International Private Enterprise (CIPE) 'Digital Economy Enabling Environment Guide' (2018) extends the policy discussion into four areas: consumer protection, data protection, cybersecurity and electronic transactions.

In the section below, we examine 'soft' infrastructure policies related to internet access and infrastructure sharing, data flows, intellectual property and innovation. While these policies may appear to be somewhat precocious to Kenyan manufacturing as it currently stands, it is important to keep in mind that technology is changing and diffusing rapidly, requiring an active approach towards digitalisation. It is important for Kenya to build its digital capabilities by advancing policy discussions on the following.

4.1 Improving access to internet and digital services through 'infrastructure sharing'

There is a digital divide in Kenya, in terms of both access to and use of the internet and digital technologies. To bridge the divide, Kenya needs to first and foremost improve access to the internet by making it more affordable. Internet tariffs are much higher in Kenya (74.18 purchasing power parity (PPP) $/month) compared to the other African countries of Ghana (65 PPP $/month) and Ethiopia (33.49 PPP $/month), as shown in Banga and te Velde (2018a).

Government policies targeting public-access solutions such as free or subsidised internet access to public/open areas (educational institutions, local and community centres, public Wi-Fi) need to be developed. As per the 2017 Affordability Report (ITWebAfrica, 2017), two countries that have made significant improvements in internet affordability (measured through indicators of access and communications infrastructure) are Benin and Botswana. Benin has moved up nine places from its 38th rank in 2016, owing to incremental and distinct improvements across a range of policy areas including transparency in decision-making and accountability of operators. By contrast, Botswana specifically introduced new rules in late 2015 that simplified the existing licensing regime and enabled technology and service neutrality, without restricting operators from holding several types of licenses such as a network licence or a services license. The Botswana government has also used its Universal Service and Access Funds (USAF) to increase the number of public Wi-Fi hotspots in hospitals, bus stops and shopping malls across seven towns.

Until 2014, all the mobile service providers in Kenya were Host Mobile Network Operators (HMNO) licensed under the Network Facilities Provider (NFP), which has rights for owning of spectrum (Kenyan Wallstreet, 2018). In 2014, the Communications Authority of Kenya decided to issue Mobile Virtual Network Operators (MVNO) licenses. Just like Airbnb, which allows customers to rent spare rooms in peoples' homes, MVNOs rent excess network capacity from regular mobile network operators (MNOs). By engaging in 'infrastructure sharing' with already established telecom providers, it is possible to be an operator without having made heavy investments into frequency spectrum licenses or into building wireless network infrastructure and capabilities in wireless technologies.

Kenya has already issued MVNO licenses to three companies – Finserve Africa Limited, Zioncell Kenya Limited and Mobile Pay Limited (Kenyan Wallstreet, 2018) – which offer mobile money and data services. This has contributed to subsequent growth in internet subscriptions, which grew 8.2% in the three months to March 2018 (Capital Business, 2018).

Granting more MVNO licenses will improve competition in the market, which can significantly lower the prices of telephony and data services in a market like Kenya, where Safaricom has a de facto monopoly and controls 70–80% of the market. By using underutilised spectrum in various service provisions, MVNOs can specialise in areas such as data and mobile money, and can sell these services at their own price. Since the MVNOs are not paying to create an infrastructure, and also have little retail infrastructure, they can charge low overheads and prices to consumers (TigerMobiles, 2017).

Kenya's success with MVNOs is particularly highlighted by the case of Equitel, which is the MVNO of Finserve Africa (Equity Bank's full-fledged fintech subsidiary), providing all kinds of mobile telephony services to its subscribers using the facilities of an already existing MNO. It is interesting to note that all three existing MVNOs in Kenya are using Indian telecom company Airtel's infrastructure, since none of the MNOs in Kenya meet the set quality standards for service. To increase linkages between domestic MVNOs and MNOs, it is important for service providers in Kenya to improve the quality of their services and adhere to strict standards. At the same time, the government can provide tax and subsidy incentives to domestic MNOs to share infrastructure with MVNOs that are targeting niche markets. Established operators are less likely to see the MVNOs as potential competitors if the MVNOs target extending data services and online financial services to rural populations, through mobile phones or computer modems, that were previously outside the coverage range of the MNO, and also if the MNO is getting financial incentives to host the MVNO. MVNOs can offer the normal 3G data access to their customers but also look at targeting other more basic phones by providing a non-data connection to the internet, as demonstrated by such service as ForgetMeNot Africa (IDG Connect, 2014).

To strengthen the digital infrastructure for improving the access and affordability of internet services and other digital services, the following actions are needed:

Actions by the government:

- Target public-access solutions such as free or subsidised internet access to public/open areas including educational institutions, local and community centres, public Wi-Fi etc.
- Grant mobile virtual network operating (MVNO) licenses to more companies in order to increase competition in the market, which can make internet and data services more affordable.
- Grant financial incentives to MNOs to either directly expand coverage to rural and marginalised areas that don't have internet access or indirectly expand coverage by sharing their infrastructure with MVNOs who are targeting such niche markets.

Actions by firms:

- Invest in 'infrastucture sharing' with established providers who have excess network capacity.
- MNOs need to improve their quality standards so that domestic infrastructure can be built and shared.

4.2 Building national 'data infrastructure'

Policies on soft infrastructure in Kenya need to address issues related to building 'data infrastructure' (UNCTAD, 2018), including laws and regulations for data privacy, protection, and cross-border free flow of data and data localisation. Data is being increasingly regarded as the 'new oil' of the digital economy (Economist, 2017), with firms witnessing not only 'servicification of manufacturing' but also 'datafication of manufacturing'. Data are getting increasingly embedded into the manufacturing process through technologies such as IoT, which uses sensors so that machines and parts in a factory can communicate with each other without the need for human intervention.

In such a manufacturing landscape, it is important for Kenya to not only leverage its data to make its manufacturing sector more competitive globally but also use data as a tool for increasing market access for Kenyan manufacturers. Many developed economies, such as Japan, have responded to the increasing presence of foreign digital corporations in the country by introducing regulations on monopolisation of data that is leading to misuse of market power.[4] Using tools such as safety nets and competition policies to safeguard the domestic digital industry can be particularly useful in African countries, such as Kenya, which are significantly lagging in internet and digital infrastructure to compete with foreign players.

Should data be localised? This is one of the most hotly debated topics today. From the point of view of foreign digital firms, the ability to freely locate data allows them to build global networks of data by cheaply and quickly expanding into new markets and economies of scale (Meltzer, 2015). Some studies have argued against data localisation requirements in developing countries, due to the economic costs of enforcing data localisation (Bauer et al., 2014); it can impede the new and growing businesses that are not able to deal with raised information and data costs. This can be associated with rising sunk costs in traditional trade models. Only firms that are already

[4] In a seminal paper, Khan (2017) describes how e-commerce platforms such as Amazon use their control over Big Data, predatory pricing models and integration across business lines to establish an anti-competitive environment and their dominant position in the market. In addition to being a retailer, Amazon is now a marketing platform, a delivery and logistics network, a payment service, a credit lender, an auction house, a major book publisher, a producer of television and films, a fashion designer, a hardware manufacturer, and a leading host of cloud server space. Therefore, the impact that Amazon has on the economy is not only driven through a reduction in trade frictions, but also in terms of spatial distribution of manufacturing and shifting economies of scale. We discuss e-commerce platforms and the role of regulatory policies, anti-trust laws, transaction costs and market competition in more detail elsewhere.

more productive will be able to bear the additional costs of data localisation. Using the ECIPE data, it has been estimated that economy-wide data localisation requirement could lead to GDP losses of 0.8% in Brazil, 1.1% in EU, 0.8% in India, 0.7% in Indonesia and 1.1% in Korea. The impact on domestic investments is also sizeable; Brazil (-4.2%), China (1.8%), India (-1.4%), Indonesia (-2.3%) and Vietnam (-3.1%) (ECIPE, 2014).

However, Azmeh and Foster (2016) argue that it is important to go beyond assessing the narrow impact on GDP and look at broader implications of data localisation on catching up. Banga and te Velde (2018a) have shown that while the manufacturing sector exhibits unconditional convergence (i.e. labour productivity in developing economies is likely to catch up with that in developed countries) due to tradability of the sector, convergence has slowed down in the period 2002–2013, as compared to 1991–2002. One plausible factor for this is the rise in digitalisation in recent years, accompanied by concentration of digital manufacturing in more developed parts of the world. Production in the digital economy is more likely to be based on a 'data thread' connecting different stages of production, suggesting that production is likely to be more concentrated in developed economies with advanced capital centres, skilled labour and R&D facilities.

The majority of the developing economies do not have localisation laws in place (Lemma, 2017), which threatens to increase polarisation forces across countries and slow down convergence. On the other hand, retaining freedom on data localisation requirements can be useful for Kenyan sectors, particularly in terms of protecting its financial and health data. Data localisation can also serve as an economic measure which can boost domestic digital players; it can attract foreign investment that will lead to knowledge and technological spillovers, skill development, and improvements in tech capacity of countries through clustering, as well as the development of a national internet industry (Castro and McQuin, 2015) that can encourage catching up. Developing countries can use data localisation as a bargaining tool in exchange for market access (Ezell et al., 2013). Moreover, it is worth noting that Kenya does not have any requirements of technology transfer for foreign investors and also allows 100% FDI in ICT services (barring telecommunication). Policies encouraging joint ventures in FDI in ICT services can be fruitful. In order to attract foreign investment despite localisation requirements, policies will be needed to lower the cost of capital for foreign firms (e.g. subsidies on electricity rates, tax holidays), improve infrastructure (e.g. installation of air conditioning, securing reliable power supply) and strengthen data security (e.g. strict cybersecurity laws).

Although data localisation has its pros and cons, it is important to take a step back and look at demands it poses on infrastructure. For data to be stored and processed within the national boundaries of Kenya, there is a need to create data centres, which are very capital intensive; they require good internet infrastructure, reliable power supply and air conditioning for servers. Having a clear legal framework and stringently enforced laws for data privacy also forms the very basis for attracting foreign companies to store the data domestically.

Although no single, comprehensive data protection law exists as yet in Kenya, the government has released a draft of the Data Protection Bill (2018), which draws in the General Data Protection Regulation (GDPR) for public consultation. As per this bill, companies will have to inform users regarding any personal data being collected, and the users have the right to decline to have their data collected or processed. Any person found guilty of interfering with the right to privacy will be liable, on conviction, to a fine not exceeding $5000. Kenya is only the second country in East Africa,[5] after Rwanda, to have legislation on data protection (StandardDigital, 2018).

[5] On the African continent, 22 countries have data protection and privacy legislation, seven have draft legislation, and 25 countries have no legislation or no data (see https://unctad.org/en/Pages/DTL/STI_and_ICTs/ICT4D-Legislation/eCom-Data-Protection-Laws.aspx).

UNCTAD (2018) highlights Rwanda's pioneering National Data Revolution Policy (2017), from which important principles can be adopted and adapted in other African countries. Rwanda's data revolution policy focuses on: (i) classification of data into sensitive and non-sensitive sets, following which sensitive data is protected; (ii) national data sovereignty whereby Rwanda retains exclusive sovereign rights on national data but is open to hosting its data in local or international data centres as per Rwandan laws; (iii) increasing access to non-sensitive data by public consolidation and publication of data with granularity, completeness, accuracy and open licensing; (v) recognition of author of data, as per data intellectual property rights; and (vi) public–private partnerships as an investment model in data industry.

Kenya is lagging in 'data infrastructure'. Urgent actions are needed to develop and strengthen a comprehensive legal framework on data privacy, protection, cross-border free flow of data and data localisation:

Actions by the government:

- Classify data into sensitive and non-sensitive sets.
- Strengthen laws on data security and privacy of sensitive data, and their proper enforcement.
- Use safety nets and competition policies to protect the domestic digital industry in Kenya.
- Develop sector-specific policies on data localisation and cross-border flow of data (UNCTAD, 2018).
- Develop policies that encourage development of local data centres (e.g. colocation data centres in Kenya, modular data centres, leveraging the African Continental Free Trade Agreement to include provisions for regional data centres) which can be important hubs for jump-starting software industries, gaming industries, internet-related industries and other data-based industries.

Actions by firms:

- Invest in e-commerce enabled websites for product sales and electronic advertising.
- Develop strategies to collect and analyse data on manufacturing within the factory and use effiiciency improving business management software.

4.3 Promoting innovation for 'glocalisation' and protecting intellectual property rights

Policies to encourage innovation – such as funding for R&D, direct or indirect subsidies and tax credits and benefits – are crucial for increasing the digital competitiveness of Kenyan firms. It is important to put in place sector-specific innovation policies along with encouraging 'glocalisation' through innovation, i.e. adapting global designs for meeting local needs and challenges. As a result of digital technologies in manufacturing and 'glocalisation', Megh Industries, a Kenyan automotive manufacturing firm, has been able to achieve impressive growth and product diversification. While a variety of bus accessories and seats are imported, the firm uses the imports to adapt and create heavy-duty seats that service the requirements of local bus operators in rural areas with bad terrains. Such local needs of Kenyan bus operators are not met through Asian imports, opening up a market space for local Kenyan firms. Similarly, Panesar Interiors, a Kenyan furniture manufacturing firm, is following an innovation-led development model. The firm is constantly looking to update and innovate its styles and is currently working on refitted drawers and wireless-charging tables, to meet the needs of local customers.

Firm-level case studies (see Appendix A) reveal that firms using digital technologies are practising innovative ways of using resources efficiently. For example, Megh Industries has switched from traditional manufacturing to cellular manufacturing of automotive components. In traditional manufacturing, similar machines are placed together (e.g. mills and drills), while in cellular manufacturing, machines are placed together according to the families of parts being produced, leading to higher efficiencies in material flow and inventory. To deal with the rising price of wood (as a result of a local logging ban in Kenya), the furniture manufacturing firm Funkidz has fully embraced the circular economy model and urban mining. It is now acquiring pallet-wood, one of

the easiest and cheapest types of wood waste to recycle, which undergoes nail removal, finishing and sanding. The firm is using electronic waste such as disposed batteries, electrical circuits, computer hardware, etc., as design components in table tops, showpieces and lamps, along with using second-hand clothing from Mitumba as cushion covers. Another furniture firm, Panesar Interiors, has also adopted elements of circular economy to utilise resources more economically – for instance, the firm uses recycled woodwork, from which mill marks and other dents are removed through sanding, and uses sawdust as a fuel to run the boiler. It has also installed solar panels on the roof. Policies incentivising R&D, innovation and urban mining can thus act as a catalyst in efficient resource utilisation.

Along with promoting R&D and innovation, it is crucial to protect intellectual property through laws on patents, trademarks, copyrights, and so on. Strengthening patent rights in Kenya can build digital trust in the international community, facilitating digital trade. Patent reforms in major reforming economies have been found to increase manufacturing exports to the US by 20%. By strengthening their intellectual property (IP) rights, in coherence with IP rights across developed economies, developing economies can attract foreign investment, technology transfer, imports of more high-tech goods versus low-tech goods, consequently leading to an increase in export capacities. As per the World Intellectual Property Organisation (WIPO), the small manufacturing firms also stand a lot to gain from IP protection, including commercialisation of production for the period of protection and negotiating licensing agreements with other companies. SMEs can particular benefit from IP protection in the form of trademark and industrial design protection in e-marketing.

However, using IP as a key business asset requires (a) knowledge of what is patentable, (b) understanding the cost and benefits of applying for a patent, (c) financing the patent application, and (d) having an IP management policy in place (WIPO). The impact of strengthening patent protection laws is also sector-specific, depending on the risk of imitation (WIPO).[6]

Although Kenya already has a legal framework for protecting IPR (such as laws on trademarks, industrial designs and copyright), which complies with international IPR rules, it continues to face a number of challenges on intellectual property due to lack of a comprehensive national IP policy. To prevent copyright and digital content piracy, the Kenya Copyright Board is working on the Copyright Amendment Bill, which is currently pending before the parliament. This bill will facilitate protection of creative works on online platforms, enabling greater digital trade. Moreover, Kenya launched the Cyber Security and Protection Bill in 2016 to provide increased security in cyberspace, enabling greater information sharing and national security (Article19, 2017).

There are also major issues in enforcement of IP rules related to trade in illicit, substandard and counterfeit products (Law Reviews, 2016). An enterprise survey conducted by the World Bank in 2013 established that one out of every four private sector firms in Kenya considers informal competition as the biggest obstacle. According to a study on counterfeits conducted by KAM in 2013, manufacturers lose up to 40% on market share, 50% on revenue and 10% on company reputation due to the proliferation of counterfeits (most of which are fast-moving consumer goods), while the government loses about $80 million in potential (KAM, 2018b). The current IPR framework within EAC has been identified as hindering the fight against counterfeits as the IPRs are country specific and there is no mutual recognition of IPR within the region (as there is no regional policy on IP).

Even within Kenya, there is lack of inter-agency collaboration, misinterpretations of law by enforcement officers and failure of courts to impose tough penalties (KAM, 2018b). The Kenya Revenue Authority (KRA), Kenya Bureau of Standards (KEBS) and Anti-counterfeit Agency (ACA) are crucial in the fight against illicit and counterfeit products. The government has introduced a new digital excise stamps system (EGMS) on some goods, including tobacco, alcoholic drinks,

[6] http://www.wipo.int/export/sites/www/sme/en/documents/pdf/ipmatters.pdf

wines and beers. The new EGMS system is designed such that details of each excise stamp appended on a product at the point of manufacturing are captured by the system at the time of printing and then tracked along the supply chain right from the production facility. It uses Quick Response Codes, allowing manufacturers and consumers to check authenticity of a product by scanning the code on the product using a smartphone. It also allows the KRA to collect more taxes. However, while the EGMS can fight illicit trade, it raises operating costs and capital expenditures, significantly increasing the cost of doing business (Aminga, 2018).

Kenya lacks a comprehensive national policy on intellectual property and insufficiently enforces existing laws. Actions are needed to encourage innovation at the firm level, enforce IP laws at the national level and harmonise IP laws at the regional level:

Actions by the government:

- Give subsidies and tax benefits to firms in order to encourage innovation and R&D, particularly in the ICT sector.
- Develop sector-specific innovation policies to encourage 'glocalisation', i.e. adapting global knowledge and technology for solving local challenges and needs.
- Encourage domestic ownership of patents.
- Use regional approaches to harmonise IPR in EAC (KAM, 2018b), and as part of this create a digital database for registered trademarks, patents and licenses in operation in order to curb the counterfeit goods digital trade.
- Liase with the private sector on how to maintain cost-competitiveness of manufacturing while using a digitalised EGMS system for tax collection.

Actions by firms:

- Invest in innovative methods for 'glocalisation' such as efficient resource-utilisation through urban mining and circular economy.
- Invest in product development and intellectual protection packages but consider costs and benefits of patenting on a case-by-case basis (WIPO).
- Develop company policies on patent acquisitions, monitoring of patents and trademarks through development of databases in order to identify new technological development and licensing partners, as well as on IP infringement (i.e. mediation and arbitration versus litigation).

4.4 Developing a well-embedded manufacturing ecosystem of digital and manufacturing start-ups and technology hubs

Targeted financial support from government and private sector players needs to be extended to digital start-ups that have the potential to transform manufacturing in Kenya. One such Kenyan start-up, being fostered by TechForTrade (based in UK), is African Born 3D Printing (AB3D), which has set up a one-stop shop for 3D printing in Nairobi, offering low-cost access to 3D printers, materials, workshops and open-source designs. These 3D printers are being manufactured from recycled materials and e-waste, making them affordable and accessible for a wide variety of local firms.

It is also important to provide financial support ecosystem enablers such as technological and innovation hubs. As of 2018, there are 442 active tech hubs in Africa, and a dozen new ones to be launched in 2018, with South Africa having the highest number – 59, followed by Nigeria (55), Egypt (34) and Kenya (30) (GSMA, 2018). Kenya's iHub is one of the most established in Africa, having around 150 companies and over 13,000 members. It is important to support development of hubs that not only provide ICT services but that also support the growth of businesses by providing them with: a space for manufacturing, manufacturing equipment, training in hardware engineering, coding, digital fabrication and IoT, and skill development. A good example of this is

makerspace Gearbox, which provides manufacturing equipment, tools, machines, training, mentorship and networking. Start-ups at Gearbox include Proteq Automation, offering the latest in industrial automation technology and machine manufacturing, and Homgenius, which has designed and developed an automated brick-making machine that can make more than 2,000 interlocking building blocks per day. As part of community projects, Gearbox has also built its first CNC-controlled plasma cutter for metal and wood, which has immense potential for manufacturing once rolled out.

These hubs have their own curriculum centred on the future of the workforce, and training is given in the relevant fields of robotics, artificial intelligence, 3D printing and blockchains. They act as an incubator for start-ups, offering support along the different steps of product formation: conceptualisation of ideas; training and modules to develop appropriate skills; networking with partners; and attracting funding. Effective public–private collaborations are important for not only supporting such hubs and start-ups in Kenya but ensuring that they are integrated and linked with the rest of the manufacturing sector in Kenya.

Kenya needs to promote digital and manufacturing start-ups, particularly in technology and innovation hubs, and to ensure that these hubs are well-integrated into the domestic economy so that positive spillovers can occur.

Actions by the government:

- Offer tax exemptions and incentives for R&D to innovative and technological hubs.
- Reduce the cost of filing a patent application for such hubs.
- Simplify the regulations for businesses and procedures for obtaining licenses, easier exit, and funding support for start-ups.

Actions by firms:

- Telecom service providers can offer subsidised internet and digital services to these hubs.
- Private sector investment into technology hubs needs to be directed towards those hubs that provide an ecosystem for start-ups; manufacturing equipment and tools; ICT and internet services; training in relevant skills; funding and networking opportunities.

4.5 Using regional approaches on e-commerce and digital products

Products in the digital economy include physical products traded through e-commerce platforms as well as electronically transmitted products. Removing the obligation of tariffs on cross-border trade puts brick-and-mortar stores at a disadvantage compared to e-commerce. Therefore, safety nets – for instance, in the form of subsidies or tax benefits – need to be put into place to support domestic brick-and-mortar stores.

To increase market access for Kenyan manufacturers, it is also important to protect and encourage development of local or regional platforms and put in place policies that can help Kenyan suppliers to link with such platforms. Third-party platforms such as Amazon not only charge a hefty commission fee (up to 40% on some products such as electronics) but also push their own products 75% of the time (ILSR, 2016). Following China's example, policies on internet finance, provision of cloud services, and platforms selling local products can be encouraged.

To estimate the impact of reduced or removed tariffs on e-commerce facilitated goods, Lemma (2017) uses the tariffs imposed on the High Technology Goods classification (International Statistics of Industrial Classification rev. 3) as a proxy and finds that a 1% reduction on import tariffs can lead to an increase of between $2 billion and $3 billion (in nominal terms) in imports and exports of such products in developing countries. In the case of electronically transmitted goods, such as digital audio and video files, videogames and computer software, research shows

that if custom duties on such goods are permanently brought down to zero, it will lead to an increase in imports in most developing economies, making them net importers (UNCTAD, 2017). It is important for policies to strengthen export competitiveness and capabilities in these goods to ensure that domestic players in these industries are not wiped out.

Kenya should use regional and continental approaches such as the African Continental Free Trade Agreement to actively leverage the benefits of digitalisation.

Actions by the government

- Use incentives and subsidies to encourage growth of national e-commerce platforms that link Kenyan manufacturers with the domestic and international economies.
- Address challenges pertaining to digital addressing, card payments, online trust and postal reliability so that e-commerce can take off domestically and regionally.
- Leverage regional and/or continental agreements such as the CfTA for strengthening its negotiating power on global platforms, encouraging regional ownership of data and e-commerce platforms to reduce data monopolisation.

B. Policies for fostering competitiveness in the digital economy

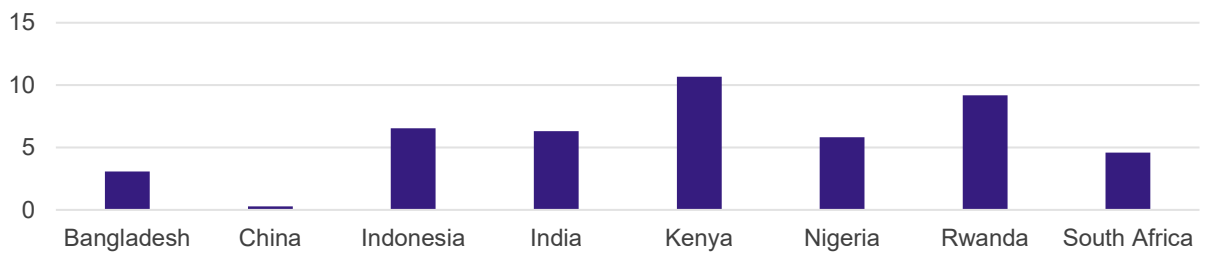
Policies to enhance digital capabilities need to be complemented with policies to increase competitiveness of Kenyan manufacturing in the digital economy. This can be achieved through addressing challenges pertaining to high cost of capital, high cost of electricity, unreliable power supply and poor infrastructure.

4.6 Financing digitalisation of manufacturing through lowering the cost of capital, new sources of financing, reducing interest rate spreads and introducing lower collateral requirements for new investment

Although the price of capital goods has fallen across some countries, it is still relatively high in African countries. ITU data show that in Kenya, the price of the ICT basket, comprising the combined cost of key ICT services – fixed telephony, mobile cellular and fixed broadband – is roughly $206, high when compared to $100 in Ethiopia (Banga and te Velde, 2018a). Internet tariffs on fixed broadband are also comparatively higher in Kenya – at about $75.8 (in terms of PPP per month) compared to $35.9 in Ethiopia.

Figure 12 shows that amongst the selected economies, the real interest rate is the highest in Kenya compared to other Asian and African countries. Even if the cost of capital and digitalisation falls in African countries, the ability to finance digitalisation will remain high due to poor access to finance in these countries, a consequence of market and coordination failures.

Figure 12: Real interest rate, 2017 (%)



Source: WDI.
Notes: Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator.

Were (2016) argues that the manufacturing sector in Kenya sources financing mainly locally, and through debt. Although there is a willingness to finance the manufacturing sector, firms find it

difficult to access credit due to high interest rates, especially in microfinance institutions (Were, 2016).

To increase access to finance, the Kenyan government introduced interest rate caps in 2016, which limited borrowing rates to 4% above the Central Bank rate. This was done to help small firms access credit at affordable rates; however, this contributed to a slowdown in lending to the private sector, since banks were unable to price risk to SMEs properly with the cap in place. Private sector credit growth in Kenya has significantly slowed down; it fell from 25% in mid-2014 to 1.6% in August 2017 (KAM, 2018b). Credit advancements to the manufacturing sector actually declined by 4.6% between 2015 and 2016 for the first time in the last five years (KAM, 2018b). In addition to the implementation of the interest rate cap, other contributing factors in the decline of credit advancements included liquidity shock in 2015/16; liquidation of three commercial banks; and a rise in non-performing loans.

Insights from our interviews with Kenyan manufacturing firms confirm that higher cost of capital and lower access to credit is a major obstacle to investing in digital technologies. One of the firms interviewed, which has successfully managed to install digital technologies, has secured a $2.5 million investment for building a brand-new factory with new equipment through Africinvest, a Tunisia-based private equity firm, part of the Integra group. However, the firm is under pressure since it is facing a short moratorium period for repayment of loans (one year). In other cases, the parent firms finance installation of new technology in the host firms. For instance, one of the firms we interviewed, New Wide Garments, obtained financing for technology through their headquarters firm in Taiwan – the New Wide Group – upon submission of their business case.

Securing loans form SMEs through development finance institutions (DFIs) lending to banks is also picking up momentum (BusinessDaily, 2018). For instance, the Kenyan I&M Bank recently secured a $40 million loan from the Dutch Development Bank (FMO) for onward lending to SMEs. This follows substantial loans taken by Kenyan banks from global funds, including International Finance Corporation (IFC) (which gave a $150 million seven-year loan to Co-operative Bank of Kenya for lending to small companies), European Investment Bank (EIB) and the African Development Bank (AfDB, which lent Kenya Commercial Bank $100 million for onward lending to SMEs in October 2017). These lenders offer favourable terms of debt like lower interest rates and longer maturity.

For Kenyan firms to remain competitive in the changing landscape of manufacturing, which is increasingly capital intensive, it is important to put in place policies that solve market and coordination failures and reduce the cost of financing capital. Actions are needed to improve access to financing:

Actions by the government:

- Liase with insitutions such as AfDB, which can provide support to local banks through partial guarantee facilities, as well as the Workd Bank, which can directly finance an enabling environment for manufacturing through IFC (Were, 2016).
- Directly expense the use of software and training to SMEs in an effort to facilitate the adoption of digital technologies in these firms. Additional revenue can be generated thorugh taxing digital monopolies.
- Give partial credit guarantees to financial institutions already involved in SME financing, accompanied by the development of financial institutions' capacity to assess credit worthiness
- Support mobile-money-based lending models such as mobile transactions, e-money usage, mobile e-money-related saving history, geo-based location data, mobile retail payment receipts etc. through strenthening the use of e-government services and the use of mobile-money for digital financing.

Actions by firms:

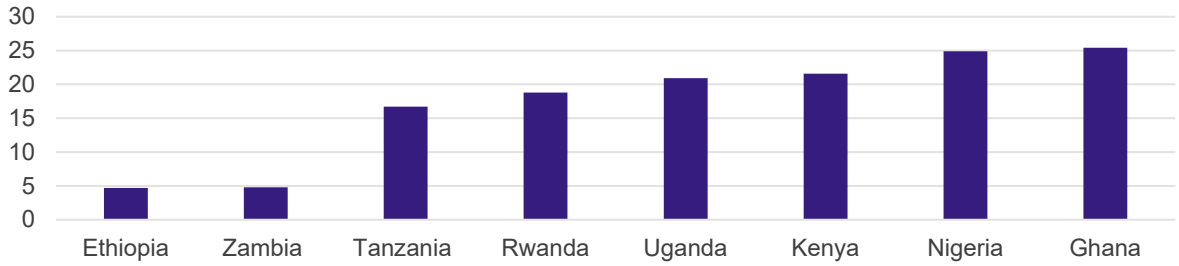
- Seek funding through alternative sources of financing such as equity financing through DFIs.
- Strengthen financial and business development literacy within the firm.

4.7 Lower the cost of electricity and increase reliability of power supply through digitalising energy services.

The high cost of electricity as well as a lack of access to a reliable power supply hampers the operation of digital technologies. As per Figure 13, the price of electricity in Kenya in 2016 was roughly 21.6 US cents per kWh (Balchin et al., 2016a), and the cost has also been highly unstable with bills rising by at least 10% per month. Kenya ranks 75th in World Bank's Getting Electricity rank; although it takes only three procedures to apply for electrical connections, it takes about 97 days on average to acquire the connection, compared to only 30 days in Rwanda (World Bank, 2018).

Firm interviews reveal that electricity for manufacturing is not only costly in Kenya, even in the export processing zone (EPZ), but power supply is also unreliable; there is no electricity for two days a month on average, and it is very expensive to buy a generator per factory. Even if power is available, poor transmission and distribution infrastructure leads to erratic power supply and outages in the country (Were, 2016). Further, the quality of electricity supplied is also a major concern for high voltage and bulk consumers because fluctuation in power and power outages lower productivity, as machines have to be restarted and their lifetime is shortened.

Figure 13: Price of electricity, 2016 (US cents per kWh)



Source: Balchin et al. (2016a)

On the supply side, the government has made tremendous efforts in improving electricity generation in the country. Major attempts to diversify Kenya's sources of electricity, especially towards wind and geothermal sources, are expected to provide as much as 45% of electricity supply by 2022 (KAM, 2018b). In May 2018, the President also announced plans to reduce electricity tariffs to 9 US cents for firms in the EPZ. Recent efforts in Kenya are also focusing on improving the reliability of power supply; some major upgrades have been made to the network infrastructure in Nairobi, resulting in a notable reduction in the duration of outages. Investments have also been made in distribution lines and transformers, along with the setting up a squad specialising in restoring power when outages occur (World Bank, 2018).

To continue to increase its competitiveness in the digital economy, Kenyan policies need to target reduction in electricity costs and improvements in the reliability of power supply and distribution. Policies in Ethiopia and Tanzania can provide good examples. Since 2011, Ethiopia has implemented the Climate-Resilient Green Economy strategy, focusing on harnessing clean energy sources such hydropower, wind, geothermal and solar power. Tanzania's electricity sector is also heavily dependent on hydropower. In 2013, to increase electricity penetration, the government reduced connection fees for both rural and urban areas (USEA, 2013). As per the World Bank, other good practices for improving access and reliability of electricity include streamlining the approval processes as well as increasing transparency of connection costs, tariffs and processes. Digital technologies can also be leveraged to automate systems for outage monitoring, restoration of service and informing customers in advance.

In the case of Kenya, exploiting its potential of renewable energy resources (particularly solar and hydroelectric) can give it a competitive edge in becoming a net exporter. Kenya is already deploying a microgrid system based on renewable energy, but this faces major challenges,

including limited access to low-cost finance, inadequate local skills and capacities (Bhattacharyya and Palit, 2016), and a risky business environment due to unknown consumer characteristics and unfamiliar business activities.

Digitalising the electricity sector can solve important challenges in Kenya pertaining to cost of electricity, access and distribution as well as reliability of power supply. Currently meter readers are tasked with making a monthly round to collect data from individual meters, which not only is time-consuming but has also resulted in increased data inconsistencies. There is a lack of accurate and timely data on electricity use in Kenya, leading to overcharged bills and consumer outrage.

Across the world, utility firms are investing in smart meters and grids to ensure reliable energy supply. 'Smart metering' will enable (a) collection of accurate and timely data on electricity usage, electrical outages and monitoring of electricity bills; (b) data integration across territories within Kenya, which can improve productivity; (c) forecasting of demand, keeping track of consumer usage patterns, preventing outages, managing peak demand; (d) optimising unit pricing of electricity; and (e) future network planning and development. It also will enable remote monitoring of power supply and demand, resolving many issues cost-effectively and reducing uncertainty and maintenance costs (Blodgett et al., 2016).

Some effort has already been made by Kenya Power for commercial users; it has installed around 6,000 smart meters at premises of large power consumers who consume above 15,000 units of power on a monthly basis, and in total more than 15,000 smart meters have been installed for large and small power consumers (NairobiGarage, 2018). The smart meters will enable electricity incentives (USEA, 2013) under the directive of Kenya Power's president, such as reduced night tariffs for manufacturers using electricity between 10 p.m. and 6 a.m.

Financing of the deployment of smart meters and issues around network capacity need to be addressed. These smart meters are fitted with digital sensors that collect the data, which then needs to be transmitted through communication networks for data monitoring and analytics, requiring internet and network stability. This is a point of convergence for utilities and telecom providers, such as Liquid Telecom in Kenya, which can offer good networking capability for installation and effective use of smart meters.

For communication to take place, wireless technology needs to be developed and diffused within Kenya. The government of Botswana has recently made significant efforts to boost wireless technologies. It has used its Universal Service and Access Funds (USAF) to increase the number of public Wi-Fi hotspots in hospitals, bus stops and shopping malls, across seven towns. To close the digital urban–rural divide, it can be useful to reduce taxes on ICT services and equipment supplied to rural areas, provide incentives to network operators to expand coverage to marginal areas, and reduce import duties of local content suppliers.

Scaling up smart meters as well as microgrid solutions enabled by mobile services; data such as real-time and highly granular information about energy usage and storage levels, functionality of devices, load balancing, and credit data as well as data on payments, refunds, etc., amplifies the need for big data solutions and cloud computing.[7] However, in the case of Kenya, simpler and more cost-effective solutions may prove more effective considering the context of lack of resources. Wireless wide area networks (WWANs) for communication, for example, could provide

[7] Microgrid system based on renewable energy is a result of leapfrogging. Microgrid systems in particular may offer one potential solution to meet basic needs while also facilitating modest productive use of electricity. But microgrid deployment faces major challenges. Amongst other things, microgrid developers have to deal with limited access to low-cost finance, inadequate local skills and capacities (Bhattacharyya & Palit, 2016), and a risky business environment due to unknown consumer characteristics and unfamiliar business activities.

a lower-cost alternative to machine-to-machine modules since they use white space spectrum, rather than mobile networks with high-speed capabilities (ITU and Cisco, 2016).

The price of electricity is much higher in Kenya compared to other SSA countries, reducing Kenya's competitiveness in digitalised manufacturing, which needs a good and reliable power supply. Actions are needed to improve access to electricity, its affordability, reliability and distribution:

Actions by the government:

- Digitalise the power sector throuh smart metering, which enables collection and anaysis of data on electricity.
- Harness renewable energy through microgrid solutions.
- Reduce connection fees in both rural and urban areas.
- Increase transparency of connection costs, tariffs and processes.
- Automate systems for outage monitoring, restoration of services, customer service.

Actions by firms:

- Telecom service providers need to offer good networking capability for installation and effective use of smart meters.
- Network operators need to expand coverge to rural areas to support deployment of smart meters.
- Firms need to switch from energy-inefficient technologies to energy-efficient technologies to benefit from cost savings from reduction in energy prices.

4.8 Improving transport infrastructure, trade logistics and postal competence for better market access for manufacturers

KAM (2018b) revealed that most of the manufacturers operated at about 53% capacity in 2017Q3, suggesting that capacity can be enhanced for purposes of export. In 2016, imports from China, India and United Arab Emirates (UAE) accounted for 23.6%, 14.4% and 6.4% respectively of total imports for Kenya or 44.4% (KNBS, 2017). Kenyan export markets are also shrinking: a recent SET survey finds that Kenya's market share in the UK declined by 9 percentage points from 2001 to 2016. Kenya's market share has also fallen with EAC, a key market for Kenyan manufactured goods (KAM, 2018b). Increased market access to regional and international markets is necessary for Kenya to reduce trade deficit.

One of the key factors that can unlock increased market access for Kenya is development of transport infrastructure – such as roadways, railways and ports – which is required across the supply chain of a firm, from sourcing inputs, to manufacturing, to final delivery to consumers. It costs between $500 and $1,000 to transport a twenty-foot (20ft) container from the port for Mombasa to Nairobi by road – 60% higher than in the US and Europe (Trade Mark East Africa, 2017). While this was expected to reduce by at least 30% following the construction of the standard gauge railway (SGR) in May 2017, the SGR has not been particularly useful in reducing transport costs for manufacturers, mainly due to an increase in delays for clearance of containers.

The firm interviews we conducted confirm this. With increases in domestic prices of steel and increasing volatility in prices, Megh Industries, an automotive firm in Nairobi, mainly imports steel for its manufacturing production. As a result of poor efficiency of ports, steel is mainly imported via the road. However, the firm faces customs delays and clearance problems when transporting by road. The SGR has not been very effective in improving logistical efficiency due to lack of harmonisation and streamlining in procedures. Another firm, New Wide Garments in Athi River EPZ, uses its importing containers as exporting containers, and reports container delays and

increasing inflexibility in time as a result of the SGR transport system. There is also a lack of electronic tracking and communication systems in industrial trucks, which increases delays.

Digitalising customs can greatly enhance efficiencies and reduce delays, as was also noted in the 2016 Logistic Performance Survey in Nairobi by the Shippers Council of Eastern Africa (SCEA). More recently, the government of Rwanda has announced plans to fully automate the clearance of exports and imports in an effort to boost revenue, reduce international trade costs through reductions in time taken to clear cargo, and to increase the flow of taxable goods (Rwanda Today, 2018).

It is also important to note that while goods can be ordered using e-platforms, they still need to be delivered using traditional systems (as long as drones are not mainstream), highlighting the need to also develop and strengthen postal competence and reliability for increasing market access. Kenya as yet ranks lower on postal reliability index (as shows by WITS) than not only Asian economies but also other African countries such as Tanzania, Uganda, Ghana and Ethiopia (Banga and te Velde, 2018a). Kenya also has poorer logistics and customs; it takes roughly 10 days to clear exports through customs, compared to 6 days in Nigeria and 7 days in Ethiopia and Ghana. Poor postal and logistical competence is likely to restrict e-commerce growth in Kenya.

To unlock market access for Kenyan manufacturers, actions are needed to improve transport infrastructure and trade logistics.

Actions by the government:

- Review the proposed SGR freight rates to make them competitive; implement the Integrated Customs Management System (ICMS) to enhance efficiency of customs processing (KAM, 2018b).
- Reduce container delays at the SGR custom clearance depots through introduction of electronic tracking and scanning procedures, as well as fitting electrical trucks with digital tracking systems that can reduce delays.
- Improve road infrastructure, postal competence and shipping reliability to enable growth in e-commerce.

Actions by firms:

- Digitalise the inventory keeping and tracking system.
- Use e-commerce platforms and mobile money for business-to-business transactions.

C. Supporting inclusive digital transformation in manufacturing

Policies to enhance digital capabilities and competitiveness of Kenyan firms, need to be complemented with policies to ensure inclusive and sustainable growth, including through up-skilling/re-skilling workers and fostering better dialogue and regulatory practices for manufacturing growth.

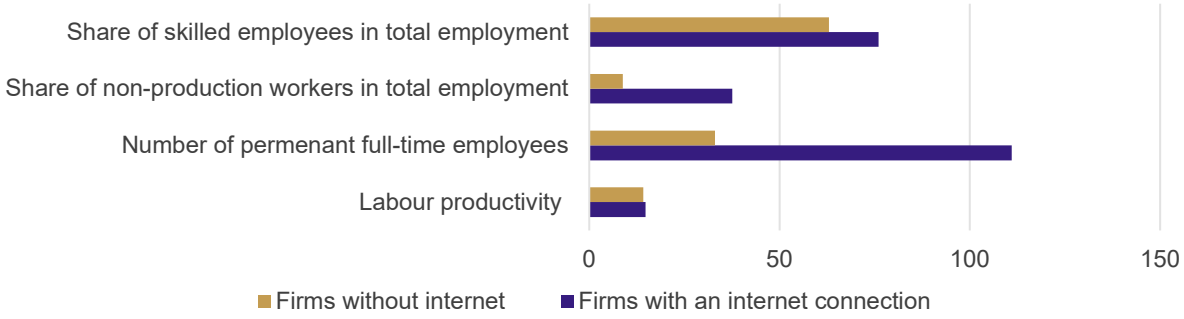
4.9 Targeted skills-development to increase absorptive capacity of the workforce

On the issue of labour and skills, Were (2016) notes that the Kenyan labour force is well educated but not well skilled. While the mismatch between education and skills is not as large as that in most of Africa, it still constrains the growth of the sector. It is clear there is an insufficient number of technicians to service the manufacturing sector or public infrastructure projects (Were, 2016).

As discussed in Section 2, digitalisation is going to only increase the demand for high-skilled workers. Banga and te Velde (2018a) find that although, on average, there is no significant difference in employment growth in the period 2007–2013 between digitalised Kenyan manufacturing firms (those that have internet) and those that are not digitalised, the average share of skilled employees is significantly higher (by 13 percentage points) in Kenyan digitalised

firms. Using the World Bank Enterprise Surveys of Kenyan manufacturing firms, the authors find that digitalised firms (firms with access to internet) have, on average, higher labour productivity and a higher share of skilled and non-production workers in total employment (see Figure 13).

Figure 13: The structure of employment in manufacturing firms, by access to internet



Source: Banga and te Velde (2018a)
Note: Data are from Kenya WBES, 2013

For Kenya, it is important to put in place policies for targeted skills-development, since skill shortages have increased over time and technology is increasing (Banga and te Velde, 2018a).8 With technology increasing at a faster rate than skills, it is important to develop complementary skills to avoid a skills-mismatch. Banga and te Velde (2018b) describe the core skills demanded from the workforce in an increasingly digital economy, which include (a) job-specific digital skills such as computer programming and technology design, job-neutral digital skills such as data analysis and browsing the internet safely, and job-neutral soft skills such as communication, analytical and critical thinking. Equipping workforce with job-neutral skills will allow them to adapt to different tasks in a rapidly changing technological landscape. The authors also highlight that some 'ancillary' skills related to manufacturing are going to remain important since they support the digital economy, including physical skills that require dexterity such as industrial driving, or even embroidery, to some extent, as well as low-skilled services such as sales, repair and maintenance.

Firm interviews across the garments, furniture and automotive industries reveal that lack of relevant skills is a prominent and common challenge in using digital technologies effectively. While SMEs such as Funkidz are not able to provide in-house training in relevant skills to workers, and ending up hiring more expensive engineers, larger firms rely on on-the-job training as a strategy for re-skilling and up-skilling the workforce. For instance, when new digital machinery is first imported in Megh Industries, the firm hires engineers from abroad to install it and to train the workforce to repair and maintain it. This is done by entering into import contracts that involve after-sales support, English speaking engineers who can offer training in the use of the machinery and feedback in case of breakdown, and annual maintenance contracts. For operation of digital machinery, skills needed depend on the type of task being performed and the type of machinery. For instance, some tasks can be performed by machines that run on their own (such as basic CNC machinery), while tasks such as manufacture of pipe endings, lining and assembly do not require much skilled labour and are harder to automate, due to both technological and economic feasibility. However, for other tasks, such as cutting, in which CNC lasers are used, workers with a poly-tech level of education (CNC knowledge and understanding of information systems) are needed, with most of the operators being trained in-house. Mechanics and engineers are increasingly needed by the firm for reverse engineering and tool development, as well as local technology managers with good industry experience.

[8] The % of firms reporting skill-shortages as a major constraint to firm operations has gone up.

The furniture manufacturer Panesar Interiors identifies skills shortages in creativity, fine arts, architecture, dimensional drawing and metal-working as a major constraint to leveraging digital technologies. To address this challenge, training is provided by the firm's training institute, which follows a curriculum focusing on training workers in industrial skills such as woodwork, joinery and carpentry but also in digital skills such as dual programming for CNC and CAD/CAM systems. In-house training is also provided by New Wide Garments in Kenya's EPZ in order to train workers on new machines. Foreign engineers and experts are brought in to teach workers about upgrading of technology and production; however, this is expensive.

Kenyan workers need to be re-equipped and re-skilled with skills relevant to manufacturing in an increasingly digital age.

Actions by the government:

- Introduce programmes for training youth in basic to intermediate digital skills (such as Rwanda's Digital Ambassador Programme, which aims to teach soft and digital skills to 5,000 young Rwandans who will then travel across the countries giving training to others in these skills).
- Revise and reorient the curriculum in Kenyan educational institutions around TVET and STEM subjects, but also increase demand of TVET through introduction of certificates and degrees.
- Reorient exsisting industry-level youth and employment training intitiatives, and revive institutions such as the National Industrial Training Authority (NITA), with focus on technical and digital skills training. Engage with the private sector when formulating the curriculum in educational institutions; introduce training programmes, internships and apprenticiships to reduce skills-mismatch.
- Boost focus on digital skills in mid-level formal education and through boot camps and workshops, as well as introducing soft skills in formal education through team projects involving use of ICT, business skills, communication, management and presentation.
- Partner with the Kenyan private sector in designing the educational curriculum, graduate schemes and on-the-job training to reduce skills-mismatch and shortages.
- Standardise educational institutions to increase youth employability ; too many unstandardised TEVT courses will not be effective.
- Use taxation and fiscal policies for tech monoplies operating within the country to leverage new revenue for skills devellopment.

Actions by firms:

- Teach their employees what it means to be a good 'digital' citizen; i.e. provide training in the secure use of the web, basic training in cybersecurity, importance of ensuring data privacy, etc.
- Co-fund skills-development for increasing employabiltiy of the youth. Large firms can provide in-house training using their own training institutions or collaborate with other firms in the same industry.
- Smaller firms can engage with firms from which they have imported digital machinery, and enter into contracts regarding repair and maintenance of these machines, which is key.
- Firms can approach DFIs for financing skills-development. For instance, one of the firms we interviewed received a $2.5 million investment through AfricInvest (a Tunisian DFI).
- The private sector should extend financial and networking support to technological and innovation hubs that provide training in skills-development and have their own curriculum on robotics, AI, digital fabrication etc., such as Gearbox and iHub in Kenya.

4.10 Focus on problem-driven governance to create a digitally enabling environment with flexible institutions, better dialogue, permissive regulatory practices and inclusive growth.

Digital transformation in manufacturing can be facilitated by putting in place policies that create a digitally enabling environment. Such policies need to target increasing flexibility of institutions, ability to work effectively as an ecosystem, and clear division of responsibilities. Better, targeted dialogue is needed amongst the government, private sector players and educational institutions, in order to understand the challenges facing manufacturing and find innovative solutions to

address them. For instance, public–private collaborations can be particularly useful in skills-development and training to prepare the future workforce for the changing nature of work in the digital economy (Banga and te Velde, 2018b. Public–private collaborations can also be useful in strengthening the use of e-government services, which can build digital trust in consumers and increase the use of internet and digital technologies by citizens and SMEs. Specifically, the manufacturing sector needs to clearly articulate its needs to the domestic technology sector in Kenya so that companies can actively develop solutions for local challenges. As per Were (2016), there is a lack of efficient collaboration between the two sectors as a result of a general lack of awareness in the manufacturing sector of how advanced the local technology scene is; as well as a stubborn perception that local tech firms are not as sophisticated as foreign firms and cannot develop effective solutions to local problems in manufacturing; and a lack of awareness in the tech community regarding the types of problems faced by Kenyan manufacturers.

In terms of the regulatory framework, Kenya has undertaken many steps to improve the investment climate and to become more attractive for foreign investors. The World Bank Group's Doing Business (2019) shows Kenya has significantly improved the ease of doing business; in 2018 it ranked 61 out of 190 countries, up from rank 80 in the year 2017. In the last five to six years, important reforms have been made in the following areas: starting a business, access to electricity, registration of property, protecting minority investors, paying taxes and resolving insolvency. The Kenyan Investment Authority (KenInvest) and the Business Environment Delivery Unit continue to make progress in reducing bureaucracy and simplifying the process of registering a business in Kenya, while recent laws such as the Bribery Act (2016) and the Access to Information Act (2016) are targeted towards fighting corruption and improving transparency in doing business.

While Kenya has made efforts to improve its regulatory system, regulations in the ICT services sector remain spread out between the central government and state entities in Kenyan counties, leading to unclear division of responsibilities and overlap of roles (Waema and N'dungu, 2012), and consequently to higher transaction (compliance) costs for private players. Fragmentation makes it more difficult for regulatory institutions to prosecute cybercrime such as software piracy, which deters foreign investment and also makes it increasingly difficult to fully align regulations with international standards. Firm interviews (see Appendix) and existing evidence further suggest that high costs of permits, lack of harmonisation in customs rules and regulations, and time and cost to register a company continue to be important challenges faced by Kenyan firms.

Important lessons in improving regulatory practices can be drawn from Rwanda, which ranks first in both ease of doing business and competitiveness in the EAC, and 3rd on the African continent. Rwanda's investment promotion focuses on, among other things, regulatory framework, registration of businesses, working permits, transfer of funds and protection of investment by the government. Since 2006, the government efforts have been directed towards privatisation of state-owned enterprises to reduce government's non-controlling share in private firms and to attract FDI, particularly in ICT services.[9] In 2016, the Rwandan government adopted the ICT act, which applies to all electronic communications, information society, the broadcasting sector and the postal sector. Its aim is to create a comprehensive legal framework for regulating ICT activities. This act institutes an ICT regulatory authority which is responsible for implementing the country's international obligations in ICT as well as promoting fair competition in the sector. Competition and fiscal policies can be effective in protecting domestic ICT firms and platforms, restricting monopolisation of the market by foreign firms and increasing accountability of tech companies, fostering an environment in which digital manufacturing can grow in a more inclusive manner.

There is a need to create a digitally enabling environment in Kenya through public–private collaborations targeting increasing flexibility of institutions, ability to work effectively as an ecosystem and clear division of responsibilities.

[9] US Department of State - 2017 Investment Climate Statements

5 SUMMARY AND CONCLUSIONS

Kenya is currently a leader in digitalisation in SSA with various public and private sector initiatives directed towards increasing the access to digital technologies. The government is also promoting the expansion of manufacturing, which has been included as one pillar of the 'Big Four' agenda, primarily due to the potential of manufacturing to create employment. It is crucial to understand that growing digitalisation, both nationally and globally, will affect jobs in Kenya, highlighting the need for a country-wide discussion on digital transformation and manufacturing job creation. If appropriate policies are put in place, digitalisation will boost manufacturing and present important opportunities in terms of lowering the cost of production, trade, and entry into the export market, all of which can create new and more productive jobs. This paper puts forward a policy framework for achieving this and discusses 10 policy priorities for digital transformation in Kenyan manufacturing.

First, the study finds that a combination of strategic public–private efforts has enabled Kenya to achieve higher connectivity, increased network capacity and more affordable internet (Waema and N'dungu, 2012); however, the level of digitalisation varies across industries and firms. On average, firms in the machinery–electronics–transport sectors and the chemicals–plastics–rubber sectors have a higher proportion of firms using the internet, emailing clients, engaging in e-commerce and online marketing, having a web presence, using mobile money (MM) and undertaking R&D. There is also a digital divide in use of internet across Kenyan manufacturing firms, with 98% of firms having internet but only 27% engaged in e-commerce for selling products.

A major concern associated with the use of digital technologies in the manufacturing sector is the impact on labour. Since manufacturing forms part of the Big Four agenda, primarily due to its job creating potential, the implications of growing digitalisation, both within Kenya and globally, brings into question the very role of manufacturing as a development pathway towards employment generation. If nothing is done to address the digital divide, which exists in access and in use, then there is likely to be increased re-shoring of manufacturing tasks and concentration of future digitally advanced manufacturing in developed countries. Growing digitalisation in the context of a persistent digital divide is therefore increasing concerns of further 'de-industrialisation' in Kenya, with falling shares of manufacturing in value-added and employment.

However, if Kenya manages to bring about digital transformation, i.e. a shift from low-productivity non-digitalised manufacturing to high-productivity digitalised manufacturing, new job opportunities can be realised. The study highlights four pathways through which digitalisation can boost employment creation in Kenya. Firstly, by deploying digital technologies and robotics, manufacturing firms can indeed create efficiencies in production which can increase their total factor productivity, leading to higher output and exports, and creation of new jobs linked to these exports. Secondly, digitalisation of manufacturing refers to increasing use of digital services, which will create jobs not only in services sectors that repair and maintain these machines but also in digital services such as data storage and information-processing services (including cloud computing, computer systems design, programming, computer aided designing and digital cutting). Thirdly, the different facets of digitalisation – such as electronic commerce, blockchain, digital trade, robotics, fintech – have in many cases significantly reduced production and transaction costs, making trade and coordination across countries easier, faster and cheaper. Digitalisation not only lowers production costs, which can enable a lot more entrants, particularly women and SMEs, to enter into the export market, but it can also increase Kenya's GVC participation, which is likely to be a driver of economic growth and employment creation in itself. Lastly, digitalisation is likely to create more productive jobs and increase the demand for skilled labour.

Firm interviews we conducted reveal that some manufacturing firms in Kenya have been able to successfully leverage digitalisation to achieve different growth outcomes: product diversification, expansion into regional markets, productivity improvements and lowered cost of production.

Economies of scale through such outcomes can also create new jobs. However, manufacturing firms face some shared challenges to digitalisation, including skills shortages in the workforce, high price of raw materials, logistical and custom delays, access to credit, high cost of electricity, and unreliable power supply.

Using (a) case studies of Kenyan manufacturing firms in the garments, furniture and automotive industries (see appendix for selected case studies), (b) available literature and evidence, and (c) an ODI–KAM bilateral meeting, the study draws the following policy insights to bring about digital transformation and job creation in Kenyan manufacturing;

Policies on building digital capabilities

1. ***Strengthening and sharing digital infrastructure for improving the access and affordability of internet services and other digital services.*** Government needs to target public-access solutions for internet access and grant more MVNO licenses, while firms need to invest in infrastructure sharing with established providers that have spare network capacity.
2. ***Developing a comprehensive legal framework on data privacy, protection and data localisation, and ensuring its proper enforcement***. The government needs to categorically classify data into sensitive and non-sensitive sets; enforce data protection laws for sensitive data; and form sector-specific data localisation and competition policies. Firms need to develop strategies to collect, analyse and use their data to improve efficiency.
3. ***Developing a comprehensive national policy on intellectual property and enforcing existing laws.*** The government needs to encourage innovation at the firm level, enforce IP laws at the national level, and harmonise IP laws at the regional level, while firms need to invest in product development for 'glocalisation' and develop patent policies.
4. ***Promoting digital and manufacturing start-ups, particularly in technology and innovation hubs, and ensuring that these hubs are well integrated into the domestic economy so that positive spillovers can occur***. Government needs to offer tax exemptions and subsidies to these hubs, reduce patent costs, and simplify business regulations, while service providers need to offer subsidised internet and digital services to these firms.
5. ***Using regional approaches to e-commerce and digital products and services, to actively leverage the benefits of digitalisation***. The government needs to support growth of national e-commerce platforms; leverage regional platforms to discuss global issues around e-commerce.

Policies for fostering competitiveness

6. ***Lowering the cost of capital by reducing interest rate spreads and lowering collateral requirements for investment in digital product***s. The government needs to establish windows in development banks dedicated to digital investment, support digital financing, and expense use of software in SMEs, while firms need to evaluate the use of equity financing and strengthen overall business development and financial literacy in the firm.
7. ***Improving access to electricity, its affordability, reliability and distribution.*** The government needs to lower the cost of electricity (already in process) and secure reliable power supply through investment in smart metering and harnessing renewable energy for microgrid solutions, while telecom firms need to offer good networking capacity for installation and use of these meters and better coverage in rural areas. Manufacturing firms need to move to more energy-efficiency technologies.
8. ***Improving transport infrastructure, postal competence and trade logistics to increase market access and leverage digital platforms.*** Digitalisation of border procedures and blockchain transport corridors is important, while manufacturing firms can create efficiencies within the firm by digitalising inventory and investing in tracking systems as well as using e-commerce platforms and mobile money.

Policies for managing inclusive digital change in manufacturing

9. ***Targeting skills development to increase absorptive capacity and capabilities of the workforce***. There is a need to showcase how firms have successfully acquired digital skills, especially for the young and for women. The government needs to revise and reorient education in schools towards TVET and STEM; increase the demand for TVET through certificates and degrees; reorient existing youth and employment training initiatives around digital skills and soft skills. Larger firms can conduct in-house training of workers on digital machines or co-fund skills-development programmes to increase employability.
10. ***Creating a digitally enabling environment in Kenya*** through problem-driven governance and public–private collaborations targeting increasing flexibility of institutions, ability to work effectively as an ecosystem, and clear division of responsibilities and permissive regulatory practices.

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APPENDIX A: HOW KENYAN FIRMS EMBRACE DIGITAL TECHNOLOGY – SELECTED CASE STUDIES

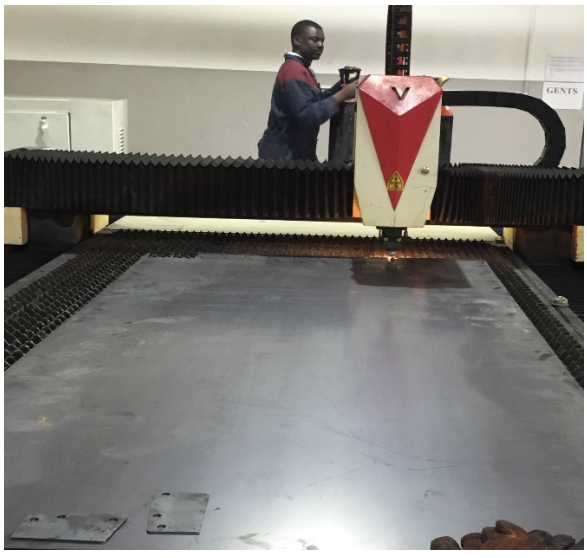
Megh Cushion Industries

Megh Cushion Industries Ltd., incorporated in 1976, set out to service the domestic furniture industry, initially supplying the domestic market with manufactured household furniture including sofa sets, lounge settees, day beds, etc. However, with the advent of motor assembly plants in 1977, they shifted their focus to supplying OEM to the local motor vehicle assembly plants that were supplying vehicles to the East African region.

Starting with a workforce of six, the company achieved impressive growth and was employing about 350 people in 1990, supplying up to 20,000 trim kits (annually to assembly plants in Nairobi (General Motors and Fiat), Thika, and Mombasa, and OEM parts to 35 different models of cars, heavy commercial vehicles, trucks etc. from Isuzu, Nissan, Toyota, Peugeot, Mazda, Mitsubishi, Suzuki, Daihatsu, Hino, Niva Lada and Fiat, amongst others.

However, with relaxation of import controls in the '90s, the local manufacturing of automotive parts started to dwindle. To remain competitive globally, in the early 2000s, the company began to diversify into transport seating such as computer seats, bus and coach seats, van conversions, after-market accessories, etc. The firm also sells OEM components (e.g. Isuzu lorry seats, Toyota door panels, Nissan hardbody) which cater to automotive assembly plants, like General Motors East Africa, and Kenya Vehicle Manufacturers, feeding directly into their lines, with on-time delivery scheduling. Currently, the firm is preparing to re-enter the OEM market with a full range of products for cars and motorcycles to service a large market that is opening up to 135 million people in the East African Community, comprising Kenya, Uganda, Tanzania, Rwanda and Burundi.

This product diversification was mainly realised through investments in multipurpose digital technology; during the period 2009–2018, the firm invested heavily in CNC auto-cut and laser technology (see photo below), pipe machinery for part preparation, fibre lasers for cutting (which have reduced the cutting time to below 45 seconds) as well as 3D scanning.



Use of CNC auto-cut laser machines for puncturing holes with specific dimensions in metal plates.

As a result, the firm went from producing less than 150 seats per month in 2000 to now producing 1500 seats per month. Plans are also underway for updating the welding machine to robotic welding as soon as the number of parts to be welded crosses 800 and it becomes economically beneficial. The firm is looking to deploy the robot FANUC, which costs about $28,000 but is easy to operate and offers more flexibility. Investment in digital technologies has, however, contributed to reduced employment – the number of workers has decreased from 350 in 1991 to about 60 people in the 2000s. While demand for both high-skilled workers and low-skilled workers has increased, the demand for middle-skilled workers has declined; i.e. job polarisation has occurred as a result of digital technologies deployed by the firm.

Along with going digital, the firm put in place a number of strategies that allowed it to maximise on the use of digital technologies. Firstly, to achieve economies of scale through 'tooling' (the

process of acquiring manufacturing components and machines needed for production), fabrics and recliners etc. were initially imported from Asia, mainly from China and Taiwan through B2B e-commerce transactions on Alibaba; and then tool manufacturers from India were recruited to reverse-engineer the imported components in order to lower the cost of production. This was done by identifying materials and components that could be locally sourced, for instance leather for upholstery. Secondly, the firm capitalised on 'glocalisation' – i.e. adapting global designs to local needs. While a large variety of bus accessories and seats were imported, the firm used the imports to adapt and create heavy duty seats that could service the requirements of local bus operators in rural areas with bad terrains. Such local needs of Kenyan bus operators are not met through Asian imports, opening up a market space for local Kenyan firms such as Megh Industries.

Thirdly, the firm was quick to adapt to changing skills needs of digital technologies. When the machinery was first imported, the firm hired engineers from abroad for installation and to train the workforce to repair and maintain the machinery. This was done by entering into import contracts that involved after-sales support, English speaking engineers who could offer training in the use of the machinery and feedback in the case of breakdown, and annual maintenance contracts. For operation of digital machinery, the skills needed depend on the type of task being performed and the type of machinery. For instance, some machines, such as basic CNC, can run on their own, while tasks such as manufacture of pipe endings, lining and assembly do not require much skilled labour and are harder to automate due to both technological and economic feasibility. However, for other tasks, such as cutting, in which CNC lasers are used, workers with a poly-tech level of education (CNC knowledge and understanding of information systems) are needed, with most of the operators being trained in-house. Mechanics and engineers are increasingly needed by the firm for reverse engineering and tool development, as well as local technology managers with good industry experience.

The firm has also shifted from traditional to cellular manufacturing. Whereas in traditional manufacturing similar machines are placed together (e.g. mills, drills etc.), in cellular manufacturing, machines are placed together according to the families of parts being produced, leading to higher efficiencies in material flow and inventory. The quality of machines, on average, has also improved, through adherence to ISO grading standards. As technology keeps changing, the firm invests in machinery updates and rents out old machinery to other local firms.

Although the firm has employed effective strategies to capitalise on digitalisation, it continues to face important challenges, including a skills gap and re-skilling of workforce, which has traditionally trained on conventional machines. Some of the industry work can be outsourced to the Technical University of Kenya (TUK), where rapid prototyping and scanning as well as parts modelling is being carried out. However, students lack sufficient training in industrial skills. Access to credit continues to be an important challenge. Although the firm has secured a $2.5 million investment for building a brand-new factory and new equipment through DFI from Tunisia's Africinvest, a private equity firm that is part of the Integra group, the moratorium period for repayment of loans is very short (one year). High cost of electricity for manufacturing, unreliable power supply and low availability of readily spare equipment also constrain firm operations.

In Kenya, high cost and volatility in prices of steel makes it difficult to locally source steel, which is the basic raw material the firm uses to make tubes and sheet blades. Therefore, steel is mainly imported, but here customs and clearance continue to be a problem – the SGR has not been effective due to lack of harmonisation and streamlining of transport rules. The price of wood has also increased. The cost of labour is also high in Kenya compared to other countries, such as Ethiopia.

Funkidz

Founded by a female entrepreneur, Wanjiru Waweru-Waithaka, Funkidz is a one-of-a-kind SME in Kenya that locally manufactures furniture for children. What makes Funkidz different from other furniture SMEs in Kenya is that it has invested heavily in technology. As a result, the beds, desks, cots, etc. manufactured here are more similar to what you would find at Ikea – flat-packable, made with computer-controlled cutting machines and printers.

Leveraging technology has allowed Funkidz to lower its cost of production, undertake mass production with exact specifications, and take advantage of economies of scale. Employing about 10 people, Funkidz is serving not only the domestic market of Kenya but also regional markets of Uganda and Rwanda. The main technology that has led to this impressive growth for the firm is Computer Numerical Control or CNC, which is the automation of machine tools by means of computers. In modern CNC systems, there are two technologies at play: first, the mechanical dimensions of the furniture parts are defined using CAD software and, second, they are translated into manufacturing instructions using computer aided manufacturing (CAM). CNC technology (see photo below), along with large printers, allows furniture design to be multiplicated, with exact specifications and quality. The new range of furniture by the firm is completely packable, easier to transport, and multifunctional. Flexibility in price is also offered via different options of customisation; for example, a bed can be purchased either unpainted or painted, depending on the customer's preferences.

Use of CNC machinery to carve wood for furniture manufacturing

Funkidz is also about to launch an augmented reality app, which will allow customers to login from their phones, browse on the firm's e-catalogue, use 3D modelling and scanning to view the furniture in augmented reality, i.e. in the customer's house, change the position and placement of the furniture around the virtual house, change the colour of the furniture, and purchase it online.

Plans are also underway to supply furniture in school, but the biggest problem faced here is the lack of skills. There is a dearth of technicians in Kenya, and in Africa, who are needed to operate computer-controlled machines, leading to skills-matching and hiring of expensive engineers to do the job. There is thus a need for retraining workers in new skills and upgrading education. As a result, a subsidiary of Funkidz, known as Funkidz tech, has partnered with Safaricom to design its own curriculum that focuses on detailed specification of furniture, drawing and dimensions, and provides training in CNC numerical cutters as well as in giving practical interviews.

While power supply is not a major problem for Funkidz – rural electrification is cheaper, and the factory receives 3-Phase power since it is on rural land for light industries – the rising prices of timber, as well as financial and market access, present important challenges to the firm's operations. The ban on logging has increased the price of wood drastically, with the price of a wooden plank increasing from 42 to 96 shillings a foot. To address this problem, the firm has fully embraced the full circular economy model and urban mining. It is now acquiring pallet-wood, the easiest and cheapest type of wood waste to recycle, which undergoes nail removal, finishing and sanding. Electronic waste – such as disposed batteries, electrical circuits, computer hardware, etc. – is being used as design components in table tops, showpieces and lamps, and along with second hand clothing from Mitumba, is being used as cushion covers.

Panesar Interiors

Incorporated in 1948, Panesar Interiors is a furniture manufacturing firm that provides furniture solutions at all levels, across homes and hotels, specialising in handcrafted, solid wood furniture. The firm employs 120 workers. Designing, product development, carpentry and sanding of wood are carried out in-house, while metalworking, timber and fabrics are sourced locally. Some fabrics are also imported from Dubai. While the firm is one of the best solid wood manufacturers in the Kenyan market, in 2016 it also exported more than 60% of its production to Tanzania, Australia, Canada and the UK.

To keep up with the changing times, the company has invested in world-class machinery and a highly skilled workforce to develop furniture that incorporates modern and contemporary styles and is customised as per customer preferences. For the first stage of carpentry, the firm hosts one of the largest wood-drying kilns in East Africa. Once the wood is dried to international standards (set by ISO), master craftsmen are engaged in customised joinery and carving processes according to customer specifications. To increase efficiency in cutting wood, the firm has installed a specialised CNC cutting machine (imported from Germany) that uses CAD technology to cut wood along five axes (see left), which ensures minimal wastage. It also has a smart 2D cutting machine to optimise on the number of wooden boards produced, and a 3D cutting machine for wooden carving.

A 5-axis CNC machine for cutting across five different axes simultaneously; enables the machining of very complex parts.

Digital technologies are also being used in the designing and product development stages of furniture production, which are carried out in-house. In particular, the auto CAD design software called Cabinet Vision is being used by engineers to design cabinets. This software offers several features including creation and presentation of 3D rendering of designs to customers, easy revisions and changes to designs, customisation of doors and drawers, creation of dimensioned floor plans and elevations, a panel optimiser which optimises boards for faster cutting, provision of job costing reports, etc. Once the design and plan of the cabinet are finalised using the CAD software, they are installed into the CNC machines using a flash disk.

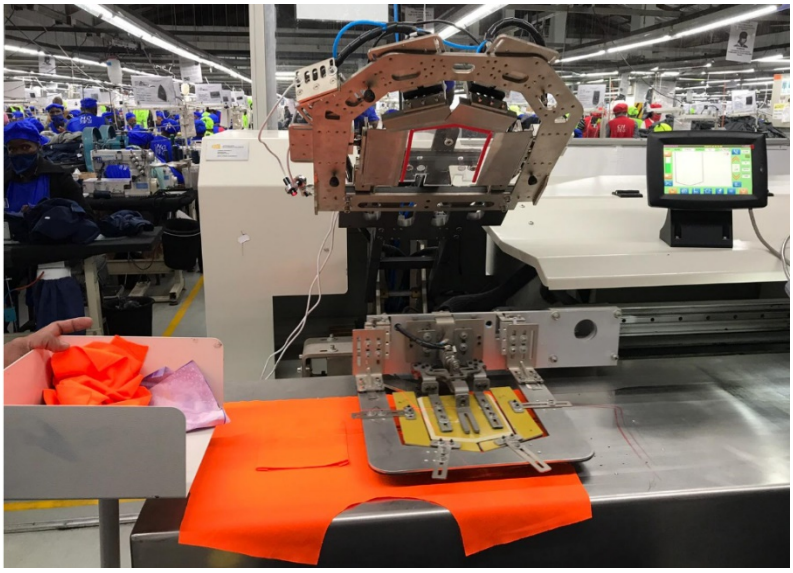
The firm identifies skills as an important challenge to its operation with digital technologies; there is a skills shortage in creativity, fine arts, architecture and dimensional drawing skills as well as metal-working. To address this challenge, on-the-job training is provided by the firm's 'Panesar Training Institute', which follows a curriculum focusing on training workers in industrial skills such as woodwork, joinery and carpentry but also in digital skills such as dual programming for CNC and CAD/CAM systems. As there is a lack of metalworking skills, this task is outsourced locally.

Success of this firm is driven by innovative thinking; the firm is constantly looking to update and innovative its styles and is working on refitted drawers and self-charging tables. The firm has also adopted elements of circular economy to utilise resources more economically – for instance, it uses recycled woodwork from which mill marks and other dents are removed through sanding, and it uses sawdust as a fuel to run the boiler. It has also installed solar panels on some parts of the roof.

New Wide Garments

New Wide Garments (NWG), based in the Kenyan EPZ of Athi River, is a garments subsidiary of the New Wide Group, a Taiwanese-owned textile and garments manufacturer. Employing about 7,500 people, NWG is the biggest firm in the EPZ, creating important employment opportunities for African youth. The main product is fashion knits, with fabrics being imported from factories of New Wide Group in China and manufactured – from cutting to shipping – in NWG factories in Kenya. Under the Agoa agreement, the firm cannot sell domestically; it exports finished garments duty-free to the US. Focusing on improving both efficiency and quality of products to remain competitive in the market, NWG ships around 2.2 million items per month to the US, with the main buyers being Walmart, PVH and Dickies (DailyNation, 2013).

Over the last 10 years, the firm has been bringing in new machines and digital technologies in order to reduce the cost of production. Financing of these technologies is not a major constraint for the firm since they are funded by the headquarters firm in Taiwan upon presentation of a business case (however, this may not be possible for other smaller firms). New technologies have been installed for automated packing of garments. While stitching is mostly carried out by workers, some tasks – such as stitching pockets on shirts – are being done by CNC sewing machines (see photo, left). The labour-intensive task of cutting is, however, done manually since it is economically beneficial; for one product line, a digital cutter costs about $55,000. For NWG, with 13 product lines, this would be a significant investment. Overall, technology has not only lowered the average cost of production but has helped in meeting international standards. Net employment has not been affected significantly; workers replaced in some tasks are retrained and employed in other tasks and operations. New product lines have also generated jobs.



Use of CAD/CAM in t-shirt manufacturing. CNC machinery used to design and stich a pocket on a t-shirt, while workers carry out other tasks of stitching and cutting.

In-house training is provided by the firm to train workers on the new machines. Foreign engineers and experts are brought in to teach workers about upgrading of technology and production; however, this is expensive. Along with retraining and skill shortages, the firm also faces high cost of electricity, despite being in the EPZ. Electricity in the Kenyan EPZ costs about 16 shillings per KW per hour, which is very expensive when compared to electricity costs in some other African economies, such as Ethiopia, where electricity costs 3 shillings per hour. For the firm, electricity costs are about 10–15% of total costs. Moreover, power supply is unreliable; there is no electricity for two days a month and it is very expensive to buy a generator per factory. Unlike in Ethiopia, water in the Kenyan EPZ is not free; in fact it is expensive and unreliable – there is no water 10 days a month. To maintain washrooms for workers, the firm has to undertake additional expenses, which drives up the cost of production. Another factor contributing to high capital and operation costs is the cost of permits, which is roughly $6,000 in Kenya.

Labour costs are also high; there has been a 32% increase in the firm's labour cost in the last three years. Labour in Kenya is more expensive than in other African countries – for instance, labour in garment manufacturing in Kenya costs about $170–180 per month per worker, while in

Ethiopia it costs about $30–50 per month. However, efficiency of local labour is high in Kenya (80%).

Imported inputs are still transported via road to the NWG firm, as the SGR has not been effective – there are high container delays and inflexibilities in clearance at the Inland Container Depot (ICD). An automated clearing depot and trucks fitted with electronic communication systems are key in improving logistical efficiency, particularly for this firm since it uses its import containers as containers for exports.