International Labour Organization

Changing demand for skills in digital economies and societies

Literature review and case studies from low- and middle-income countries

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▶ Foreword

Technological advancements and digitalization have been profoundly reshaping our work and lifestyle, business models and operations, and government policy choices. While digitalization has brought tremendous benefits to our economy and society, as it spurs efficiency and productivity gains and makes our lives more convenient, it poses many challenges, such as digital divides and unequal employment effects. As the trend towards greater adoption of technologies and digital transformation is accelerating, in particular in the context of the COVID-19 pandemic, it risks exacerbating pre-existing inequalities or even creating new ones as some jobs are automated and certain skills become less demanded. Although the digital transformation is facilitating job creation, the opportunities are not equally shared and hence those without the right capacity, knowledge and skills risk falling further behind.

This report shows that education and training play a key role in reaching the ambition of equipping the current and future workforce with right mix of skills for the digital economies and ensuring that everyone enjoys the benefits of the digital transformation. Drawing on the existing literature on digitalization and changing skills demand, the report sheds light on the changes to employment, occupations, tasks, work and organizational arrangements induced by digital transformation, and their implications for digital and non-digital skills, as well as the impact of these process at the sectoral level based on empirical evidence from case studies. Both the literature review and the empirical analysis were conducted just before the outbreak of the coronavirus disease (COVID-19) pandemic. As the situation rapidly changed and the process of digital transformation accelerated, some adjustments and updates were made to the report. Generally, however, these were slight changes to bring the report in line with the context of the global health crisis. A full understanding of the implications of the COVID-19 pandemic on digitalization and skills demand remains a task for the future.

It is clear that rapid digitalization, coupled with the current COVID-19 pandemic, is causing disruptions in labour markets by altering the demand for specific tasks and skills and leading to job losses, in particular jobs involving routine tasks. To mitigate the economic and social impact of these disruptions and to make most of digital transformation, proactive training and support for workers are highly needed to help them either to deepen their existing skills sets or to acquire new ones, so that they can move from one occupation to another or adapt to new tasks. It is therefore critical to identify and anticipate the changing demand for skills in different sectors and strengthen the education and training systems to better deliver skills required for the digital transformation.

The report also examines how digital skills are measured, by reviewing various concepts and measures of digital skills. It identified limitations in the current measurement tools and underlines the necessity for the development of comprehensive and globally comparable measures of digital skills. This would facilitate better assessment of changes in digital skills demand and supply, which, in turn, could facilitate more informed policy decisions and more effectively address the skills challenges posed by digital transformation. We believe that the report will contribute to a better understanding of the key skills implications of the digitalization process and help to ensure that the current and future workforce are equipped with required skills for the digital transformation.

Srinivas Reddy,
Chief, Skills and Employability Branch, ILO

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▶ Table of contents

Foreword 3
Acknowledgements 4
Executive summary 9
Abbreviations 11
Glossary 12

1. Introduction **14**

2. Literature review on the technological transformation and its implications for skills **18**

2.1. Mapping the global level and scope of digital transformation 20
2.2. Employment changes induced by digital transformation 23
2.3. Changes in occupations and tasks and their implications for skills 26
2.4. Changes in the modes of work and work organization and their implications for the skills change 30
2.4.1. Non-standard forms of employment 30
2.4.2. Gig economy 30

3. COVID-19 and digitalization, and the implications of this process for skills **34**

3.1. Labour market consequences of the pre-existing digital divide during the pandemic 36
3.2. Digital acceleration and its effects on sectors 37
3.3. Impact on the way we learn 39
3.4. Impact on the way we work 40
3.5. Changes in demand for skills 41

4. Measuring shifting skills **42**

4.1. Digital skills: what to measure? 44
4.1.1. Definitions of digital skills from academia 45
4.1.2. Definitions of digital skills from national governments, international organizations and businesses 46
4.1.3 Measuring digital skills: supply side 46
4.1.4 Measuring digital skills: demand side 48
4.2. Digital skills: how to measure? Review of measurement tools 50
4.2.1. Supply-side measurement tools 50
4.2.2. Demand-side measurement tools 51
4.3. Digital skills needs: what information does the measurement convey? 56
4.4. Towards a global digital skills measure 59

5. Impact of digitalization on skills within and across sectors 62

5.1. Sector focus 1: Agriculture 64
5.1.1 Context of the COVID-19 pandemic 64
5.1.2. Digitalization trends, impact on skills and cross-country comparison 65
5.2. Sector focus 2: Manufacturing 68
5.2.1. Context of the COVID-19 pandemic 68
5.2.2. Digitalization trends and impact on skills 68
5.2.3. Case studies 70
5.2.3. Cross-country comparison 74
5.3. Sector Focus 3: Services 75
5.3.1 The context of the COVID-19 pandemic 75
5.3.2. Digitalization trends and impact on skills 76
5.3.3. Case studies 80
5.3.3. Cross-country comparison 86
5.4. Digital transformation is uneven across sectors and countries 88

6. Conclusions and policy recommendations 90

6.1. Getting skills right, including digital skills 92
6.2. Right mix of basic, core work and technical skills as a foundation for the further development of digital skills throughout lifelong learning 93
6.3. Incorporating digital skills into early learning, compulsory and secondary school curricula 94
6.4. Reorienting teaching methods to deliver digital and core work skills 96
6.5. Giving the right tools to the teachers 97
6.6. Reinforcing TVET to deliver digital skills 98
6.7. Supporting necessary skill delivery through tertiary education 100
6.8. Activating skill response at the enterprise and industry levels 102
6.9. Supporting strategies for effective lifelong learning 105
6.10. Integration of skill policies with other labour market policies 107
6.11. Digitalization and coordination with other policies 109
6.12 Support to developing countries in overcoming barriers in digitalization 110

References 111

Annex 123

A. Case study: United Republic of Tanzania – transport and logistics sector 123
B. Case study: India – retail sector 124
C. Case study: Cambodia – arts and creative sector 126
D. Case study: Argentina – construction sector 128

List of boxes

Box 1. Skills for online platforms: evidence from Ukraine 33

Box 2. Measuring real-time data on postings in the gig economy 55

Box 3. Examples of technological penetrations into the Ethiopian smallholder agriculture sector include: 66

Box 4. Services sector in two countries of the Latin America region: case studies from Mexico and Costa Rica ***77***

Box 5. UNESCO programmes to develop the digital skills of girls and women 95

Box 6. Co-working spaces reshaping non-formal and informal lifelong learning of digital workers 106

List of figures

Figure 1. Distribution of firms using email, by country's level of development 20

Figure 2. Conceptualizing digital skills as a subset of skills for digital economies: overlaps and linkages with other types of skills and their components 60

List of tables

Table 1. Incidence of email use by firms; as percentage of all firms, by region and sector, circa 2015 21

Table 2. Examples of employment changes and their implications for skills 24

Table 3. Examples of changes in occupations and tasks, and their implications for skills and skills response strategies 27

Table 4. Manufacturing: Examples of digital technologies' applications and skills needs that they create 69

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▶ Executive summary

Digital transformation has already been bringing extraordinary economic dividends, efficiency and productivity gains in a wide range of sustainable development areas. It contributes to innovation in products, in processes, in work and organizational arrangements. As such, it holds the promise to substantially improve the job quality and productivity of existing jobs, as well as lives of workers. The coronavirus disease (COVID-19) pandemic has accelerated the digital transformation and underscored the vital role that it plays in limiting disruptions to the world of work and in ensuring learning in times of crisis.

The developmental benefits from digital transformation can only be fully reaped, however, if the technologies can be enjoyed by everyone. Yet, this is far from being the case. In the globalized world, the speed of digital adoption and sophistication is creating a new and growing developmental gap – the digital divide – where countries, enterprises and workers not able to swiftly adjust to digital economy run the risk of falling behind. The pressing need to bridge this digital gap is accentuated by the current global health crisis. The unevenness of technology adoption, and hence the unevenness with which businesses can reap the benefits of new developments, is often due to differences in infrastructure, connectivity and access to technologies. It is also due, however, to the lack of capacity and technical knowledge of either business owners and managers, or workers, or both. The digital gap increasingly concerns the capacity, knowledge, and skills needed to access and analyse the information.

Digital transformation carries sizeable employment challenges. It creates, and will continue to create, new direct, indirect and induced jobs, but it will also destroy others. The total employment effect of the digital revolution, while hard to foresee, is non-deterministic. Transiting to the digital future where more jobs will be created will not happen by default: it is a social and political choice, requiring a coherent and holistic policy approach.

Digital transformation not only means that some jobs will disappear, but also that the vast majority of the existing work tasks within traditional jobs will be modified. Many existing tasks will be complemented by technology. New skills will be demanded, including in hybrid jobs requiring the combination of digital skills and multidisciplinary training. The success of an individual on the labour market will, however, be determined by a good mix of hard technical skills specific to a job and sound basic skills as a foundation for further learning throughout life and strong core work – or soft – skills.

In order to assess the effect of digital transformation on changes in digital skills demand and supply, digital skills first need to be properly measured. There are many examples of digital skills conceptualizations and their measurements from academia, national institutions, international organizations and businesses. There is still a lack, however, of comprehensive data based on a strong relatively objective comprehensive conceptual framework, covering developed and developing countries, and comparable across countries and over time. Moreover, the digital skills gap is mimicked by the digital skills measurement gap: in countries where the development of skills to keep pace with digitalization is lagging behind, so are the measures of digital skills. The most comprehensive measures exist in developed countries with deep penetration of digital technologies and with their wide use for work and for life. This calls for the development of measures that will enable a comparable global assessment of digital skills.

The results of case studies confirm the lack of data on digital skills and difficulties in measurement. Despite the limitations, several generalizations based on existing data and empirical case studies emerge. First, there are differences in the digital skill demand between countries even with similar levels of development, and within and across sectors. Those reflect different structures of economies (with some occupations and jobs having low digital skills requirements), technology adoption by businesses, but also the existing supply of digital skills. Second, digital technologies adoption raises the demand for all types of digital skills – basic, middle-level, relying mostly on the supply of technical and vocational education and training (TVET), and specialist, drawing from university-level education. Specialist (professional) skills

in information and communications technology (ICT) are among the most sought-after, driven by the higher-than-average growth of ICT industries globally, including in developing countries. This trend is expected to continue. Third, core work skills, such as empathy, creativity, collaboration, customer service, problem-solving, and the ability to learn, adapt and apply new methods and approaches are in particular demand. Combined with ICT skills, they are rewarded at a premium.

In addition, empirical findings based on case studies demonstrate that the availability and quality of digital infrastructure influence both the adoption of digital technology and the acquisition of digital skills, and infrastructure bottlenecks and related challenges are most often observed in low and lower middle-income countries. Added to that, a stark misalignment between the skills possessed by graduates and the skills sought by enterprises is commonly found in economies at all income levels. As digitalization is spreading so fast into various sectors and technological changes are so rapid, existing formal education and training programmes have difficulty keeping up with the changing skills requirements.

Hence, for skills and lifelong learning systems, the stakes are high. The timeliness or lack thereof with which education and training systems respond to digital transformation challenges can put these systems in a virtuous interaction with the world of work, or alternatively, widen the disconnect between the demand and the supply of skills, exacerbating skills gaps and delaying the adjustment to the new context. On the one hand, education and training systems need to deliver a solid and yet agile mix of skills required for the digital economies. On the other hand, they need to create an enabling environment for dynamic and active learning over the life cycle to ensure that people keep pace with digital transformation.

In order to meet the challenge of translating digital skills demand into the right skills of current and future workforce, the educational and training systems should adhere to the following baseline principles and policy measures:

- Finding the right mix of basic, core work and technical skills as a foundation for further development of digital skills throughout lifelong learning;
- Incorporating digital skills into early learning, compulsory and secondary school curricula;
- Reorienting teaching methods to deliver digital and core work skills;
- Giving the right tools to the teachers;
- Adapting TVET;
- Supporting necessary skills delivery through tertiary education;
- Activating skill response at the enterprise and industry levels;
- Supporting strategies for effective lifelong learning;
- Integrating skills policies with other labour market policies;
- Carrying out digitalization and coordination with other policies;
- Supporting developing countries in overcoming barriers to digitalization.

In addition, skills policies need to be well articulated with other labour market policies, especially those helping to sustain labour market transitions through working lives. Lastly, they must also integrate the digital skills challenge with other national policies, such as those in the demographic, climate change, and trade and globalization domains.

▶ Abbreviations

AI	artificial intelligence
ALMP	active labour market policies
ASEAN	Association of Southeast Asian Nations
CEDEFOP	European Centre for the Development of Vocational Training
COVID-19	coronavirus disease
CPS	cyber-physical systems
CV	curriculum vitae
DLT	distributed ledger technology
ERP	Enterprise Resource Planning (software)
ESJS	European skills and jobs survey (CEDEFOP)
EU	European Union
GIS	geographic information system
GDP	gross domestic product
ICT	information and communications technology
IoT	internet of things
ISACA	Information Systems Audit and Control Association
IT	information technology
ITU	International Telecommunication Union
MOOC	massive open online courses
MSME	micro, small and medium-sized enterprises
OECD	Organisation for Economic Co-operation and Development
PIAAC	Programme for the International Assessment of Adult Competencies (OECD)
PISA	Programme for International Student Assessment (OECD)
PPE	personal protective equipment
R&D	research and development
SDG	Sustainable Development Goal
SME	small and medium-sized enterprise
SPS	sanitary and phytosanitary
STEM	science, technology, engineering and mathematics
STEP	Skills Towards Employability and Productivity
TBT	technical barriers to trade
TVET	technical and vocational training

▶ Glossary

Artificial intelligence (AI): simulation of human intelligence processes by machines, in particular by computer systems. These processes include: learning (the acquisition of information and rules for using the information); reasoning (using rules to reach approximate or definite conclusions); and self-correction.

Big data: extremely large data sets, produced through the digitization of content, greater monitoring of human activities through digital technologies, and the spread of the internet of things.

Big data analytics: a set of techniques and tools used to process and interpret big data. It may be used to analyse relationships, establish dependencies and perform predictions of outcomes and behaviours. Big data analytics also enables machine learning, a driver of artificial intelligence.

Blockchain: a distributed register designed to store static records and dynamic transaction data without central coordination by using a consensus-based mechanism to monitor the validity of transactions.

Cloud computing: the practice of using a network of remote servers hosted on the internet to store, manage and process data, rather than a local server or a personal computer.

Cobot: collaborative robot, intended to physically interact with humans in a shared workspace (in contrast to robots operating autonomously).

Cognitive technologies: products of the field of artificial intelligence which are able to perform tasks that only humans used to be able to do. Examples of cognitive technologies include computer vision, machine learning, natural language processing, speech recognition and robotics.

Competency: the proven or demonstrated individual capacity to use know-how, skills, qualifications or knowledge in response to usual and changing occupation situations and requirements.

Core skills, or core work skills: a set of non-technical skills, such as soft, social and emotional, cognitive and metacognitive skills, basic skills, including literacy and numeracy, digital literacy and numeracy, and basic environmental awareness, transferable across occupations and jobs.

Cyber-physical systems (CPS): computer-based algorithms that work with physical processes in which embedded computers and networks monitor and control the physical processes of machines and artificial intelligence (AI) in a feedback loop whereby one informs the other. Self-driving cars are an example of one such system.

Digitalization: the use of digital technologies and digitized data to influence how work gets done, transform how customers and companies engage and interact, and create new – digital – revenue streams.

Digital reality: wide spectrum of technologies and affordances that include the processes known as "augmented reality", "virtual reality" and "mixed reality" that simulate reality in various ways.

Digital transformation: changes affecting individuals, businesses and societies brought about, on the one hand, by digitization and, on the other, by internet-enabled interconnections that allow these processes to operate globally.

Digitization: the conversion of analogue to digital form.

Distributed ledger technology – also known as DLT: type of secure database or ledger for keeping track of who owns a financial, physical or electronic asset, but without the need for a centralized controller of these data. Instead, the data are shared in a peer-to-peer manner across multiple sites, countries, or institutions.

Internet of things – also known as IoT: system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. Examples include the control of lights or air-conditioning systems from a remote location, and autonomous cars.

Job: set of tasks and duties performed, or meant to be performed, by one person, including for an employer or in self-employment.

Machine learning: AI application that provides systems the ability to automatically learn and improve from experience without being explicitly programmed to do so.

Mismatch or skills mismatch: widely applicable term referring to different types of skills gaps and imbalances such as over-education, under-education, overqualification, underqualification, over-skilling, skills shortages and surpluses, and skills obsolescence. Skills mismatch can be both qualitative and quantitative, referring both to situations where a person does not meet the job requirements and where there is a shortage or surplus of persons with a specific skill. Skills mismatch can be identified at the individual, employer, sector or economy level.

Occupation: set of jobs whose main tasks and duties are characterized by a high degree of similarity. A person may be associated with an occupation through the main job that he or she currently holds, a second job or a job previously held.

Precision agriculture: integrated crop management system that attempts to match the kind and amount of inputs with the actual crop needs for small areas within a farm field. Precision agriculture uses one or more of the following sources of data: soils, crops, nutrients, pests, moisture or yield, for optimum profitability, sustainability and protection of the environment. Also referred to as satellite farming.

Qualification: formal expression of the vocational or professional abilities of a worker which are recognized at international, national or sectoral levels and which takes the form of an official record (certificate or diploma) of achievement, attesting to successful completion of education or training, or satisfactory performance in a test or examination.

Skill: ability to carry out mental or manual activity, acquired through learning and practice, where skill is an overarching term which includes knowledge, competency and experience as well as the ability to apply these in order to complete tasks and solve work-related problems.

Skills gap: situation in which the skills level of as employee or group of employees is lower than that required to perform the job adequately, or the type of skill does not match the job requirements.

Skills shortage: situation in which certain skills are in short supply, for example where the number of job seekers with certain skills is insufficient to fill all available job vacancies.

Ubiquitous linked sensors: networked sensors designed to remotely connect, track and manage products, systems and grids; they are at the heart of the internet of things.

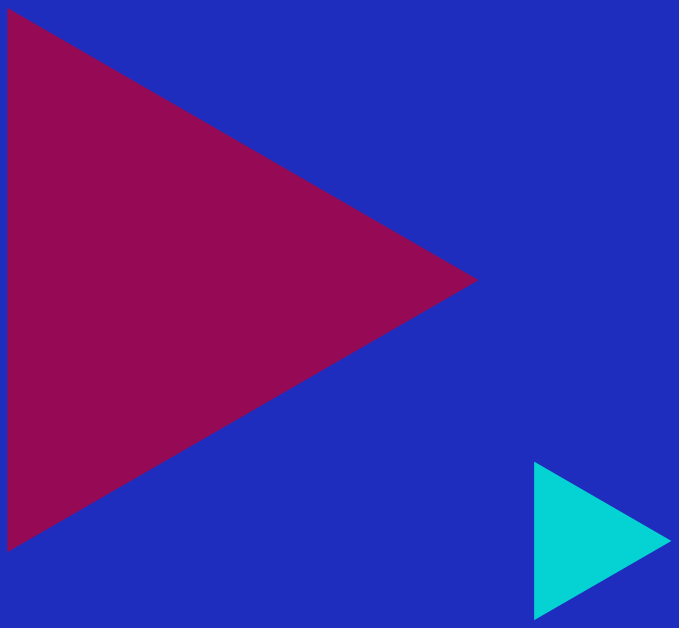
1

Introduction

The digital transformation has been bringing extraordinary economic dividends and efficiency and productivity gains in a wide range of sustainable development areas, from agriculture to health, infrastructure, environment and education (ILO 2019a; UNESCO 2018a; World Bank 2016). It is contributing not only to innovation in products, but also to innovation in processes, work and organizational arrangements. As such, it holds the promise to substantially improve the quality and productivity of existing jobs, and also the lives of workers.

Yet developmental benefits from digital transformation can only be fully reaped if the technologies can be enjoyed by everyone. This is far from being the case, however.

[...]



[...]

In the globalized world, the speed of digital adoption and sophistication is creating a new and growing developmental gap, a digital divide, in that countries, enterprises and workers that are unable to swiftly adjust to the digital economy run the risk of falling behind. By the beginning of the 2000s, the adoption of advanced internet technology accounted for more than half the difference in wage growth between developed and developing countries (Forman et al. 2012). At the end of 2019, however, almost half of the world's population were not connected to the internet and could not take advantage of the transformative power of information and communications technologies (ICTs) (ITU 2020a). This shortfall is particularly acute in the least developed countries, where only 25 per cent of the urban population and just 10 per cent of the rural population have access to the internet (ibid.). Those worst affected by this situation are people in sub-Saharan Africa and South Asia, women, and people living in remote and rural areas (ITU 2020a; UNESCO 2016; Broadband Commission 2017b).

The need to bridge the digital divide has been given particular urgency by the current coronavirus disease (COVID-19) pandemic. While the crisis has speeded up the transition to the digital economy, it has also widened the gap between advanced economies and lower income countries, rural and urban areas and among households at different income levels. While digitalization is enabling people to cope with the pandemic by teleworking, engaging in online learning, using telemedicine and other online services, those unable to take advantage of technologies are at risk of being left further behind. The ILO-UNESCO-World Bank survey of training providers in early days of the COVID-19 pandemic demonstrated that poor connectivity and lack of digital infrastructure were the major barriers to participation in training during the crisis (ILO et al. 2021).

The fact that digital transformation spreads unevenly across countries, coupled with different occupational and sectoral structures, means that there will be unequal employment effects across countries at different stages of development and of technology adoption. On the one hand, in the absence of proactive policies, the digital technological gap between most advanced and least advanced countries is likely to grow. On the other hand, most experts agree that activities with the highest automation potential, and hence the highest potential to become redundant, are routine-based jobs with predictable physical activities (see, for example, Chui et al., various years, and ILO, 2018a, for further discussion of this issue). More such jobs are concentrated in developing rather than developed countries, and also among informal workers, women and migrant workers. This means that it is developing countries that will disproportionately bear this additional burden of employment adjustment to technological disruption (Carbonero et al. 2018). It is also the employees in most exposed roles that are least likely to receive any on-the-job training or even have any prior formal education (Nedelkoska and Quintini 2018). Thus, even if digitalization will create new work opportunities, access to them will be highly unequal, calling for specific skills transition policies to mitigate this inequality.

Most critically, the unevenness of technology adoption, and hence the unevenness with which businesses can reap the benefits of new developments, are also often due to lack of technological knowledge on the part of either business owners and managers, or workers, or both. Indeed, employers' surveys suggest that digital skill gaps are often the most important barriers to the uptake and leveraging of technology (see, for example, ILO, 2016a). In their turn, the working-age individuals in urban areas who report that lack of information and communications technology (ICT) skills is a barrier to employment and higher earnings constitute up to 40 per cent of the workforce in Viet Nam, and over 20 per cent in Colombia, the Lao People's Democratic Republic and the Plurinational State of Bolivia (World Bank STEP surveys). Moreover, in developing countries, progress is still to be made in basic literacy, which is a key precondition for effective use of any digital technology and for developing digital skills. In countries such as Mali and Uganda, about three quarters of third-grade children cannot read. In Afghanistan and the Niger, around 70 per cent of adults are illiterate (World Bank 2016). For those who do have basic general skills, even the most basic digital skills may still be lacking. For example, of the many people in Africa who do not use the internet, some 70 per cent simply do not know how to use it, and many even do not know what it is (ibid.).

Given this state of affairs, the digital gap predominantly consists in the capacity, knowledge, and skills needed to access and analyse information. It is such skills and capacities that determine the extent to which workers, businesses and societies can truly enjoy the benefits of the digital revolution. Added to that, our dependence on digital goods and services during the pandemic, and the accompanying rapid adoption of digital technology and processes underline the critical importance of the development of digital skills. Digital skills are vital to coping with drastic changes in education and the workplace and building resilience to economic and social shocks such as those presented by the global health crisis.

The question of how skills for broader digital economies generally, and digital skills specifically, can be developed and sustained by all workers regardless of their gender, age and place of residence, is a continuing challenge for governments around the world (Broadband Commission 2017a). All stakeholders will have to play a proactive role and assume responsibility for ensuring a win-win digital transformation scenario. Businesses will have to increasingly support their existing workforces through reskilling and upskilling and increasingly value these actions as investments. Workers will have to assume even more responsibility in lifelong learning. Governments will have to create or adapt enabling environments in order to accommodate these efforts. In that context, the success of the digital transition will require "proactive investment in developing a new surge of agile learners and skilled talent globally" (WEF 2018a). The realization of the so-called "augmentation strategy" – whereby technologies will complement and amplify the human workforces' comparative advantages rather than substitute them (Davenport and Kirby 2015) – will critically depend on these actions.

In the light of the scenario outlined above, this report sets out a quadruple objective. First, it intends to map the level and scope of digitalization, and provide evidence on the implications that it has for employment, occupations and skills, and also work and organizational arrangements. Second, it overviews various concepts and measures of digital skills, with a view to providing observed evidence of how digital skills demand is growing globally. Third, it examines the impact of digitalization on skills within and across sectors, with empirical evidence collected from case studies in selected countries. Lastly, it addresses the fundamental challenge of how skills and lifelong learning systems should respond to the rapid pace of technological and structural change induced by digitalization.

The report draws on a literature review and a set of case studies. The case studies cover a mix of sectors: agriculture; services, including tourism, art and creative industry; ICTs; retail and e-commerce; transport and logistics; and manufacturing, including construction, automotive and electronics. The short case studies were based on interviews with key stakeholders, focus groups and national literature. The case studies covered a mix of low- and middle-income countries across different geographical regions: Argentina, Cambodia, Costa Rica, Ethiopia, Georgia, India, Mexico, Morocco, Uganda, Ukraine, United Republic of Tanzania and Viet Nam. Some results of the case studies are included in chapter 5 and in the Annex. As the research and literature review for the case studies were initially completed before the outbreak of the COVID-19 pandemic, the impact of the global health crisis, in particular on different economic sectors, is given only limited consideration and the case studies have been lightly updated without the conduct of further detailed research.

2

Literature review on the technological transformation and its implications for skills

Photo by National Cancer Institute on Unsplash

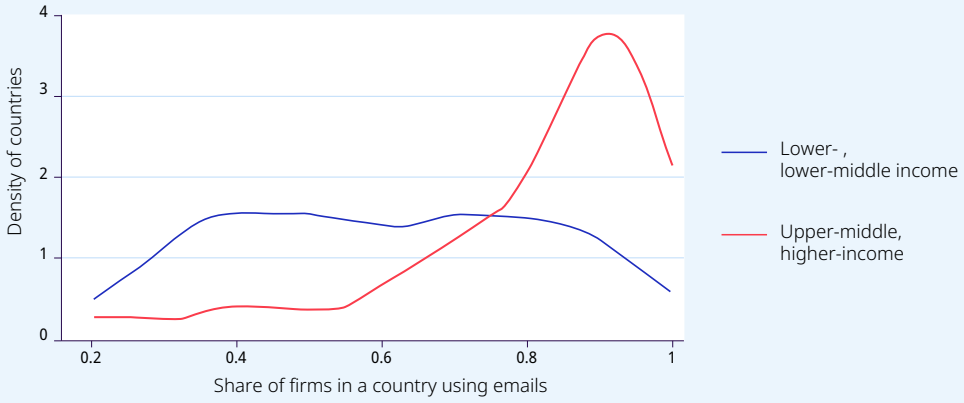
▶ 2.1. Mapping the global level and scope of digital transformation

The rapid pace of technological and structural change brought about by digitization and digital penetration in all economic activities are processes that affect the entire world. According to the International Telecommunication Union (ITU 2020a), there is a continuing, general upward trend in both access to ICTs and in their use. Globally, as of 2020, the share of household with internet access stood at 57 per cent but with significant gaps between urban and rural households (72 and 37 per cent respectively), between males and females (55 and 48 per cent) and between advanced economies and developing countries (87 and 68 per cent, for urban areas, and a much wider gap for rural areas in those two groups of countries: 81 and 28 per cent). In the 52 largest economies with available data, 76.4 per cent of the population owned a mobile phone (ITU 2018). The number of mobile phones exceeded the number of people on the planet, owing to the large number of phones owned by businesses. In the middle of 2020, there were an estimated 105 mobile-cellular subscriptions per 100 inhabitants, with a slight decrease registered during the COVID-19 pandemic (ITU 2020a).

Businesses are increasingly leveraging technology to harness their productivity and competitiveness potential and, especially in the context of the global COVID-19 pandemic, to allow for remote interactions and sustained operation. According to the World Bank Enterprises Survey data, in 139 countries in and around 2015, among formal companies with at least five employees operating in the manufacturing and services sector, the share of those having a website stood at 45.5 per cent and the share of firms using email to interact with clients and suppliers at 70.3 per cent. These differences, however, hide important disparities of digital technologies adoption across regions and countries at different levels of development. For example, the email use by firms has been the highest in Latin America (at 86.9 per cent) and Europe (at 84.7 per cent), and the lowest in sub-Saharan Africa (58 per cent).

Even within regions, however, the differences are striking. For example, in sub-Saharan Africa, in 2016–2018, less than one fourth of all of firms used email in Chad and Nigeria, in contrast to nearly 70 per cent in Benin, Ghana, Mali and Senegal. In Asia, firms' use of email ranges from less than one fourth in Iraq and Myanmar to 54 per cent in Pakistan and 85 per cent in China. In upper-middle and higher-income countries, a much higher share of firms use email than in lower and lower-middle income countries (figure 1). Differences are also observed across sectors of activity: in most regions, firms in services are more likely to use email than firms in manufacturing (table 1).

▶ Figure 1. Distribution of firms using email, by country's level of development



Source: Author's own computations based on the World Bank Enterprise Survey, 2019.
Notes: Data for 120 countries, survey years 2010–2018 (latest available data).

▶ Table 1. Incidence of email use by firms; as percentage of all firms, by region and sector, circa 2015

Region	Manufacturing	Retail and wholesale trade	All other services, including hotels, restaurants, and transportation
Africa	48.47	46.63	51.21
East Asia and Pacific	68.55	62.00	72.23
Europe and Central Asia	84.58	79.67	80.38
Latin America and Caribbean	85.58	84.17	88.35
Middle East and North Africa	31.91	44.28	43.60
South Asia	46.59	42.74	51.27

Source: Author's own computations based on the World Bank Enterprise Survey, 2019.
Notes: Data for 120 countries, survey years 2010–2018 (latest available data).

Looking beyond simple issues of connectivity, email usage and mobile network, digitalization is tightly linked to the rate of adoption of advanced technologies, namely AI, cognitive technologies, blockchain, distributed ledger technologies (DLT), extended reality technologies, internet of things, cloud computing and big data. Such technologies, being disruptive in nature, have been the driving force of innovation and transformation, offering immense prospects for restructuring the economy. While the disruptive impact on jobs of the adoption of AI is widely discussed in the literature, as indicated throughout this report, its potential is also recognized, in terms of increased productivity, the facilitation of data-driven decision-making and the freeing up of workers to concentrate on less-mundane tasks (EGFSN 2018). As AI-related innovations and penetration across economic sectors affect the way in which businesses operate, they are also rapidly transforming jobs and tasks, and related skills needs.

The use of AI and machine learning reaches well beyond advanced manufacturing, including their use for such functions as operational decision-making in retail or personal injury claims in financial services (Deloitte 2019). With industries and countries around the globe increasingly investing in development of AI capabilities to stay competitive, AI investment is forecast to increase by a factor of more than two and a half by 2023 (IDC 2019), indicating the greater expected impact on jobs, tasks and skills. According to the business intentions by 2025 as recorded in the latest report by the World Environment Forum (WEF), AI is experiencing its most extensive applications in the sectors of ICT, financial services, healthcare, and transport (WEF 2020d).

In recent years, blockchain and its underlying distributed ledger technology have been viewed as a promising tool to revolutionize a wide range of industries, markets and public sector domains, from e-government to global supply chains, financial services and healthcare. Some notable advantages of a distributed ledger, such as decentralization, greater flexibility, greater transparency and an audit trail, are already being realized as business benefits (WEF 2020a). For example, in the pharmaceutical industry, blockchain solutions are deployed for product provenance, track-and-trace and supply chain governance (Deloitte 2017). In logistics industry, blockchain is used for digitizing trade workflows and end-to-end shipment tracking (IBM 2018). Some estimates suggest that it would take another decade for blockchain to become prevalent in supply chain management (Cowen 2018), indicating that its impact on trading sectors and their value chain is likely to grow in future.

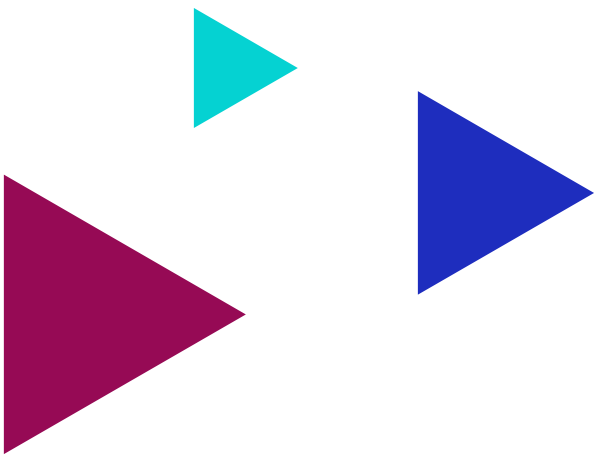
The adoption of advanced digital technologies by businesses is uneven. Over the period 2013–16, five economies accounted for 72 to 98 per cent of the top 25 fast-accelerating digital technologies (OECD 2019e). Industrial robot installations experienced an annual growth rate of 11 per cent between 2014 and 2019, but that rate has been declining in all major markets in recent years owing to the global economic downturn and trade tensions (IFR 2020). The outlook suggests that a major contraction in industrial

robotization is expected in the short run due to the economic crisis caused by the pandemic but that, in the medium to longer term future, this crisis will boost digitalization and the robotics industry worldwide (ibid.). Just five countries – China, Germany, Japan, the Republic of Korea and the United States of America – account for 73 per cent of the total global robot installations (ibid.).

In 2018, the IDC estimated that every connected person in the world on average would interact with devices forming part of the so-called "internet of things" (IoT) devices nearly 4,900 times per day by 2025 - that is about one interaction every 18 seconds (UNCTAD, 2019). Yet, investment in the IoT remains highly concentrated in the top seven countries (the United States, followed, in order, by China, Japan, Germany, the Republic of Korea, France and the United Kingdom of Great Britain and Northern Ireland) which account for nearly 75 per cent of worldwide spending on IoT (ibid).

Similarly, worldwide, artificial intelligence patents have increased six-fold between 2006 and 2016, creating the sentiment of vastly accelerating technological change (Ernst et al. 2018). Most of this increase is led by the United States, however, limiting access by other countries to patents that could be beneficial for their economic development (ibid).

It is clear that those businesses that will be first-movers and leaders in the adoption of these and other more sophisticated digital technologies will also be the ones putting up the strongest resistance to – and mastering – globalization pressures and competition. Yet, in order to embrace technologies, businesses also need a workforce that is able to use technologies. Furthermore, the key business players will be those who can rely on workforces capable not only of using existing technologies, but also adopting new ones and creating still newer ones. Thus, an additional development gap is growing between large businesses, in particular those in developed countries, which can invest in both technological advancements and talent, and small and medium enterprises, in particular in developing countries and the informal sector, which lack such capabilities. Skills shortages and gaps are increasingly seen as a major barrier to technology deployment, and also to the more equal distribution of benefits of technologies across firms, industries and economies and within societies.



▶ 2.2. Employment changes induced by digital transformation

Digital transformation carries sizeable employment challenges. It creates – and will continue to create – new direct and indirect jobs, roles and tasks, but it also destroys many others (Nübler 2016; see also Ernst et al. 2018 for a review). At the same time, the total employment effect of the digital revolution is hard to foresee. Some researchers indicate that the broader adoption of technology, whether digital or digitally induced (robotics and automation), is more likely to lead to net job losses or to exert downward pressures on wages (Frey and Osborne 2017; Arntz et al. 2016; Decanio 2016). In the countries of the Association of Southeast Asian Nations (ASEAN) alone, it is estimated that, over the next 20 years, more than 60 per cent of workers in Indonesia, Philippines, Thailand and Viet Nam will be susceptible to automation in sectors such as electrical appliances and electronics. Moreover, over 80 per cent of workers in the textile, clothing and footwear industry could be substituted by automation in Cambodia and Viet Nam (ILO 2016a). Other observers, however, point to the difference between jobs and tasks that "can" be automated, and those that actually "will" be automated, mitigating such alarmist concerns (for an overview, see Kucera 2017).

Ultimately, the repetitive nature of tasks performed in jobs requiring routine skills and their susceptibility to substitution by technologies only indicates the potential of such substitution. The degree of job automation and its impact on the speed of the employment adjustment should be viewed instead in a much broader perspective.

On a global scale, the extent to which digital disruption across countries will translate into employment and occupational changes will also depend on many other factors, including the availability and quality of digital infrastructure (physical networks, software and data), structures of global value chains, current local employment structures, job content, the applicability of digital technologies to different existing kinds of work, the speed of adoption of technologies, their cost-effectiveness as compared to existing technologies (including still relatively cheap labour in many parts of the world), skills availability, access to credit enabling the processes of technological reorganization, investment and trade policies (UNCTAD 2018).

In some sectors, the technologies for extensive automation do not yet exist, thus the speed of employment effects will also depend on the development and commercialization of new automation technologies. In least developed countries, the occupational structure is still oriented towards agriculture and subsistence farming; many of their workers are informal and self-employed. The skills content within the same jobs in developing countries is much less standardized than that in developed countries (Dicarlo et al. 2016). Technological adoption may be slower, with slower disruptive effects. But much also depends on factors such as digital policies and digital investments, which may enable developing countries to leap forward and gain access to the very latest technologies, thus being able to compete on a more level playing field with industrialized countries. In this case, digital skills will have to be adapted much faster to the newest technologies.

To date, job losses due to technological changes, including digitalization, have been concentrated mainly in manufacturing and parts of the services sectors. They primarily concern routine jobs, such as machine operating, bookkeeping, data entry, jobs in processing and logistics. Experts in digitalization and robotization agree that displacement risk is indeed high for tasks that can easily be performed by software-driven robots, including in many services sectors where digitalization and artificial intelligence have come to play a bigger role (ILO 2018a).

The higher the IT content in job tasks, the lower the risk of job automation (OECD 2019e). For that reason, the economies where digitalization has already penetrated in job tasks of all economic sectors, have lower risks of job losses due to automation. By contrast, economies whose jobs have low digital content and with a high share of routine jobs in manufacturing must ready themselves for a higher degree of automation in the coming years.

Yet, the likelihood of automation is not only limited to jobs with routine tasks. Recent advances in machine learning, AI and big data are increasing the likelihood of automation for formerly sheltered jobs with non-routine cognitive and manual tasks (Eurofound 2018). For example, cutting-edge technologies have opened up the possibility for tasks, known to require complex decision-making, creativity and problem-solving skills or human physical presence and manual dexterity, such as medical diagnosis, caring, cleaning and driving, to be automated (ibid). Table 2 provides examples of employment changes which are either already occurring or are predicted to occur.

▶ Table 2. Examples of employment changes and their implications for skills

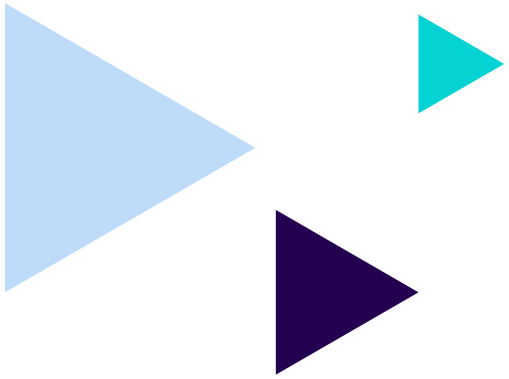
Expected employment changes	Source
"Forty three percent of businesses surveyed indicate that they are set to reduce their workforce due to technology integration, 41% plan to expand their use of contractors for task-specialized work, and 34% plan to expand their workforce due to technology integration" (p. 5). Furthermore, "15% of a company's workforce is at risk of disruption in the horizon up to 2025, and on average 6% of workers are expected to be fully displaced" (p.8).	WEF, 2020e
About 14% of jobs on average across OECD countries are at high risk of automation, and another 32% of jobs are likely to change radically as individual tasks are automated.	OECD, 2019f
United States: 47% of jobs susceptible to the risk of replacement by automation.	Frey and Osborne, 2015
United States: only 9% of jobs are at risk of automation, if due account is taken of the heterogeneity of job-level tasks.	Arntz et al., 2017
While less than 5% of all occupations can be automated entirely using demonstrated technologies, about 60 per cent of all occupations have at least 30 per cent of constituent activities that can be automated.	MGI, 2017a; Chui et al., 2016.
ASEAN-5: 56% of jobs are at risk of automation over the next 20 years, with up to 70% of all workers in Viet Nam and 89% of wage workers in the Philippines	Chang and Phu, 2016; ILO, 2016a
Recent research based on CEDEFOP's European skills and jobs survey (ESJS) data suggests that only 14% of EU jobs face a high risk of automation, with most related tasks substituted by machine learning algorithms	CEDEFOP, 2019
Western Europe: 8.3 million jobs lost in industry against 10 million new jobs created in services by 2035.	Berger, 2016
38% of jobs in the United States, 30% of jobs in the United Kingdom, 21% of jobs in Japan and 35% of jobs in Germany at risk to automation.	PwC, 2018
1.2 billion full-time equivalents and $14.6 trillion in wages are associated with activities that are automatable with current technology. This automation potential differs among countries, ranging from 40% to 55%.	Chui et al., 2017, based on 46 countries, representing about 80% of the global workforce
Developing countries: Two thirds of all jobs could be susceptible to automation in coming decades, from a purely technological standpoint	World Bank, 2016

Source: ILO (2019a) and Balliester and Elsheikhi (2018), with adaptations and further sources as per the table.

Digitalization and automation also induce job polarization. There is evidence that the share of employment in high-skilled and in low-skilled occupations has been growing, while that in middle-skilled occupations is declining (Ernst et al. 2018; OECD 2016b; World Bank and IMF 2016; Brookings 2016).[1] Moreover, if not retrained, many of the displaced middle-skilled workers may be forced to accept lower-skilled and lower-paying jobs, thus putting further downward pressure on wages in the low-wage sector (Dauth et al. 2017). However, with the global trend of increasing levels of educational attainment, the low-skilled workers who are not able to adapt to new technologies and working practices also face the risk of losing their jobs due to increased competition for jobs from relatively better educated workers (OECD, 2019f). This job polarization will be all the more accentuated in the absence of effective transition policies, including adequate opportunities to acquire new relevant skills.

Reskilling and upskilling workers can help them to move from one occupation to another or adapt to new job requirements in the context of rapid technological transformation. Companies estimate that some 40 per cent of workers will require reskilling of up to six months' duration and 94 per cent report that they expect employees to pick up new skills on the job (WEF 2020d). Yet, participation in job-related training is lowest among those whose occupations are most likely to be transformed as a result of digitalization (Orlik et al. 2018). According to the survey run by the Organisation for Economic Co-operation and Development (OECD) Programme for the International Assessment of Adult Competencies (PIAAC), while 67 per cent of people in jobs within the lowest decile of automatability report taking part in at least one type of job-related training in the last 12 months, only 31 per cent of workers in the highest decile of automatability report having attended the relevant training (Nedelkoska and Quintini 2018).

While the net employment effects of digitalization and technological transformation are likely to be positive in the long run, the transition in short and medium term may turn out to be painful. Regardless of the overall employment effects, the remaining jobs will have to be transformed. The challenge, thus, is the ease with which workers will be able to transition from old to new jobs and perform new tasks within old jobs. Because this challenge is mounting over other challenging trends – including globalization, climate change, demographic shifts and widening inequalities – if left alone, digital transformation may not be able to deliver on the developmental promise (ILO 2019a; see also Balliester and Elsheikhi 2018 for a review). These challenges are being further disrupted by the COVID-19 pandemic and the subsequent economic crisis. Transitioning to the digital future where more jobs will be created is a policy choice, requiring not only market adjustment, but also societal learning processes, and general social and political transformation (Nübler 2016).



1 Some of these effects may, however, be contestable: middle-level jobs may also be disappearing because they are most susceptible to offshoring. At factory level, there are examples of how automation may boost middle-skill job numbers at the expense of low-skill jobs or provide a path for middle-skilled workers to advance to technician levels.

▶ 2.3. Changes in occupations and tasks and their implications for skills

Digital transformation not only means that some jobs will disappear, but also that most of the existing work tasks within traditional jobs will be modified (OECD, 2016a, 2016b, 2017a and 2017b; PwC, 2018). The exact modification depends on the type of tasks within each job, and how technology can either complement, or substitute, workers in these tasks (World Bank, 2016), or how it can modify existing tasks. For example, it is estimated that in 32 OECD countries, 32 per cent of jobs are likely to see significant changes in how they are carried out (Nedelkoska and Quintini 2018).

According to McKinsey Global Institute (2017a), few occupations can actually be fully automated; that said, however, in 60 per cent of all occupations, at least 30 per cent of the activities are technically automatable. Such automation of parts of jobs does not necessarily imply a reduction in the amount of work to be done, and therefore does not necessarily imply a reduction in numbers employed to do the jobs; but it can imply that jobs will become more complex, being supplemented with additional tasks that are harder to automate and also tasks related to the use of technology itself. In a similar vein, according to WEF (2020e), it is expected that, by 2025, the time spent on current tasks at work by humans and machines will be equal. This is expected eventually to affect not only the information and data processing and information search and transmission tasks performed in an organization, not only with repetitive tasks in production lines, but also those tasks which at the current time are still entirely human performed, including communicating and interacting; coordinating, developing, managing and advising; and reasoning and decision-making (WEF 2018a).

Many of today's tasks will be complemented by technology. This means that businesses will increasingly demand that workers possess skills allowing them to perform non-routine tasks which technology augments rather than replaces (World Bank 2016). For example, with important investment in assistive technologies, many care jobs are already heavily affected by automation in some countries, such as Germany. This affects the content of care jobs in which technology competencies are becoming more important and tempers the rapidly growing demand for care workers that is being created by the ageing of populations and enhancement of healthcare. In the education sector, the rise in technology-enabled self-paced learning and in blended learning approaches is affecting skills requirements in handling software, learning platforms and resources, and also in related pedagogical skills (ILO 2021a).[2]

There will also be demand for new tasks, including in new occupations (table 3), which will increasingly require conceptually new vocational training and tertiary education. Occupations such as specialists in AI and machine learning, process automation experts, information security analysts, user experience and human-machine interaction designers, software engineering and data science, and robotics engineers will be increasingly sought after as the technologies on which they work mature and become more mainstream. But as digitalization is spreading fast into various domains, and technological changes are very rapid, existing formal training programmes may not be catching up with the changing skills demand. As a result, digital skills gaps prevail and this could hinder effective innovation and adoption of new technologies. For instance, according to WEF, 55 per cent of the companies that took part in the Future of Jobs survey identified skills gaps in local labour market as the biggest barrier to adoption of new technologies (WEF 2020e).

Some sectors, however, are feeling the shortage of skills more strongly than others: for instance, in the financial sector three out of four companies saw the lack of skills as a major barrier (WEF 2018a). Skills gaps go beyond basic digital skills and include specialized digital skills shortages which are

2 High-level overview of how digitalization is affecting TVET and skills systems is available in the joint ILO-UNESCO report (ILO, 2020e).

becoming increasingly evident. For example, according to the International Information System Security Certification Consortium, known as (ISC)², in 2018 there was a shortage of 2.93 million cybersecurity professionals in the labour market ((ISC)², 2018).

▶ Table 3. Examples of changes in occupations and tasks, and their implications for skills and skills response strategies

Occupational changes	Implications for skills	Response strategies
Jobs and tasks that may decrease in demand or be automated: Routine-based tasks that include predictable physical activities, processing and collecting data, such as machine operators; data entry clerks, accounting and payroll clerks, secretaries, auditors, bank tellers and cashiers, ticket inspectors, postal workers	Technical skills obsolescence	▶ On-the-job training to gain access to new tasks or responsibilities; ▶ Reskilling and upskilling to new occupations through initial or continuing vocational training courses, including publicly funded or co-funded courses and those provided through public employment services and supported by active labour market policies (ALMPs).
Changes of tasks within established occupations Due to technology adoption, such as the growing use of smartphones by farmers; or digitizing of patients' files by medical practitioners	Foundational (literacy and numeracy), core employability skills (such as communication) and the range of technical skills will need upgrading, and can be significantly leveraged by basic and transversal ICT skills.	▶ Initial training, including vocational ▶ Non-formal and informal digital skills acquisition, including massive open online courses (MOOCs) ▶ Relatively short on-the-job training
Due to technology sophistication, such as learning new software and work methods. Examples include: big data analytics or cloud computing for data analysts, data scientists, e-commerce and social media specialists, software publishers	New technical and specialized digital skills may need to be learned or some technical skills upgrading may be needed; advanced digital skills are required and necessitate regular upgrading.	▶ On-the-job training to gain access to new tasks or responsibilities ▶ TVET or university degree ▶ Non-formal and informal digital skills acquisition, including MOOCs
Due to the technology use in leveraging human skills. Examples include: internet content creation and networking for Sales and Marketing Professionals; internet communication, creativity and leadership for Training and Development; Organizational Development Specialists, Innovation Managers	Soft human skills, such as creativity, critical thinking, complex problem-solving, emotional intelligence, resilience and flexibility, can substantially leverage technical professional skills. Transversal ICT skills can augment the value of soft human skills.	
New jobs and tasks: Roles that are significantly based on and enhanced by the use of technology, but also often needed in combination with traditional technical skills, such as AI and machine learning specialists in manufacturing. Examples include: process automation experts, information and cybersecurity analysts, user experience and human-machine interaction designers, robotics engineers, blockchain specialists, cobot trainers	Required are advanced (specialist) digital skills related to understanding and leveraging the latest emerging technologies. Often required are non-IT specialized skills in other domains.	▶ TVET or university degree in cross-specializations ▶ Significant long-term on-the-job training ▶ Reskilling and upskilling through long-term vocational training courses, or longer continuing training ▶ University education

Source: Authors' own elaboration based on WEF (2018); Luksha et al. (2015); McKinsey Global Institute (2017a); World Bank (2016) and wider ILO project experience.

According to research conducted by Nesta (2018), using data of 41 million job advertisements and machine-learning algorithms, not all digital skills will be equally important in the future. The in-demand digital skills in occupations with increasing prospects involve non-routine tasks, problem-solving and the creation of digital content such as graphic and engineering designs, software products and services and analytical outputs (Djumalieva and Sleeman 2018). On the other hand, certain digital skills such as using software for administrative purposes are linked to occupations that are predicted to decline (ibid.) (See further examples in table 3). This implies that a close assessment of the prospect of specific digital skills is a prerequisite before decisions are made to invest in digital skills development (ibid).

Technical digital skills alone will not make it possible to reap the full benefits of digitalization. What is increasingly sought by businesses is a combination of such skills and subject matter skills. As a result, there will be an increasing number of cross-professional, so-called "hybrid jobs" and "hybrid specializations", which will see more elements of technology being integrated into traditionally non-technical positions. Many of these changes are driven by the digital revolution, which is erasing not only occupational, but also industry boundaries (Accenture 2016). Examples of hybrid occupations include pharmaceutical marketing specialists, who are required to have fluency in medical concepts, research methodology regarding drug trials, but also data analysis and digital marketing; or business and economic journalists, who need to have specialized background in economics and statistics, but also to possess writing, interviewing and data visualization skills, and to be at ease with social media.

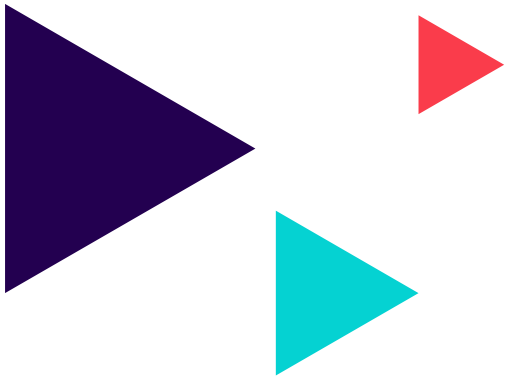
In the culture and media sector, the profession of television reporter now has little to do with the teams of the past comprising a reporter, a sound engineer, a camera operator and a network engineer: as of 2018, it was common for the same person to be responsible for the entire editing and technical process, as well as for editing written texts to be posted on the web, with follow-up on social media (ILO 2019b). Coding skills today are required not only of programmers, but also of artists and designers, engineers and scientists (Burning Glass 2016). Possession of such hybrid assortments of skills will require not only strong initial specialization in both technical and hard knowledge skills, but also lifelong skills upgrading to master technologies and subject matter expertise that do not yet exist.

In order to enhance the adaptive capacity to continually improve skills over the life cycle, digital skills will need to be complemented by a range of non-cognitive social and emotional skills, or core work skills often defined as soft skills, which are often acquired in early childhood and at school (MGI 2017a). A study on the future of skills for the United States and the United Kingdom by Pearson, Nesta and the Oxford Martin School also found that interpersonal skills such as coordination, teaching and social perceptiveness will be in greater demand by 2030 (Bakhshi et al. 2017). It is the appropriate combination of digital, hard technical and core employability skills that will be rewarded at a premium and will provide workers with sound future employment prospects, as they will be able to move easily between jobs, occupations and sectors. More generally, humans will remain integral to the Fourth Industrial Revolution, as it will be their creativity and ideas driving the change. It is humans who will develop and program robots and cobots (collaborative robots), and work alongside them (Gleason 2018).

In a similar vein, a recent report on the jobs of tomorrow by the WEF underlined that "the transition to the new world of work will be both human- and tech-centric" (WEF 2020b). The report identified seven key professional clusters that are expected to create 6.1 million new job opportunities over the period 2020–2022. While some emerging professions such as those in data processing, AI, engineering, cloud computing, product development and green economy reflect the importance of adopting new technologies, others, such as care economy, marketing, sales, content production and people and culture clusters, emphasize the significant role of humans in the future of work (ibid). In addition, the skills most likely to be needed in these emerging professions are both technical and cross-functional and can be broadly categorized into business skills, specialized industry skills, general and soft skills, tech baseline skills and tech disruptive skills (ibid).

It is important to note that these occupational and skills transformations will not equally concern everyone. The gender gap in the level and content of education, if left unchanged, will translate into a gender gap in digital occupations. For example, jobs in the ICT (services) sector, the sector in highest demand and with some of the highest returns on education, are over seven times more likely to be held by men than women (World Bank 2016). At the country level, the gender employment gap among ICT specialists is large in India, Indonesia and Thailand, where women constitute only some one third of all employees and tend to be at a disadvantage in terms of career advancement in the ICT sector (ILO 2019d). Given that this gender gap is partly due to low number of female students in the relevant fields of study and training, a better coordinated and targeted approach to encourage more women to study ICT-related fields and remove gender barriers in digital occupations would be indispensable (ibid).

Technology advancements require different measures of education and training, reskilling and upskilling, and AMLPs (table 3), which should be continued throughout an employee's life and career. This points to the need for a lifelong learning approach in a structure which would include interministerial coordination, social dialogue and a combination of public and private financing of training.



▶ 2.4. Changes in the modes of work and work organization and their implications for the skills change

Digital transformation brings sizeable economic and social dividends, improves efficiency and productivity. Yet, it is disruptive: it brings about changes not only to the products and services, but also to the modes of work, processes, and organizational arrangements.

2.4.1. Non-standard forms of employment

New information technologies, the expansion of telecommunications and internet, and the higher quality and lower costs of digital infrastructure have created environments conducive to the proliferation of non-standard forms of employment, including temporary work, part-time work, temporary agency work, dependent self-employment and disguised employment. This is happening because new technologies modify the way in which businesses manage their human resources, including insourced and outsourced staff. Some of the technological developments, including new software predicting peaks in demand, have enabled businesses to manage their labour demand in a minute-by-minute manner, increasing the need for short-term, part-time and on-call work (ILO 2016b). Others, which allow real-time comparison, organization and the management of fragmented production scattered around the globe, have facilitated the development of global supply chains and outsourcing, with labour contracting and outstaffing as its natural extension (ILO 2016c).

While many businesses have restricted outsourcing to peripheral functions of their business, such as cleaning, IT, distribution, maintenance, or payroll, others have come to rely on non-standard work arrangements for what were arguably core functions of the business (Weil 2014; ILO 2016b). In the EU, in 2019, some one fourth of all the establishments surveyed had relationships with other establishments to carry out certain business activities: 5 per cent engaged in outsourcing and 21 per cent collaborated with other establishments; the highest outsourcing rate was found in the construction sector (10 per cent) (CEDEFOP and Eurofound 2020). Between 2019 and 2022, over half of multinationals in developed and emerging economies were planning to expand their use of contractors doing task-specialized work and remote staffing beyond physical offices, significantly modify their production and distribution value chain, or modify their geographical base of operations (WEF 2018a).

These changes in business organization have profound implications for human resource management by firms, and also for skills. Employers are increasingly adapting their human resource strategies to finding the relevant skills in the market – including internationally – rather than developing them in-house, because they do not want to spend resources on training staff that they would not retain. There is indeed evidence that firms that rely heavily on non-standard work tend to underinvest in training, both for standard and non-standard employees (Lepak and Snell 2002; Kleinknecht et al. 2015; Fagan et al. 2014; Eurofound 2012), creating the risk of insufficient employer-provided training generally. For workers, the implication is that the responsibility of training and skills development has been now increasingly shifted on to them, whereas previously it rested largely with firms (Barley and Kunda 2004).

2.4.2. Gig economy

Another recent technological development is the growth of the so-called "gig economy", also called the "on-demand" or "sharing economy". Forms of work in the gig economy are very heterogeneous, but the main ones include jobs obtained through online labour platforms (also known as crowdwork platforms) and "work-on-demand via app" (De Stefano 2016; Graham et al. 2017). Platform work and work through applications have been gaining prominence in all parts of the world and spreading to numerous sectors

and occupations. They became possible because of technological developments, notably, the easier access to the internet throughout the world, including by mobile phone, and the development of online platforms and apps.

"Work on-demand via app" is disrupting traditional sectors and activities such as transport, cleaning, courier and delivery services, but also some forms of clerical work, which are offered and assigned via mobile apps (ILO 2016b). Work through apps is accessed, selected and agreed upon online, but is then executed locally (Prassl and Risak 2016). While this work usually requires low or middle-level skills, it does also require a reasonable level of digital skills, needed to install an app, set up own account, communicate with the app owners (usually by email) and clients, and cash money.

In contrast, work on online digital platforms is not only accessed online, but is also executed online. According to some specialists, the global market of online platform work was estimated at US$4.4 billion in 2016 (Chew Kuek et al. 2015). The use of online platforms is also estimated to have grown by 25 per cent over the period 2016–2017 alone (Kässi and Lehdonvirta et al. 2018; OLI 2017) and such platforms are forecast to mediate one third of all labour transactions globally within the next decade (Standing 2015). For businesses, "platform ecosystems are nothing less than the foundation for new value creation in the digital economy" (Accenture 2016). Initially led by so-called "born digital" companies, the opportunity to use scalable labour force sourced from the platforms is now open to every company in every industry (ibid).

Online crowdwork platforms position themselves as intermediaries that match demand and supply of labour, putting workers and clients in contact with one another. Clients – whether physical persons or companies – can post tasks, while workers can find those tasks that best match their skills and their availability for doing work. The tasks that can be posted and executed vary tremendously in nature, ranging from microtasks requiring just a few minutes of time for execution and a relatively low level of skill (examples include writing reviews of a product, product categorization, "liking" a webpage) to macrotasks that require considerable time and skill for their execution (examples include website development, statistical analysis and report writing). Consequently, online platforms tend to specialize as platforms offering mostly microtasks, such as Amazon Mechanical Turk, and those offering mostly macrotasks, such as Upwork. Some platforms also focus on a specific field of activity, sourcing highly specialized workers, such as translators, professional writers and editors, IT programmers and developers, designers, engineers, or architects.

Clients posting tasks on these platforms come mainly from developed countries, such as the Australia, France, the United Kingdom or the United States. By contrast, the vast majority of workers performing the tasks are based in middle and lower-income countries. The largest work performers are, in descending order, India, the Philippines, the Russian Federation, Ukraine, Pakistan and China (Graham et al. 2017). In Ukraine, for instance, workers operate on over 40 different platforms, with over two thirds of workers performing tasks fully or partially for clients from abroad (Aleksynska et al. 2018).

Platforms give businesses access to skills that they do not possess and which would be very costly to have on a permanent basis. In addition, they can use the workforce only for those tasks that they need and discontinue the relationship once they are completed, thus making possible a workforce that is available on demand and scalable (Graham et al. 2017). The worldwide distribution of workers means that on-demand staffing and task completion can also be effected on a 24-hour basis (ILO 2018b). Conversely, workers gain access to clients worldwide, "transcending the constraints of their local labour markets" (Graham et al. 2017). This is of particular relevance for workers in rural areas where other job opportunities are stagnant or may not exist (Greene and Mamic 2015; Narula et al. 2011). This is also true for older workers, workers with health problems and disabilities, workers otherwise facing discrimination (such as migrants) and encountering difficulties in finding employment, and for workers who wish to combine labour with other responsibilities, including care for children and for elderly (Graham et al. 2017).

The development of the gig economy has numerous implications for digital skills. First, while many of the tasks are easy and require only basic skills, workers must possess relatively good transversal ICT skills

in order to understand how these digital apps and platforms work. They need to know not only how to manipulate a phone or a computer, but also how to create an account, search and accept online work, and receive and cash money for work through digital media. Complementary soft skills are also required, such as creativity, communications and client orientation, in order to promote their own portfolio, successfully communicate with clients, improve their rating and develop an online reputation. Indeed, an ILO survey of 3,500 workers living in 75 countries and operating on five major global microtask platforms shows that the level of education of workers even performing very simple microtasks is generally high, with the majority of such workers holding a bachelor's or postgraduate degree. Moreover, the fields of study are usually technology and science-oriented: almost two thirds of microtaskers are specialized in science and technology, and a third in economics, finance and accounting (ILO 2018b).

Second, the proliferation of online work contributes to the polarization of skills. On the one hand, workers performing macrotasks, in particular on specialized platforms, are competing with world-class specialists and facing the challenge of constantly upgrading their skills. They choose to specialize in rare and higher-paid tasks, including those of a digital nature. Surveys of online workers show that such high-level specialists view continuous learning as a necessary everyday component of their work success. They study at their own initiative and use a variety of digital tools to upgrade their knowledge (see box 1). On the other hand, workers performing microtasks not only do not need to upgrade their skills, they also risk becoming deskilled. This is because their generally high level of education and digital skills is not matched by the simplicity of the tasks that they perform. Such deskilling disproportionately concerns women (box 1). Moreover, the technologies behind platforms increasingly break down traditional tasks into smaller and simpler tasks, in order to attract the crowd, so to speak, rendering them even more simple (Cheng et al. 2015). Many microtasks (such as object recognition and photo labelling) are used by client firms as inputs for machine learning. As the demand for the latter will only increase, so will the number of simple microtasks of various kinds, further luring relatively skilled workers from developing countries to easy work opportunities.

Some of the performed tasks can also be malicious in nature, such as those contributing to false advertising, creating content access for political campaigns and pushing a specific political agenda, which can have negative societal effects (Choi et al. 2016). Currently, there are no regulations governing such activities. The activities themselves may be well paid, attracting workers in developing countries and remote areas with little outside employment options. Moreover, many young people with good digital skills see them not only as an easy way of earning money, but also as activities with a certain cachet, regarded as "cool" (Kaspersky 2017). More generally, these activities raise the question whether the valuable skills possessed by the workers from developing countries are put to the best use on such platforms, and whether the scarce resources invested in the acquisition of these skills are actually well used (ILO 2018b).

While many platforms offer skills categorization and certification schemes as a key mechanism for matching workers to clients, one key challenge is to facilitate the inter-platform recognition and portability of skills (Lehdonvirta et al. 2019). Specific features of platforms increase the costs incurred by workers in switching from one platform to another, and thus potentially create obstacles to job mobility. For example, platform workers usually lose their personal work histories upon changing platform and this may tie the workers to certain platforms (ILO 2018b). Recent research shows that platforms workers will increase their earnings by obtaining skills certificates, thus making their skills more visible to employers and decreasing employer uncertainty (Kässi and Lehdonvirta 2019), and inter-platform recognition and the portability of certified skills are therefore important for worker's employability. It remains a challenge to convince platform businesses of the need for such recognition, since they generally consider it unprofitable to widen the profiles of their workers.

Proliferation of the sharing economy has also meant that, with few borders in the online labour markets, workers search specialized vacancies in either local or global labour markets. They thus need to adapt their knowledge, language skills and, sometimes, cultural awareness to work possibilities provided by internationally operating platforms. Knowledge of English, and also of other widely spoken languages, including Spanish, French, Russian and Arabic, considerably enlarges their ability to reach clients from other countries, including those with higher standards of living and willing to pay higher rates. They constitute important multipliers for digital skills.

Some governments, such as those of Malaysia and Nigeria, have conceived specifically dedicated digital strategies to harness the developmental benefits of their workers' access to online platforms, including through modifications brought to publicly provided education and training and through workshops to explain to workers how platforms operate (Graham et al. 2017). Yet, the risks are that workers will spend considerable effort in laboriously acquiring skills that bring short-term gains in a relatively narrow set of tasks to be performed online, but which do not always result in a productive activity adding value to the country or region in which they live (ILO 2018b).

▶ Box 1. Skills for online platforms: evidence from Ukraine

In 2018, the ILO conducted a survey of online platforms workers in Ukraine, a country occupying the first place in Europe, and the fourth place in the world, in terms of the amount of work performed online.

The survey revealed that the most demanded spheres of platform work were working with texts, such as copywriting and rewriting (23 per cent of all respondents performed such tasks); IT (12 per cent); filling in opinion polls and questionnaires (8 per cent); sales, photo and video (6 per cent each); microtasking including collecting and processing information (5 per cent each); design, translation and consulting (4 per cent each). A closer analysis of IT tasks showed that the most popular areas are website creation and maintenance, including Hypertext Markup Language (HTML) and Cascading Style Sheet (CSS) coding; testing; programming for mobile platforms and for personal computers; microcontroller programming; modelling and 3D graphics; and system programming.

There is a strong gender segregation in terms of performed tasks. IT is strongly dominated by men (88 per cent of IT workers are male). Other male-dominated spheres are design, sales, and video or photo work (with 61 per cent, 68 per cent, and 64 per cent of men in each field respectively). By contrast, women dominate translation (74 per cent of which is performed by women), other types of work with texts (72 per cent), review writing and completing polls and questionnaires (61 per cent), teaching and tutoring (70 per cent), and microtasking (55 per cent). In addition, there is also strong task segregation along the market served. Over 80 per cent of workers specializing in the IT sector, consultancies and microtasking have at least some clients who are non-Ukrainian, most of these being located in developed countries. By contrast, only 60 per cent of workers specializing in text processing have non-Ukrainian clients, and many of those are from neighbouring Russian-speaking countries. Gender-biased task segregation, coupled with market segregation, translates into a significant gender pay gap in online work, which is considerably higher than in the Ukrainian offline economy.

The majority of respondents perform jobs in fields unrelated to their formal training. In addition, when questioned about the level of their skills in relation to the requirements of the tasks that they have completed over the last three months, 33 per cent said that they needed further technical training; 23 per cent believed that they needed to improve their English to gain access to more and better jobs; and 10 per cent believed that their skills were more advanced than necessary for doing the tasks on the platforms where they worked. Only 31 per cent felt that they had a perfect match of skills to perform work on the platforms on which they usually worked, and workers with one or two years of experience were most represented in this group. The most heterogeneous group was constituted by workers who performed mainly editing and writing tasks: their share is the largest among workers claiming to have the best match of skills, as compared to workers performing other tasks; but their share is also the largest in the group of workers who believe that their skills are more advanced than necessary, and in the groups of those who need to improve their English. Recalling that these tasks are performed mainly by women, it may be stated that the effects of over-education and perhaps of some deskilling on the platforms are most keenly experienced by women. Interestingly, in the group of workers who would need more technical training in order to gain access to more and better jobs, IT specialists represent the largest share.

The majority of respondents also stated that they were constantly working on improving and developing their skills and learning. This takes place mainly at their own initiative. In order to improve their skills and competence, workers use a variety of tools, including open online learning tools, video courses freely accessible through YouTube, specialized websites and forums, and specialized electronic books.

Source: Aleksynska et al. 2018

3

COVID-19 and digitalization, and the implications of this process for skills

▶ 3.1. Labour market consequences of the pre-existing digital divide during the pandemic

There have always been disruptions and changes in the world of work and learning but the COVID-19 pandemic has brought even more disruptions, occurring at a hitherto unheard-of pace and scale. In a matter of weeks, the world witnessed an unprecedented global shutdown with mass closures of industries and businesses, and also of educational and training institutions in an attempt to contain the spread of the virus. Consequently, many individuals were furloughed or lost their income and livelihoods, and students and trainees experienced serious disruptions to their learning.

According to the ILO's recent global estimates, 8.8 per cent of working hours were lost globally in 2020, equivalent to 255 million full-time jobs (ILO 2021a). The recurring waves and outbreaks of the COVID-19 pandemic and ensuing strict public health measures mean that global working-hour losses remain high in 2021, reaching an estimated level of 4.4 per cent in the second quarter of 2021 (ibid). Although both men and women suffered from the labour market disruptions, the adverse impact was much greater for women than men, and for young workers than older workers (ibid).

Yet, despite massive shocks, the economy and society kept functioning during the COVID-19 pandemic, largely thanks to digital technologies. Since the onset of the pandemic, a significant proportion of the global workforce has switched to teleworking, using tools such as virtual private networks, videoconferencing and cloud services. Consumers and businesses alike have gone digital to a greater extent, purchasing more goods and services online and embracing more digital channels and automating processes. The rapid adoption of digital technologies driven by the global health crisis will continue once the pandemic is over, accelerating changes in the mode of work and work organization, and skills requirements in labour markets.

It is, however, important to note that not everyone was able to reap the full benefits of the digital acceleration during the crisis. Only those workers in teleworkable occupations and sectors with the necessary technological infrastructure could make a shift to working from home (ILO 2021d). It was much more likely that higher-skilled white-collar workers could telework during the pandemic than low and middle-skilled blue-collar workers, and employment losses were far smaller in occupations where telework was feasible (ILO 2021a). The capability to switch to remote working not only varied within countries but also between countries, depending on the labour market structures and availability of adequate infrastructure (ILO 2021d).

Even before the pandemic, there was a significant gap between countries with different levels of income in the digital connectivity and the scale of technology usage. During the COVID-19 crisis, the countries which moved fastest towards digital and technological modes of working were those whose digital systems were already relatively well developed (IFC 2020). Those countries already well equipped with adequate infrastructure, available technology solutions and skilled digital workforce were better positioned to turn this crisis into an opportunity and make further steps to digital transformation. This difference is also observed within countries, in particular between urban and rural areas (ibid). Given this context, the impacts of the accelerated digitalization on jobs and related skills are likely to differ between and within the sectors and countries.

The COVID-19 pandemic has not only revealed but also aggravated the existing digital inequalities affecting workers and learners across the world. Although various policies and measures were immediately put in place to minimize any adverse impact, increased digital disparities can have long-term negative consequences in the labour and skills markets if not adequately addressed. It is therefore vital to understand the lasting impact of the crisis-driven digital transformation on the current and future demand for jobs and related skills, and to remain constantly abreast of the evolving situation in the ongoing digital transformation, with a view to informing relevant policy formulation and implementation.

▶ 3.2. Digital acceleration and its effects on sectors

The upsurge of digital consumption accelerated by the pandemic is propelling the expansion of e-commerce, logistics, digital media and digital financial services sectors, along with the demand for related skills. For example, according to the analysis made by LinkedIn of jobs trends for 2021 in 19 countries around the world, the most in-demand jobs and skills are related to e-commerce and logistics, such as those of online specialists, e-commerce coordinators, supply chain assistants and warehouse team leads. As for skills, there is an increasing demand for digital marketing, search engine optimization, warehouse operations and inventory management skills (LinkedIn 2021b).

As consumers' digital engagement in knowledge and information sharing, online entertainment and social networking increased during the crisis, the use of digital media for businesses has become even more important than before. This has pushed up the demand for digital content creators, content coordinators, podcasters, social media managers and digital marketing specialists in many countries (ibid). In addition, users are increasingly turning to digital methods to access financial services and the fintech market has shown strong growth during the crisis, particularly in emerging and developing countries (World Bank and WEF 2020). This is driving changes in the sector's skills profiles, which were already under way, requiring more skills to meet the growing needs created by the digitalization process. Various studies anticipate that many of the recent changes in customer behaviour and business models are likely to persist well beyond the pandemic.

The current pandemic has also brought to light the importance of embracing digitalization in the healthcare sector. Telemedicine helps individuals to access healthcare services while minimizing risk and exposure to COVID-19 for both the patients and the healthcare professionals (WHO 2020a). Digital tools such as digital contact tracing apps are used to monitor the spread of the novel coronavirus (ibid). AI and machine learning are increasingly being harnessed to facilitate faster diagnosis, medical research, treatment and early warning of future health crises (WEF 2020e).

Although issues related to equity and accessibility, and also data privacy and security in the digital health sector still remain to be settled, improved attitudes by consumers towards telemedicine are expected to support the digital health transformation in the post-pandemic world (MGI 2021a). Yet, it is important to note that the potential to enhance health systems in delivering quality services with better use of digital technologies can only be tapped when health professionals with the requisite skills are available to support the digital health transformation.

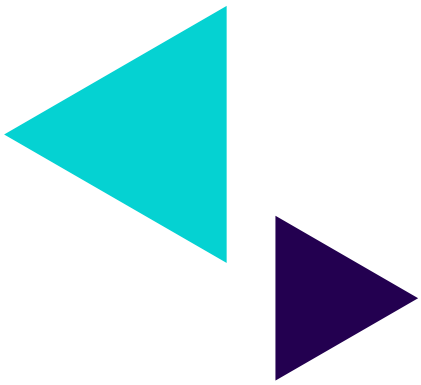
In this digitally accelerated world of work, employers across different sectors had to find a way to close the skills gaps arising from the pandemic and some have chosen to train their employees to adapt their skills and roles to the evolving situation. For example, findings from the comparative study of rapid assessments of reskilling and upskilling needs due to the COVID-19 crisis in nine African countries show that, on average, 58 per cent of surveyed employers responded that they provided training to their existing employees during the COVID-19 pandemic with some difference across sectors. Employers in the services sector provided the most types of training to their employees, while agricultural firms were less likely to provide training during the pandemic (ibid). Where the training was taking place, 87.7 per cent of the surveyed employers focused on health and safety training, 43.6 per cent on the use of digital technologies for communication and 28 per cent on the use of digital technologies for internet connection (ibid). The latter two training areas were given particular priority by larger establishments and those in the services, industrial and construction sectors, compared to those in the agricultural sector (ibid).

This trend will not slow down as the businesses learned through the pandemic that the uptake of those technologies holds the key to remaining competitive in this uncertain economic environment and to building resilience and agility for the future. For example, according to the study by the IBM Institute for Business Value (IBV), high-technology adopters outperformed their peers during the pandemic by an

average of 6 percentage points in revenue growth, in 12 out of the 18 industries analysed (IBM 2020a). In a related research exercise, 60 per cent of the surveyed executives around the world [3] responded that they were stepping up their companies' digital transformations during the pandemic (IBM 2020b). Executives indicated that they would include investment in technologies such as AI, IoT and blockchain in their COVID-19 recovery planning (ibid). Similar trends are also observed in various surveys and studies on this topic.

The heterogeneous nature of the adoption of digital technology across countries and across sectors means, however, that the global workforce has been exposed to digital technologies to a different extent. According to a McKinsey global survey of 800 executives, the greatest acceleration of digitization and automation has been observed in the financial services and technology sectors since the outbreak of COVID-19 (MGI 2020a). Although the crisis has fast-forwarded the digital transformation across many sectors, the level and pace of the uptake of those technologies vary and the difference may widen further in future.

Although it is impossible to envisage accurately how the accelerated digitalization would play out in the post-pandemic world and to predict its impact on the future labour market, some trends are clear. The pace of adoption of core technologies of the fourth industrial revolution such as AI, big data, IoT, cloud computing and robotics, and the concomitant processes of automation and digitization are likely to accelerate further in the post-pandemic world (WEF 2020c). Since the COVID-19 outbreak, those technologies are increasingly being used in a variety of domains such as healthcare, manufacturing, banking, retailing, and logistics and transportation to cope with changing demands and facilitate business continuity.



3 The survey, which was conducted in collaboration with Oxford Economics, collected responses from 3,450 executives in 22 industries and 20 countries from April to June 2020.

▶ 3.3. Impact on the way we learn

At the peak of COVID-19-induced closures of learning institutions in April 2020, nearly 1.6 billion learners were adversely affected (UNESCO 2020). Students and trainees in technical and vocational education and training (TVET) in particular faced greater challenges as the effective acquisition of practical skills and work-based learning, including apprenticeship training, which is an essential component of TVET, could not be achieved remotely (ILO et al. 2021). As the pandemic shows no signs of weakening, many education and training institutions are still struggling to cope with a constantly evolving situation, which will ultimately influence the learning prospects of individuals.

While learners in countries that have been well equipped to switch to online learning could continue their learning journey, those in countries that have not been equipped with adequate infrastructure or resources to support the uptake of digital learning approaches faced greater challenges (UNESCO 2020; ILO et al. 2021). This was probably more the case in the TVET fields where prolonged underinvestment in digital technologies and related skills development had slowed down the digitalization process (ibid). In addition, the digital divide, including the digital skills divide, even within individual countries, prevented the provision of equal quality educational and training opportunities for all learners, in particular for those from low-income households (ibid).

The COVID-19 pandemic and the sudden increased need for distance learning and training have turned a spotlight on the education technology sector, also referred to as "edtech". Education and training institutions and their students and trainees increasingly adopted a wide range of education technologies to mitigate the impact of the closures of learning institutions. The findings of a global interagency survey of the effects of the crisis on TVET provision show that the crisis triggered a rapid uptake of distance learning approaches in TVET.[4] Thus, the majority of TVET respondents in 46 out of 92 countries reported the provision of courses that were entirely based on remote learning during the pandemic, whereas, prior to the COVID-19 outbreak, there were only 13 out of the 92 surveyed countries in which a majority of TVET respondents used to provide online distance learning regularly or often (ILO 2021c).

The most common tools used for this purpose included video conferencing, video recordings, discussion forums or platforms and virtual learning environments. Some respondents also reported the use of simulation software such as STR, Opera and Amadeus for training, along with various social media platforms and communication tools to facilitate interaction and coordination between trainers and students (ibid). The crisis has created opportunities to trial digital approaches to the delivery of education and training.

Although challenges related to general and technological infrastructures remain to be resolved, it is clear that education technology has immense potential to enhance the teaching and learning experience and to improve access to learning and skills recognition and this potential must be further harnessed. To achieve this, workers in the education and training sector, ranging from teachers, trainers and administrators to education and training support personnel, would need to develop relevant skills to effectively integrate technology into education and training delivery.

4 An interagency survey on TVET and skills development in the time of COVID-19, targeted at TVET providers, policymakers and social partners, was implemented by the ILO in collaboration with UNESCO and the World Bank over the period from 5 April to 15 May 2020. The survey, which collected data from 1,353 respondents, representing 126 countries, captured the main challenges faced by TVET institutions during this crisis and brought to light innovations in teaching and learning.

▶ 3.4. Impact on the way we work

Another clear trend that has emerged from the pandemic, coupled with accelerated digitalization, is the massive increase in the number of people working remotely. Wherever possible, this is likely to continue well beyond the pandemic, probably involving hybrid models of remote and face-to-face work (WEF 2020d; MGI 2020a; OECD 2021). According to the WEF Future of Jobs Survey (2020),[5] over 80 per cent of the surveyed employers reported that they are accelerating the digitalization of work processes and expanding remote work opportunities. Furthermore, there has been a surge in the labour market for remote jobs since the onset of the pandemic, driven by strong demand from both sides of the market – employers and jobseekers (LinkedIn 2020; Glassdoor 2021).

With fewer locational constraints, this shift can provide employers a better access to the pool of talents with diverse skills and open up more opportunities for job seekers or employees, facilitating a movement of skills around the world (LinkedIn 2021a). For example, employers based outside the large cities can attract and source talents more easily and the workers may not necessarily have to live in major urban areas to get better jobs (ibid). It also has the great potential to offer people with disabilities, women, young people and migrant workers flexible opportunities to participate in the labour market (ILO 2021e).

On the other hand, it may mean more competition globally among workers with the same skills with potentially downward pressure on income (ibid). Added to which, many workers would have fewer opportunities to engage in learning activities, in particular informal activities that take place through in-person interactions with colleagues at the workplace (OECD 2020a). This trend may have a longer-term impact on the labour market, including how and where the work is performed, how business hire and organize their work, and who takes responsibility for training and skills development, while further reinforcing the growth and impact of the digital economy.

The rise of remote work increases the dependence on data, software and networks, and will require employers to invest more in data security and migration to the cloud to enable effective and safe remote working (Burning Glass 2021). This trend will obviously drive a stronger demand for skilled workers in certain roles such as cybersecurity, cloud computing and networks systems (ibid). In addition, those workers entering into remote working arrangements would require at least basic digital skills and strong soft skills such as communication, adaptability, collaboration and emotional intelligence to carry out tasks effectively in a remote environment. Furthermore, employers considering the adoption of remote work as a more permanent option beyond the pandemic would need to craft skills and training strategies that are also adapted to working remotely (ILO 2021f).

5 The global survey dissemination took place during the first half of 2020. The final sample comprised 15 industry clusters and 26 countries, which collectively represent 80 per cent of the world's GDP. In total, the report's data set contains 291 unique responses by global companies, collectively representing more than 7.7 million employees worldwide.

▶ 3.5. Changes in demand for skills

In this rapidly evolving technological landscape, both generic and specialized digital skills have become even more important than before in a wide range of occupations. Findings from the comparative study of nine African countries during the pandemic show that there has been increased demand for digital skills (ILO forthcoming). The analysis carried out by the European Centre for the Development of Vocational Training (CEDEFOP) of the skills demand composition of online job advertisements posted in 2020 has revealed that digital skills represented one of the most demanded skills areas with noticeable growth compared to 2019, and the pandemic is driving this trend in many occupations, in particular non-ICT occupations in labour markets of the EU Member States (CEDEFOP 2021). As digitalization is no longer confined to specific industries, but has become an important solution for survival, digital skills are increasingly required in jobs where this was not the case before (ibid).

There can be no doubt that job and occupation-specific technical skills are important for people to keep their jobs during and beyond the pandemic, and possession of generic transversal digital skills is now a requisite for many jobs. At the same time, core work/soft skills have become more essential than ever to successfully navigate the transition to the digital world of work, especially in turbulent times like those of today. For example, the ILO's rapid assessment of reskilling and upskilling needs due to COVID-19 in nine African countries shows that technical and core skills are most sought after by employers in new hires (ILO forthcoming). According to the latest McKinsey Global Survey on reskilling, the crisis highly increased the need of the workforce with strong core skills such as adaptability, empathy and leadership (MGI 2021b). This trend of increasing demand for core skills may well extend beyond the pandemic, with an evolving business environment that requires employers to be innovative, flexible, agile and more adaptable to change than ever before.

As illustrated in this chapter, COVID-induced digitalization is spreading fast into various domains and rapid technological changes are taking place. This means that existing education and training programmes may face difficulty catching up with the evolving skills demand, which was already an issue prior to the pandemic. As a result, the workforce skills gaps may prevail and this could hinder effective innovation through appropriate adoption of new technologies. Moreover, sizeable inequalities have been observed in the level of preparedness by the workforce to respond to the growing skills demands for digitalization in different economic sectors, across countries and across specific groups of workers. The current global health crisis is even reinforcing these existing inequalities between countries and societies.

Looking forward to the recovery from the pandemic, skills will play an even more important role than before as a buffer against the effects of various transitory disruptions and as an enabler in many aspects, such as the need to implement new digital technologies and to help workers to keep or change their jobs. In this context, it will be crucial to step up efforts to reskill and upskill workers, with a specific focus on vulnerable groups such as youth, women, migrants, refugees and low-skilled workers, all of whom face a high risk of job transformation. In addition, it is essential for countries to anticipate and monitor skills needs, reflecting on how crises like the COVID-19 pandemic and megatrends such as digitalization reshape the world of work. This information is key to the alignment of skills training with labour market needs, and to facilitating school-to-work and career transitions. Furthermore, measures for skills development and lifelong learning should form an integral part of comprehensive economic, fiscal, social and employment policies that promote an inclusive, job-rich recovery from the COVID-19 crisis.

4

Measuring shifting skills

Digitalization, by affecting the composition of specific tasks, is altering the demand for specific skills (ILO 2018a). Moreover, this is happening across all levels of skills and education (MGI 2017a; Freeman 2014). But what exactly is meant by digital skills? How can these skills be distinguished from all others, and how can they be measured?

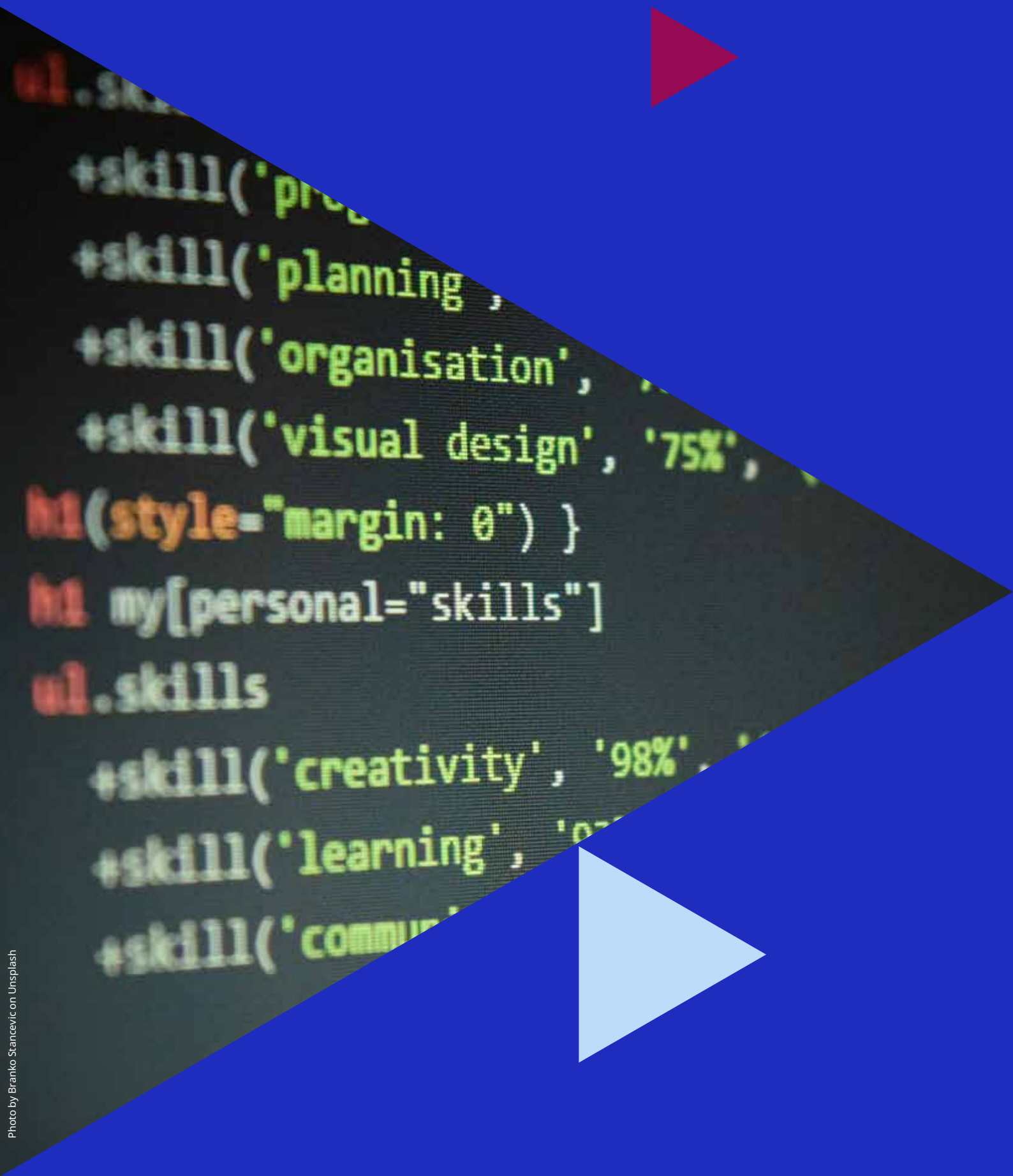


Photo by Branko Stancevic on Unsplash

▶ 4.1. Digital skills: what to measure?

From the discussions above it is clear that there is a distinction to be made between digital skills and skills for the digital economy. Properly speaking, skills for the digital economy would include a full range of skills, including digital skills specifically, but also skills that pre-condition the deployment of digital skills (namely, foundational skills that are required to make use of any technology, such as literacy); and skills that complement digital skills and augment their effect, such as certain higher-order skills that are not necessarily specific to technologies: analytical thinking, research skills, synthesizing and extracting the most important information, creativity, communication, problem solving and others. In addition, technical skills for a specific profession remain a key component of skills for digital economies generally. In other words, digital skills may be viewed as a subset of the broader set of skills for the digital economies, adding to the skills that were recognized as essential for economies even before the digital era.

In this context, it should be noted that definition of the digital economy is a complex issue: finding an internationally agreed definition that accommodates all perspectives of the digital economy and allows accurate measurement and international comparability has been a challenge (OECD 2020b). As digitalization is accelerating continuously and its economic and societal impact is considerable, the international community needs to resolve the issue of its definition to better guide measurement efforts. As a preliminary step, in 2020, the Digital Economy Ministers Meeting of G20 countries recognized the proposal by the Saudi presidency of a tiered definitional framework that supports the following overarching policy definition of the different elements of the digital economy: "The digital economy incorporates all economic activity reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services, and data; it refers to all producers and consumers, including government, that are utilizing these digital inputs in their economic activities" (OECD 2020c, p. 34).

In turn, the notion of digital literacy was defined by the ICT Literacy Panel in 2002 along the following lines: ICT literacy is using digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society (International Literacy Panel 2002). This definition is based on that posited by Allan Martin, who sees digital literacy in broader terms, as "the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process" (Martin 2005, pp. 135–136).

How can digital skills be defined? While the literature on this matter is growing increasingly fast, it has not yet reached a consensus. Part of the reason for this is that even the term itself varies across contexts, from digital "skills" to digital "literacy", "competencies", "aptitudes", "knowledge", "understanding", "dispositions" and "thinking" (Broadband Commission 2017a). This diversity reflects the different forms of digital technology and the diversity of its use within different circumstances and contexts. It also reflects the fact that digital skills may refer not only to a specific knowledge, but also to the combination of different behaviours, habits, dispositions and critical understandings (ibid).

Another reason is that new digital technologies are also constantly evolving, as new devices and applications appear, modifying the set of digital competencies required to master them. The concept

of digital skills needs to evolve constantly in order to keep abreast of ICT trends. In this context, it is unsurprising that many of the existing measures of digital skills developed only a decade ago may be seen as incomplete, as many refer to the use of computers, rather than broader technology devices including smart phones with apps (ibid). The rapid development and penetration of digital technologies into daily lives are also giving rise to new skills relating not so much – or not only – to the technical use of technology for work, as to the general awareness and understanding by people of technologies (Fau and Moreau 2018).

Lastly, various conceptualizations are proposed by different stakeholders, ranging from academia to national governments, international organizations, employers and trade unions, reflecting their own approaches to technology usage and needs. For example, many refer to the use of technology to perform work within an offline employment relationship, and do not address the possibilities of digitalization of the employment relationship itself (ibid). Others focus on digital skills for everyday life and broader social inclusion rather than for specific work tasks.

4.1.1. Definitions of digital skills from academia

In order to have a focused framework, numerous researchers initially equated digital skills with internet skills, looking solely at the technicalities of internet use (examples may be found in Bunz et al. 2007; Hargittai and Hsieh 2012; Krueger 2006; and Potosky 2007). As reviewed, however, in Van Deursen et al. (2014), it was soon acknowledged that internet skills, as a subset of digital skills, are broader than simply what might be termed "button knowledge". Further conceptualizations proposed to augment basic internet skills with the skills to comprehend and use online content (see Van Deursen et al. 2014 and 2016 for an extensive review). In other words, in conceptualizing digital skills, it is important to avoid a purely technological focus, and rather to combine the medium-related internet skills and content-related internet skills.

In addition, several scholars have augmented this conceptualization by incorporating content creation skills, communication and socio-emotional skills required for the use of social media (ibid). For example, looking more broadly at digital competence, Ferrari (2012) has proposed the combination of information skills, communication skills, content creation skills, safety skills, and problem-solving skills. Another example is provided by Helsper and Eynon (2013), who define "digital skills" as encompassing four broad categories: technical, social, critical, and creative skills. Technical skills in these frameworks, however, are understood generically (such as cleaning viruses, participating in discussions online, learning to use a new technology), without reflecting the digital skills needs of a specific profession, including IT.

Some other authors stress the importance of loading the digital skills concept with additional work-related professional components. For example, Steyaert (2000), referenced in Fau and Moreau (2018), proposes the consideration of three levels of digital skills: instrumental skills, which denote the basic technical and operational know-how in relation to the use of technological devices; structural or informational skills, which relate to a cognitive rather than technical dimension: seeking, selecting and processing online information, understanding, interpreting and evaluating it; but also strategic skills, which refer to the ability to use the information proactively to affect one's professional and/or personal environment. In turn, Van Deursen et al (2016) measure internet skills across the following dimensions: operational, "the skills to operate digital media"; information navigation, "the skills to search, select and evaluate information in digital media"; social, "the ability to use ICT to develop relationships and exchange"; creative, "the skills making it possible to create content"; and mobile, "skills of using apps".[6]

6 The latter framework, with adaptations, has been operationalized by ITU (2018).

4.1.2. Definitions of digital skills from national governments, international organizations and businesses

Some of the conceptualizations adopted by national governments and international organizations contain approaches similar to the ones outlined above. In addition, many of them focus in a much more operational manner on the distinction between digital skills for everyday life and digital skills for professional life. In such frameworks, digital skills for everyday life often form basic digital literacy, a sort of "survival skill in the digital era" (Eshet-Alkalai 2004). They can be considered as similar to pre-digital era foundation skills: less technical than those needed for work, but serving as prerequisites for more sophisticated digital skills required for professional work with digital technologies, and also providing a core employability skill applicable across many occupations and sectors. The ILO global framework on core skills for life and work in the 21st century (ILO 2021b) includes basic digital skills and defines them as the following abilities:

- to use basic hardware (the ability to operate a personal computer, tablet, mobile phone or other digital device using the hardware functionalities, such as a keyboard, mouse, navigation buttons and touchscreen technology, where appropriate);
- to use basic software (the ability to use and troubleshoot basic programmes and applications, and able to word process, manage files, and access and adjust privacy settings);
- to operate safely in an online environment (the ability to safely use basic online functions, applications, digital learning and communication platforms and media to explore, analyse and share information safely and ethically).

Beyond the basic digital skills definition, the existing measures of digital skills may be categorized as those focusing on the supply side of digital skills and those focusing on the demand side of digital skills.[7] Examples of the two categories are provided in the following sections.

4.1.3 Measuring digital skills: supply side

The European Union Digital Competence Framework 2.0, also known as DigComp 2.0, groups various components of digital competence into five areas: information, communication, digital content creation, safety and problem solving, realized during the previous three months by internet and computer users. Each of the areas contains a subset of measures. Initially measured at three levels of competence, the outcomes of each component are now being measured at eight levels of competence, ranging from "Foundation" to "Highly specialized", and the highest such levels also include the ability to apply digital skills to employment and learning (EC 2018a; Carretero et al. 2017). The Digital Competence Framework is among the very few systems that make it possible to assess not only computer-related skills, but also skills of working with mobile apps.

The Digital Literacy Global Framework (DLGF) was developed by UNESCO, by adapting the DigComp 2.0 framework on a global scale and using empirical studies from economically diverse countries. The framework was designed to serve as the reference for indicator 4.4.2 of Sustainable Development Goal (SDG) 4: "Percentage of youth/adults who have achieved at least a minimum level of proficiency in digital literacy skills" (Law et al. 2018; ITU 2020b). To better serve as a guide to monitor, assess and further develop digital literacy across countries at all stages of development, the framework adapted the existing DigComp 2.0 framework with two additional competence areas, namely "devices and software operations" and "career-related competences", and one additional competence, namely "computational thinking" under the problem-solving competence area (ibid).

7 This dichotomy is not perfect, however, as some of the supply-side measures may also be considered as demand-side ones. Examples include self-reported level of skill in a given job.

OECD (2016a) defines ICT skills in the following three dimensions: generic ICT skills, enabling persons to use technologies in their daily work, such as accessing information online or using software; specialist ICT skills in programming, developing applications and managing networks, for the production of software and web pages, operation of e-commerce, and management of cloud and big data; and ICT-complementary skills, including the capacity to process complex information, communicate with co-workers and clients, solve problems, plan in advance and adjust quickly (ibid).

The OECD PIAAC Survey of Adult Skills represents one of the most comprehensive institutional efforts to assess adults' proficiency in key information-processing skills. These include literacy, numeracy and problem-solving in technology-rich environments. The survey, while not a direct measurement of computer literacy as such, is designed to measure "highly transferable skills, which are relevant to many social contexts and work situations", and also "learnable" skills, "subject to the influence of policy" (OECD 2016d). The PIAAC data are used by the OECD to construct occupation and country-level indicators of three types of digital skills (OECD 2015a, 2016c): generic ICT skills for everyday work; specialist skills, such as the ones used to programme, develop applications, and manage networks; ICT complementary skills, such as the capability to communicate on social networks and to brand products on e-commerce platforms. The PIAAC includes a comprehensive range of questions covering these issues.

The OECD Programme for International Student Assessment (PISA) measures the ability of 15-year-olds to use their reading, mathematics and science knowledge and skills to meet real-life challenges. Since 2000, the ICT familiarity questionnaire has been offered to countries as an optional part of the PISA assessment and students have been asked basic questions about their self-efficacy in the use of ICTs (OECD 2019g). The PISA 2021 ICT Framework was launched to serve as the basis for upgrading the ICT questionnaire and guiding the integration of ICT-related questions into background questionnaires for the PISA 2021 cycle (ibid). The updated self-efficacy questions ask students to evaluate their abilities based on a set of tasks and situations that reflect the five competency areas: first, accessing, evaluating and managing information and data; second, sharing information and communicating; third, transforming and creating digital content; fourth, problem-solving and computational thinking; and fifth, knowledge, skills and behaviours related to online security, safety and risks.

The International Telecommunication Union (ITU) assembles data on the following digital skills: copying or moving a file or folder; finding, downloading, installing and configuring software; sending e-mails with attached files, such as a document, picture or video; connecting and installing new devices, such as a modem, camera or printer; creating electronic presentations with presentation software, including images, sound, video or charts; writing a computer program using a specialized programming language; using copy-and-paste tools to duplicate or move information within a document; using basic arithmetic formulas in a spreadsheet; and transferring files between a computer and other devices.

Some conceptualizations place digital skills at the heart of the skills sets required by digital economies and societies. Such is the approach of the Broadband Commission and UNESCO, which distinguish three areas: first, basic functional digital skills, defined as entry-level skills to make rudimentary access to and use of digital devices and applications; second, generic digital skills, defined as skills enabling persons to use digital technologies in meaningful and beneficial ways, which can be measured in ways similar to the European Union Digital Competence Framework 2.0 or the OECD Digital Skills framework outlined above; and third, higher-level specialized skills, defined as skills that enable persons to use digital technology in empowering and transformative ways, including advanced skills that form the basis of specialist ICT occupations and professions but also awareness of alternative ways of generating and using digital data in beneficial or resistant ways (Broadband Commission 2017a).

Additional supply side indicators of skills can include qualifications, certifications, occupation or job titles, curricula vitae (CVs), including self-evaluations through standardized CVs, such as Europass, and professional memberships, to name a few.

4.1.4 Measuring digital skills: demand side

Some of the conceptualizations on the demand side are fairly similar to those on the supply side. This applies in particular to surveys targeting workers rather than employers, measuring the digital skills content of their specific jobs. For example, the CEDEFOP European skills and jobs survey measures ICT skills required for a specific job at three levels: basic, for example, using a personal computer, tablet or mobile device for emailing or internet browsing; moderate, using word-processing or creating documents or spreadsheets; and advanced, developing software, applications or programming; using computer syntax or statistical analysis packages.

Conceptually different approaches are used in enterprises surveys, where the focus is on employers' needs and on the specific requirements of a job. Directed at the employers (managers, human resource specialists), they can include questions pertaining to the estimation of the current and future composition of the workforce; plans to close key skills gaps in their enterprises, including strategies to grow the talent in-house, future reskilling needs and the type of reskilling provision. One example of this kind of survey is the European Company Survey conducted by the European Foundation for the Improvement of Living and Working Conditions (Eurofound). Alternatively, they can look at the division of labour between humans, machines and algorithms (such as the WEF Future of Jobs Survey). Often, such surveys combine qualitative open-ended approaches to measuring skills demands. Such surveys, however, rarely measure the specific level of the required digital skills.

In this respect, initiatives such as the global skills and competency framework for the digital world – or SFIA framework have been useful, as they provide for an understanding of the specific digital skills requirements of an enterprise and of a job. The SFIA framework was developed to assess the digital skills demand in specific digital, IT and software engineering communities, but, as companies are expanding their digital operations, the framework is now being used much more extensively. The SFIA framework is different from other conceptualizations because it focuses on the levels of responsibility across different roles in a number of professional disciplines. There are seven distinct and progressive levels of responsibility, namely: "follow" (level 1), "assist" (level 2), "apply" (level 3), "enable" (level 4), "ensure and advise" (level 5), "initiate and influence" (level 6), and "set strategy, inspire and mobilize" (level 7).

The levels are intended to describe the behaviours, values, knowledge and characteristics that an individual should have in order to be identified as competent at a specific level. Those are applied to skills in a range of domains, from a company's business strategy and planning, to human resource management, sales and marketing. The key advantage of this framework is that it does not depend on the technology being used and can be applied to any digital technology. While SFIA does not collect data making it possible to measure trends in the supply of digital skills, it is intended as a tool to enable individual businesses to assess the existing professional IT skills of their staff, identify operational risks in teams, plan future skills demand, create role profiles and relevant job descriptions, and manage talent.

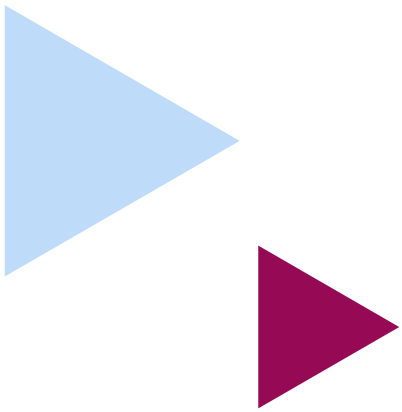
In addition, several of the workforce-focused digital skills frameworks from national contexts have been widely developed by research institutions and adopted by policymakers and industry (Gekara et al. 2019a). For example, the Digital Skills for the UK Economy Framework (ECORYS 2016), which provides digital skills mapping, is built on three dimensions of digital skills: basic digital literacy skills; digital skills for the general workforce; and digital skills for ICT professions, and is used to provide policy recommendations (ibid). The Canadian Digital Skills Framework (Chinien and Boutin 2011) consists of four essential digital skills clusters: foundational skills; transversal skills; digital technical skills (use of digital systems and tools and application of security measures); and digital informational processing.

The Australian Workplace Digital Skills Framework has two dimensions. The first dimension presents the digital skills categories, while the second defines the level of need and performance. The digital skills category dimension contains four high-level categories, eight subcategories and 17 indicators. The

high-level categories are the following: digital ways of thinking (digital creativity and innovation and digital problem-solving); digital ways of working (data analytics and digital communication and collaboration); digital tools for working (digital device and information systems competency); and living in the digital age (digital safety and security, and social and ethical responsibility). The second dimension of the digital skills framework reflects the level of need and performance for each of the major categories, subcategories and related indicators, according to occupation type and job complexity. The comprehensive framework is aimed at providing a consistent approach to identifying needs and developing digital skills within the general non-ICT Australian workforce (Gekara et al. 2019b).

Lastly, one way of measuring real-time skills demands is by use of the online job vacancies analysis, which has been a traditional measure of imbalances of demand and supply in the labour market for decades. This can be performed by public agencies and also by private companies. For example, the private company Burning Glass Technologies proposes nation-wide hierarchies of digital skills most important to specific jobs, such as those involving general middle skills. Those can include:

- productivity software skills, such as the use of spreadsheets and word-processing programmes, which are required for the vast majority of middle-skill job seekers. These skills serve as an entry point into middle-skill roles, upon which additional skills may provide opportunities to advance;
- advanced digital skills, which provide a direct opportunity for career advancement, both in middle-skill and toward high-skill occupations. These skills, such as digital media and computer networking, provide middle-skill jobs with strong salaries, and are critical in high-skill jobs;
- occupationally specific digital skills, which represent a set of specific skills required to work in specific technical occupations. For example, work as a radiologic technologist (or radiographer) cannot be done without understanding the operation of X-ray machines and CT imaging.



▶ 4.2. Digital skills: how to measure? Review of measurement tools[8]

4.2.1. Supply-side measurement tools

Notwithstanding the different conceptualizations of digital skills, Van Deursen, Helsper and Eynon (2014) indicate that there are three mainstream approaches to measurement of digital skills supply. First, digital skills can be measured by directly asking individuals about the use of the internet or the applications that have been installed. Within such approaches, a certain hierarchy of applications and programs is assumed; when an individual uses an application that is considered as sophisticated or specialized, this serves as an indication of a high level of digital skills. Second, individuals may be asked to self-assess their level of digital skills. A key disadvantage of this approach is that the scale can be interpreted differently by different individuals. For example, men and younger people tend to overestimate their skills level (Van Deursen et al. 2011), while those working in technology start-ups who have colleagues with high levels of digital skills as a reference group are likely to underestimate their skills as compared to the rest of the population (Talja 2005). The third type of approach involves tests in a laboratory or other controlled environment that provide subjects with particular assignments to observe their command of internet skills. Such tools have the most internal validity, but are also particularly costly and complex to administer. When it comes to measuring digital skills in the population at large, and especially in several countries, performance tests are usually not feasible.

Scenario-based performance tasks may be used as a proxy for performance test surveys. These tasks address these limitations as they can be completed online by a larger sample (ITU 2018). Individuals are asked to solve information problems using simulated software such as email, web browsers, or presentation software (Ester van Laar et al. 2020). One disadvantage of this approach, however, is that it requires questions with one answer or solution and is therefore ill-suited to assessing such skills as critical thinking and creativity (ibid). In addition to those population surveys (youth, adult, worker), there are also teacher-oriented assessment programmes.

In terms of the operators administering them, these measurement tools may be classified as: academia-led research efforts; nationally representative surveys; institutional data and tools developed by international organizations; or data collected by private sector enterprises.

One of the best-known examples of digital skills assessment from academia is the DiSTO project of the London School of Economics, conducted in Australia, Brazil, Chile, the Netherlands, the United Kingdom, the United States and Uruguay. Comprehensive surveys at the national level include Australia (ACARA 2015), Chile (Claro et al 2012), Norway (Hatlevik 2009) and the United States (Institute of Education Sciences, National Center for Education Statistics 2012).

An overview of both nationally representative surveys and academia-led research efforts is provided by Van Deursen, Helsper and Eynon (2014). These authors indicate that many of these surveys seem to be the most appropriate tools for collecting data on digital skills, and in particular on internet skills. Yet, according to these authors, they also have limitations, such as: incompleteness, as often only some skills are measured, and these measures do not keep pace with the rapid digital changes; conceptual blurredness, as some skills questions measure not only, or not so much, digital skills, but also related skills, such as blogging skills can be a measure of communication and creativity rather than digital skills

8 This section reviews data aimed at assessing the digital skills of adults. For an overview of the surveys of the digital skills of children and youth, see Fau and Moreau (2018). For an overview of differences between education systems in computer and information literacy, see Australian Council for Educational Research (2016).

per se; over-simplification, if digital skills are measured as a single dimension; and excessive reliance on self-reported measures that are context dependent and positively biased (ibid).

At the international level, the OECD PIAAC Survey of Adult Skills is run in over 40 countries. Its main advantage is that it makes it possible to collect internationally comparable data and also to track the issues over time, on a wide range of digital skills. Data collection is performed through individual self-assessment surveys which focus on the frequency of use of a range of digital technologies, as well as the level of complexity required for their use.

The OECD PISA programme has involved more than 90 countries and economies and some 3 million students worldwide since its launch in 2000. PISA's performance-based assessment of students' knowledge and skills in reading, mathematics and science provides internationally comparable data. In 2021, PISA has been operating a separate ICT assessment relying not on a test but on students' self-reported attitudes and self-efficacy measures regarding ICT use. In previous cycles, the ICT familiarity questionnaire has been offered to countries as an optional part of the PISA assessment.

The ITU uses nationally representative household surveys to assemble data on an array of digital skills. The following question is asked: "Which of the following computer-related activities have you carried out in the last three months?" In 2017, the collected data covered 52 countries.

WEF, in its annual Executive Opinion Survey, conducted in 2017–2018 among 16,658 business executives in 140 countries, asked executives to assess digital skills among active population. The question reads: "In your country, to what extent does the active population possess sufficient digital skills (e.g. computer skills, basic coding, digital reading)? [1 = not all; 7 = to a great extent]". The answers are then aggregated to produce a country average (WEF 2018b).

Focusing on Europe, the European Commission Digital Economy and Society Index (DESI) is a macroeconomic composite index, computed for the 28 EU Member States. The objective of this indicator is to summarize Europe's digital performance and track the evolution of EU Member States in digital competitiveness. The index is constructed on the basis of five indicators: connectivity of economies; human capital and digital skills; use of the internet (nature and degree of diversification of internet activities); integration of digital technologies by companies; and digitization of public services and administrative procedures. The second component – human capital and digital skills – includes two subdimensions: "basic skills and usage" and "advanced skills and development". The "basic skills and usage" component is constructed on the basis of the EU Digital Competence Framework outlined in the previous section. It shows the share of individuals with at least basic skills as per the Digital Skills Indicator. The data are collected through the ICT survey on ICT usage by households and individuals. The "advanced skills and development" component includes indicators on ICT specialist employment and graduates in STEM disciplines. The data relating to this second component, including individuals' level of digital skills, computer skills, internet skills and ways of obtaining ICT skills, are also reported by Eurostat.

4.2.2. Demand-side measurement tools

The main approaches to measuring skills demand include surveys of enterprises and employers; wage pressure analysis; employment pressure analysis; and vacancy analysis. While enterprise and employer surveys are often considered the best way of assessing specific real-time occupational and sectorial needs, they may lack representativeness if the sample is small or includes only formal enterprises. They may also lack internal validity and comparability: this is especially true if managers in different professions and occupations have a different understanding of their digital skills needs. Sometimes, answers may reflect the urgency or the difficulty of filling specific positions, or other structural problems of an enterprise such as low pay, rather than any genuine skills gap (OECD 2017a). In its turn, vacancy analysis has also been criticized on the grounds of insufficient representativeness and the fact that prolonged postings may reflect positions difficult to fill rather than general skills demand and skills inadequacy (ibid). With the generalization of online platforms for job advertising and the advent of big data analytics, these concerns are increasingly mitigated, reviving the attractiveness of data of this kind.

For example, the World Bank Enterprise Surveys are carried out regularly in over 100 countries, at the enterprise level. One of the survey questions is "What is the most serious obstacle affecting the operation of your business?" The question offers several options, including "educated workforce". It also requests respondents to indicate "To what degree an inadequately educated workforce is an obstacle to the operations of your firm", from "small" to "very severe". While the question does not give any understanding of the specific demand for digital skills, it is useful in providing a general understanding of skills shortages, including in the digital domain, and the resulting data can be compared across the largest set of countries. A series of other questions, pertaining to use of high-speed internet connections on company premises, use of email to communicate with clients and suppliers, or use of the internet to make purchases for the establishment, sell and market products, carry out research and develop new products and services may also be used as a proxy for the demand for generic digital skills of a company.

A more specific initiative from the World Bank is its Skills Towards Employability and Productivity (STEP) Database. This is aimed at measuring skills, including digital skills, in low and middle-income countries in a comprehensive and comparable manner. Its questionnaire is designed to foster a better understanding of the interplay between skills and employability and productivity (Gael et al. 2014). The database comprises two parts: household-based surveys and employer-based surveys. The household-based surveys include questions related to cognitive skills (reading, writing, and mathematics); a direct assessment of reading proficiency and related competencies scored on the same scale as the OECD PIAAC; self-reported socio-emotional skills; and job-relevant skills that respondents possess or use in their job. These data make it possible to assess general skills. Where digital skills are concerned, questions are asked about computer use on the job and outside of work (including the frequency of computer use and inventory of the software used). Lastly, there is a question on whether the lack of computer skills has hindered employment, promotion or pay raises.

In its turn, the employer-based survey is designed to assess the structure of the labour force; cognitive skills, behaviour and personality traits; job-relevant skills that are currently being used; the skills that employers look for when hiring new workers; the provision of training and compensation by employers; and the level of satisfaction with the education and skills training available in the labour force (World Bank, various years STEM; Gael et al. 2014). By 2019, the surveys had been carried out in 17 countries.

At the European level, the European Company Survey, conducted by Eurofound, is a tool allowing to examine workplace practices, including in terms of human resource management. Regularly carried out since 2013, it surveys management representatives in over 24,000 establishments in the Member States of EU-27, plus Iceland, Montenegro, North Macedonia, Turkey and the United Kingdom. The survey contains a number of questions on general recruitment, career development and training provided by companies (Eurofound 2015). In 2019, the survey was carried out jointly with CEDEFOP, with a special emphasis on the impact of digitalization on the strategies deployed by companies to meet their skills needs, through recruitment, human resources development practices and work organization (CEDEFOP and Eurofound 2020).

Its counterpart, the CEDEFOP European skills and jobs survey (CEDEFOP 2015, the next one is scheduled for 2021), collects information on the match between workers' skills and the skills needs of their jobs. The survey is conducted among 49,000 employees in all EU Member States. Administered among workers and not employers, it is an important source of information on whether or not workers' qualifications and skills are matched to the changing skills demands and complexities of their jobs. The survey includes a series of self-assessment questions designed to gauge the extent to which a selection of worker skills is seen to be important in their jobs and the extent to which their skills (includes all skills selected as well as an additional 11 foundational, technical and generic skills) are at the level necessary for them to do their job. Where digital skills are concerned, the survey includes information on the highest level of ICT skills required to carry out job tasks. The difference with demand-side surveys is not so much in the components of digital skills that are measured, nor in the adopted scales, but in the fact that the survey is administered at the workplace to employees rather than to a population at large. Furthermore, the questions pertain to the specifics of an occupation rather than to general digital competencies that can

be used for any job or for life, making it possible to focus more specifically on occupational and sectoral skills demands.

The OECD Skills for Jobs Indicators database (OECD 2017a) offers a different approach to measuring digital skills. Rather than measuring them directly in a survey-type way and through specific individual questions, the database constructs composite indicators from available macroeconomic data. Composite indicators of skills needs, including digital skills, are constructed by combining data on hourly wages, employment, unemployment, hours worked and under-qualification at the occupational level; these data are used to gauge the extent of skills shortages or surpluses in an occupation in a country.

The level of importance of a skill to an occupation is obtained from O*NET. O*NET is a database developed by the United States Department of Labor in collaboration with its Bureau of Labor Statistics' Standard Classification of Occupations (2018). It contains detailed information on a range of worker-related characteristics, worker requirements, and occupational requirements in 974 individual occupations in the United States, grouped into approximately 20 broader job families. The database serves as a useful tool in providing a broad, economy-wide picture of skills demand in general, and also of certain specific digital skills. It may be argued that one of the limitations of the database, however, is that it uses the O*NET data to construct indices for non-European countries, where the specifics of occupations may differ both from those in the United States and between individual European countries (Dicarlo et al. 2016). The ILO is working on adapting the tool to conduct similar measurements in developing countries, taking into account the data scarcity and inconsistency on a number of elements of the composite indicator.

Another OECD database, the World Indicators of Skills for Employment (WISE) Database (OECD 2015b), addresses the measurement of digital skills demand from a conceptually different angle. It identified five broad areas related to digital skills: contextual factors (general macroeconomic indicators, such as GDP); skills acquisition (indicators such as literacy rate, gross enrolments and others); skills requirements (indicators such as employment shares by occupation); skills mismatch (indicators such as changes in unemployment by education); and economic and social outcomes (such as labour productivity or employment rate). The data mainly come from secondary sources, such as other international organizations, including the ILO, the OECD, UNESCO, the World Bank and Eurostat. The database provides a contextual overview of digital economy issues. Of particular relevance to the digital economies are indicators of access to the internet (taken from the World Bank Development Indicators); access to mobile phones (ibid); and the use of IT at work (based on the OECD PIAAC and the World Bank STEP database).

The so-called "state of profession" surveys also constitute important sources of demand-side digital skills data. Conducted at the industry or occupation level, they can be particularly useful, especially when they combine quantitative and qualitative data, including expert opinions. They may be conducted by private entities jointly with national agencies. Notable examples include the $(ISC)^2$ Cybersecurity Workforce Study or the Information Systems Audit and the State of Cybersecurity survey conducted by the Information Systems Audit and Control Association (ISACA).

Large private-sector enterprises and think-tanks also conduct their own surveys aimed at understanding the skills demands of business, skills shortages and reskilling needs. Rather than looking at the general digital skills of an entire population, they are often conducted with a focus on specific digital skills requirements in a designated sector or occupation. As such, they can provide useful real-time labour market information for business leaders and anyone interested in sectoral and occupational skill analysis and skill forecasting.

For example, WEF has so far implemented three rounds of its Future of Jobs Survey. The survey is conducted among chief human resources and chief executive officers of leading global employers in 15 sectors in 26 advanced and emerging economies. It includes questions on trends that are predicted to have positive or negative impacts on business growth, the technologies that are likely to play a part in that expansion, the rationale and barriers related to this technology expansion, and the workforce shifts that will be needed to effectuate those changes (WEF 2020e). The last survey also included some questions related to the immediate effects of the COVID-19 pandemic. The sample includes large multinational

companies and some more localized large companies significant in terms of revenue or size. The countries covered by the survey are Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Malaysia, Mexico, the Netherlands, Pakistan, Poland, the Russian Federation, Saudi Arabia, Singapore, South Africa, Spain, Switzerland, Thailand, the United Arab Emirates, the United Kingdom and the United States. Two areas remain out of the survey's scope, however: small enterprises with fewer than 100 employees and the informal sectors of, in particular, developing economies (WEF 2020e).

Another way of approaching skills demand is to look at job vacancies. Some international organizations are considering the use of big data to analyse online job postings in order to understand employers' requirements and inform career and continuing vocational and educational training decisions. For example, CEDEFOP is currently joining forces with Eurostat to develop a fully-fledged EU-wide system to collect and analyse data on skills demand using online job postings.

New technologies, such as big data, are being increasingly used to analyse real-time digital skills requirements by private companies, such as EMSI Burning Glass Technologies, which mines job advertisements across various job sectors to find sought-after skills. In 2018 alone, it collected nearly 28 million online job postings, by extracting information daily from online job boards, newspapers and employer sites in the United States and de-duplicating postings for the same job. The data are then analysed to provide a variety of analytics on labour market and skills trends to the employers, higher educational institutions, and the government. The company also collects real-time job vacancies data in several other industrialized countries.

Another example is LinkedIn skills data on most demanded skills. As a professional social network website with nearly 800 million members in more than 200 countries and territories,[9] LinkedIn enables individuals to create their professional profile, establish a professional network and find jobs that are posted by companies. Company representatives can also directly look for the right professional profile and contact potential candidates through this platform. Using the data on job postings and individual profiles, LinkedIn collects real-time information on the most demanded skills and competencies by looking at all the hiring and recruiting activity that was conducted through the website between January and September each year and identifying the skills categories that belonged to members who were more likely to start a new role within a company or arouse the interest of companies. Clearly, the results of these analyses are framed by the sample: skills demand reflects the demand of those companies that signed up for (paid) membership, while most of the LinkedIn members already have basic digital skills since they were able to subscribe to the platform.

The ILO has also been working on a skills framework for research purposes, using data derived from the Uruguayan platform BuscoJobs, which provides real-time data both on the supply side, by capturing characteristics of job applicants, and also on the demand side, covering online job vacancies.

While considerable potential is offered by the use of web-based big data in the framework of skills needs identification, in terms of the harvesting of real-time data and the rich and granular datasets, it is important to keep in mind the limitations of such data in terms of coverage, especially in the context of developing countries. Not only is the coverage dependent on the connectivity and the size of the informal economy in a given country, but in more advanced economies, the online job vacancy platforms also tend to be biased in favour of professional categories and lower skilled jobs tend to be underrepresented.

9 Further information available at https://about.linkedin.com/.

The development of online platforms and apps for work, however, continuously poses new challenges relating to the job postings data. This is because, instead of posting a vacancy on a job-search platform, employers may now post fragmented tasks on a digital labour platform, to be performed online by workers located anywhere (see box 2). The skills demands in one country can thus be met by the skills supply in another country without the physical movement of workers. The challenge for the future prediction of national skills needs is therefore related to the extent to which various skills will be accessible from other countries without the physical movement of workers.

▶ Box 2. Measuring real-time data on postings in the gig economy

The development of the gig economy inspired numerous initiatives to measure its extent. As the work in the gig economy is performed online, basic digital skills are its key prerequisite. Thus, measurements of the extent of the gig economy can also shed light on the digital skills demand throughout the world.

One such measure is provided by the Online Labour Index (OLI), developed by Oxford-based researchers (see Kässi and Lehdonvirta 2018). The OLI is the first economic indicator that gives an online gig economy equivalent of conventional labour market statistics. It measures the supply and demand of online freelance labour across countries and occupations by tracking the number of projects and tasks across platforms in real time. The OLI is constructed by tracking all the projects and tasks posted on the five largest English-language online labour platforms, which are estimated to represent at least 70 per cent of the market by traffic. The projects are then classified by occupation or task and employer country.

The OLI index shows that, over from May 2016 to August 2018, the online crowdwork economy has grown by over 25 per cent. The index also makes it possible to track changes in demand for specific tasks and skills. For example, it shows that, over the same period, there has been a stable demand for writing jobs and professional services, while software development, clerical and administration, and graphic design jobs have grown in demand, although with high volatility (ibid). The biggest demand in the gig world is for graphic design, software development and technology.

Measuring the gig economy through the OLI, while novel and useful, also has its limitations. One of them is related to the fact that the OLI measures the gig economy by tasks. This means that, over time, with the technological developments that will allow for finer task fragmentation, the index may overestimate the true growth of the gig economy. Another challenge is posed by the fact that, recently, some of the online labour platforms on which the index is based have started handling the vetting and hiring of the online digital workers on their clients' behalf. These vacancies usually do not generate an openly posted vacancy and are consequently missed by the OLI data collector (as acknowledged by the authors themselves), thus underestimating the growth of the gig economy. In addition, having worked for a regular client found through such a platform, up to 30 per cent of workers switch to working with those clients directly, bypassing the platform, even when such practices are forbidden by platforms (see Aleksynska et al. 2018). Lastly, the rapid proliferation of online platforms, and also of job postings through alternative online media, such as closed social network groups, will mean that the OLI will represent a continuously shrinking iceberg of the gig economy.

Source: Authors' own elaboration

▶ 4.3. Digital skills needs: what information does the measurement convey?

The panoply of data tools on digital skills, often based on different concepts, translate into different measures of digital skills. Each of them serves its own purpose, many are not directly comparable. Yet, several overarching and interrelated tendencies may be discerned.

According to the World Bank Enterprises Survey, some 18 per cent of formal firms in 139 countries consider an inadequately educated workforce as a major constraint to their business. With respect to digital skills specifically, for example, in ASEAN, 27 per cent of firms state that the skill which is hardest to find is technical knowledge; 25 per cent of firms cite innovation and creativity (ILO 2016a). Between 2018 and 2022, the largest businesses in developed and emerging economies expect that at least 40 per cent of their required workforce skills will have to be modified because of the adoption of new digital technology (WEF 2018a). As a result, by 2022, no fewer than 54 per cent of all employees will require significant reskilling and upskilling (ibid).

Looking at the current job requirements, in the EU, the majority (52 per cent) of adult employees state that their job tasks require a moderate ICT level and another 19 per cent state that they require a basic level (CEDEFOP 2016). The countries with the largest share of adult workforces that need at least basic or moderate level of ICT skills to do their jobs (over 80 per cent) are Denmark, Ireland and Sweden. By contrast, this share is less than 60 per cent in Cyprus, Greece and Romania. Across the region, about 14 per cent need an advanced ICT level. Yet, 14 per cent of employees stated that they do not need any ICT skills at all in their jobs, with Bulgaria, Latvia, the Netherlands and Portugal having the highest share of such employees (over 20 per cent).

By sector, the majority of workers who do not need any digital skills to perform their jobs are found in the agricultural sector (33 per cent) and the accommodation, food and catering sector (29 per cent) (ibid.). Most of the latter jobs are performed by women. At the same time, it is also in these sectors that workers using digital technologies at work report the biggest lack of fundamental ICT skills. Some workers are also dependent on advanced digital technology for their work. Among those, workers in elementary occupations, assemblers and those in sales jobs are most affected by inadequate levels of digital proficiency (ibid). In addition, CEDEFOP's European skills and jobs survey shows that around 10 per cent of adult workers in the EU are at high risk of technological skills obsolescence. Around 21 per cent of adult employees state that it is very likely that several of their skills will become obsolete in the next five years, the share rising to 30 per cent for those working in ICT services (CEDEFOP 2017).[10]

The adoption of digital technologies raises the demand for all types of digital skills – basic (foundational), generic – transversal ICT skills – and specialist. In selected OECD countries, including the largest European economies, Australia, Canada and the United States, by 2012 over 40 per cent of workers were using generic digital skills on a daily basis for such purposes as communication and information searches (OECD 2015a). The occupations with most intensive use of such generic digital skills, outside of the ICT professions, were finance professionals and sales marketing and development managers, close to 100 per cent of whom made daily use of such technologies (ibid). In 2017, 82 per cent of middle-skill jobs advertised in the United States required digital skills, a 4 per cent increase since 2015 (Burning Glass 2017).

10 It should be borne in mind, however, that a risk is something that may or may not happen. In ICT services, obsolescence of some skills is a normal and expected part of working life for which workers compensate in the normal course of events by renewing their skills. The challenge is to ensure that such renewal remains feasible.

Specialist (professional) ICT skills have been among the most sought-after skills, driven by the higher-than-average growth of ICT industries globally. Over the period 2013–2017, the profession of software engineer has been the one making the most gains globally, and in particular in Eastern Europe and Central Asia, and in Latin America and the Caribbean, as observed in hiring trends (WEF 2018a). In the EU, the gap between the demand and the supply of ICT professionals is forecast to grow on average by 16.39 per cent per year between 2013 and 2030 (EC 2014).

In addition, core employment soft skills have been in particular demand, and this trend is expected to continue in the future. In Europe, adults in jobs requiring at least moderate-level ICT skills also require a strong level of complementary soft skills, such as planning, organization, communication and teamwork (CEDEFOP 2017). Jobs requiring advanced ICT skills also require complementary problem-solving skills, the ability to learn, adapt, and apply new methods and technologies, and also proficiency in foreign languages (ibid). According to Linkedin, the core skills that companies need most in 2019 are creativity, persuasion, collaboration, adaptability and time management (Linkedin 2019). Those complement the platform's top-ranking hard skill of cloud computing.

Despite the growing spread of business demands for new occupations and tasks, much of the data also point worryingly to a considerable share of the global workforce that is either fully or partially excluded from the digital economy, or is not catching up fast enough. This exclusion is due not only to limited access to technologies, but also, and primarily, to a widespread lack of required digital skills in the global workforce. Moreover, there are sizeable inequalities in the workforce's preparedness to respond to the growing digital skills demands, across countries and across specific groups of workers.

According to the ITU (2018), and based on data from 52 countries, in the three months preceding the survey, on average only slightly over half of individuals (57 per cent) used basic digital skills such as copying files or folders or using copy-and-paste tools; 41 per cent used standard skills such as installing or configuring software or using basic formulas on spreadsheets; and only 4 per cent used specialist language to write computer programs. Individuals in developed countries are clearly at an advantage: in these countries, the share of the population using basic and standard digital skills is about 20 per cent higher than in developing countries (ibid).

Even this digital skills gap may, however, be an under-estimation at the global level. For example, data available in Asia and Pacific region come from countries that are technologically advanced and savvy, including India, Indonesia, Japan, Malaysia, the Philippines, the Republic of Korea and Singapore. In these countries, basic digital skills of the general population are higher than those of Europeans, while general and specialized skills are comparable. By contrast, less advanced countries simply do not collect and do not report such data. This is the case of most African countries. Those countries that collect data on digital skills, such as Côte d'Ivoire, the Niger and Togo, show considerably lower levels of skills as compared to Asia and Europe (ibid). Similar findings are reported by WEF (2018b), indicating that employers in Angola and Guinea consider that the active population has the poorest digital skills, as compared to other countries.

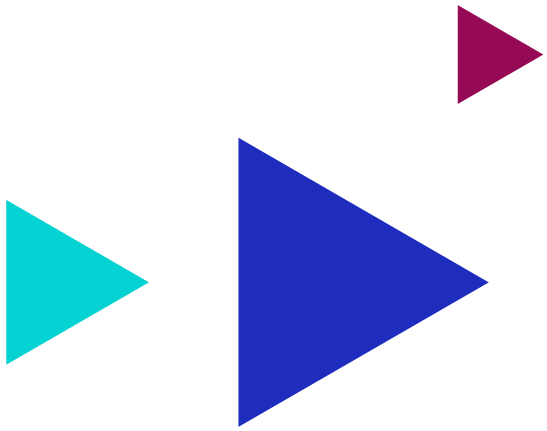
In the Plurinational State of Bolivia, Chile and Mexico, general populations have lower digital basic skills but higher general and advanced digital skills as compared with the Arab States, such as Kuwait, Saudi Arabia, Tunisia and the United Arab Emirates (ITU 2018).

Other data sources also reveal important cross-country disparities. For example, based on PIAAC data, OECD (2019a) reports that, outside of Europe, the active populations of Japan and the Republic of Korea have the highest incidence of digital problem-solving skills. Within Europe, the highest incidence of digitally savvy citizens is found in the Nordic countries, while the Southern European countries have the fewest citizens with high levels of digital skills. These findings are matched by Eurostat data based on DESI. WEF (2018b) also shows that, in Sweden, employers consider that the active population has the greatest level of digital skills, as compared to other countries.

Important differences in digital skills are observed also within countries, across different population groups. One critical divide is the residential locality: individuals in rural areas are much more likely to have no more than basic and standard digital skills as compared to those living in urban areas (ITU 2018). This is especially true in developing countries. For example, according to the World Bank STEP data, in 17 developing countries, one third of urban workers used digital technology at work; this share was considerably smaller for those living in rural areas. In rural Sri Lanka, in contrast to urban areas of the country, twice as many working-age individuals reported that lack of ICT skills was a barrier to employment and higher earnings (World Bank 2016).

Gender differences in digital skills is another – sadly unsurprising – divide. Often, this divide reflects general gender inequality in a country, both when looking within a broad range of countries (ITU 2018; UNESCO 2017a), or within a specific region. For example, within Europe, on the basis of Eurostat data, it is estimated that 25 per cent of men and 27 per cent of women have no or low digital skills. There is a gender gap of 12.9 percentage points in women's disfavour in respect of digital skills of above basic level (EC 2018b). The biggest gaps in absolute terms are observed in Austria, Luxembourg and the Netherlands and Austria, which are also countries with some of the highest percentage of people with above basic digital skills. In Bulgaria, Cyprus and France there are more women with above basic digital skills than men – although all these countries are below the EU average for individuals with above-basic digital skills. Latvia also has a reverse gap, with the incidence of above-basic digital skills among women being 20.8 percentage points higher than for men (ibid).

The largest gender gaps in digital skills are observed in professional ICT skills, which are reflected in the substantial underrepresentation of women in ICT professions. Based on STEP data, it is estimated that, in developing countries, men are 2.7 times more likely to work in an ICT services sector than women, and 7.6 times more likely to be in an ICT occupation (World Bank 2016). These differences are preconditioned by gender differences in basic digital skills, coupled with a generally lower rate of internet and mobile phone usage by women, and are also linked to cultural perceptions (especially in South Asia and Africa), and the professional orientation of girls to more occupations perceived as more "female" (ibid; UNESCO 2017a).



▶ 4.4. Towards a global digital skills measure

In summary, digital skills may be regarded as a new dimension of skills in general. They require traditional foundational (cognitive) skills and they may be augmented by, and in their turn augment, core employability skills (both hard and soft). It is significant that, as demonstrated by this overview of existing concepts, digital skills do not simply pile up on top of foundational skills, both hard, and soft. Instead, they tend to overlap with those other skills, sometimes having them as a precondition, and sometimes conditioning them. Moreover, technologies also constantly modify the definition of digital skills. While early assessments of digital skills found that they primarily concerned computer and Internet skills, they are now expanding to include mobile applications and will probably expand further, embracing digital technologies more broadly.

The development of digital technologies and the diversification of their use may also modify the definitions of traditional foundational, hard and core/soft skills over time, resulting in larger and more complex overlaps with digital skills. For example, web design may be viewed both as a core work skill of creativity and communication, and also as a digital skill. The skill of web design did not exist in the pre-digital era; when it emerged, it was largely a pure digital skill, but quickly evolved as a new aspect of creativity and communication skills mediated by the technology. These overlaps and linkages are presented in schematic form in figure 2, which shows how various digital skills relate to other types of skills useful in digital economies.

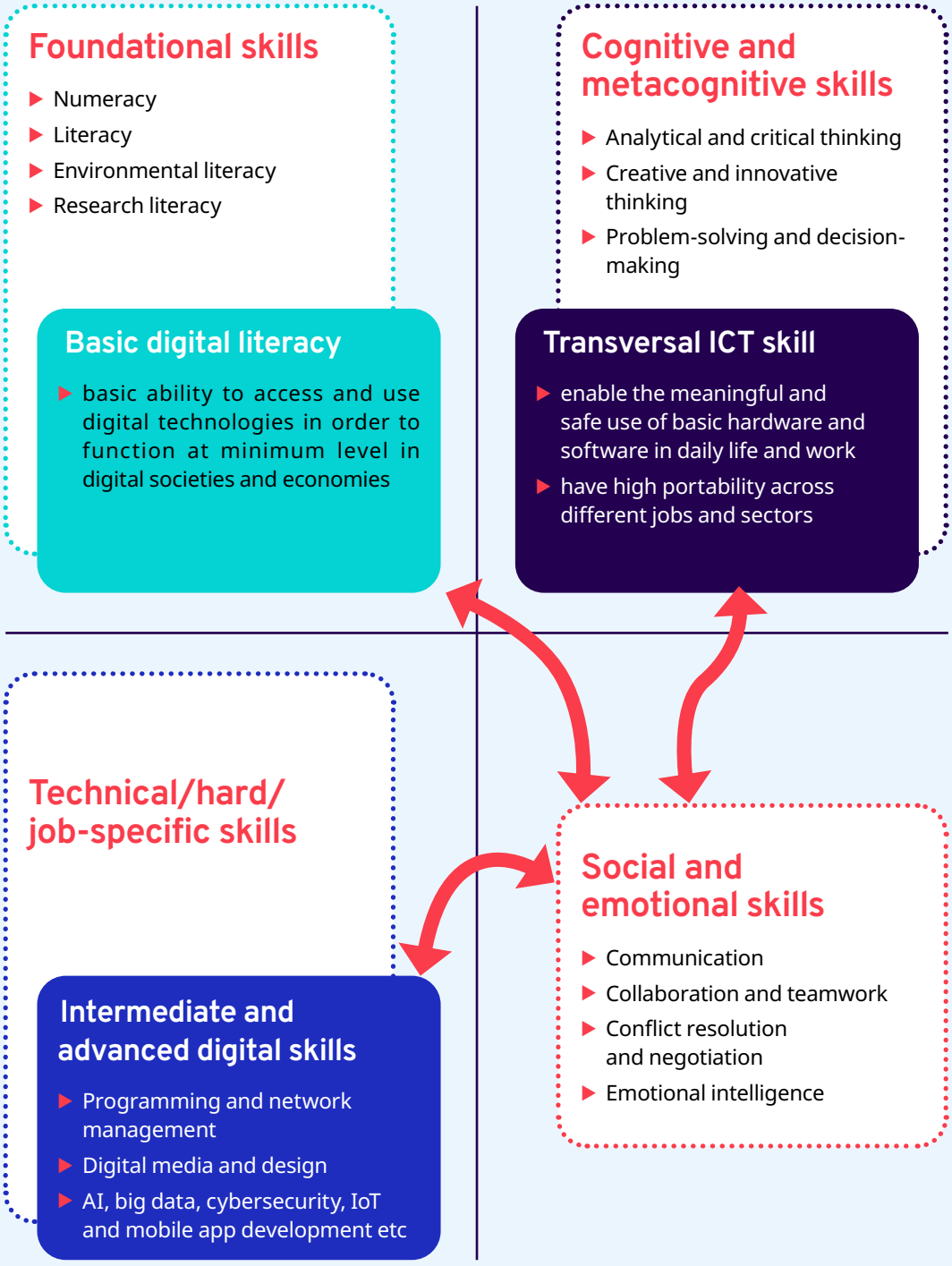
Digital skills have several layers, from the basic digital literacy skills needed to access technologies (sometimes referred to as "button knowledge"), to transversal ICT skills which enable the meaningful use of technologies in daily life and work and, further, to intermediate and advanced digital skills, imparting specialized knowledge on how to transform existing digital technologies and create new ones. Each of these layers, in turn, represents a continuum of skills (figure 2). Basic digital literacy and transversal ICT skills are the most portable and are easily transferable across different jobs. Intermediate and advanced digital skills may be less transferable and may be more sector and occupation-specific.

It is also clear that, for each individual, the extent of the overlap between these different skills will depend on the specific nature of that person's occupation and work mode. For example, for a digital platform worker, digital skills will have a heavy loading of communication skills, perhaps much less than for an agriculture worker who is perfectly at ease with digital technology to predict demand for crops and calculate the amount of fertilizers. Conversely, employers in different occupations and sectors will require a different mix of digital and non-digital skills.

These considerations explain why conceptualizing digital skills may not be an easy exercise and how different concepts may be useful, depending on the purpose for which the measurement is to be undertaken. Importantly, frameworks measuring digital skills demand can benefit from insights of measures of digital skills supply, and vice versa.

The overview presented above of such different measures leads to several methodological conclusions. First, it is clear that comprehensive data based on a strong, relatively objective, comprehensive and complete conceptual framework – whether looking at skills demand or skills supply – and comparable across countries and over time is still lacking. Some digital skills frameworks focus chiefly on user skills, while others have a focus that includes good coverage of technical skills. The scope of what is meant by digital skills is therefore quite radically different, depending on the definition used. Different measurement scales are also often applied across surveys, even if the same categories of skills are studied (for example, some studies look at frequency of use while others at level of competence, and yet others at the diversity of software and devices used), further impeding comparability.

▶ Figure 2. Conceptualizing digital skills as a subset of skills for digital economies: overlaps and linkages with other types of skills and their components



Source: Authors' own elaboration on the basis of the reviewed frameworks.

Second, the existing efforts often have limitations of excessive reliance on self-reported measures (whether by workers or by employers) that are context-dependent. Many of the measures contain a social desirability bias, and comparisons across sectors and occupations remain limited at best. Some of the measures confound skills measurements with the measurement of use, such as frequency and intensity of use, or the number of software packages that a worker is expected to master rather than the ability quickly to learn how to use a new one.

In addition to these general methodological limitations, there are two other key limitations of the current data on digital skills. First is the country coverage: while developed countries enjoy a panoply of data making it possible to study various aspects of digital skills, developing countries can rarely boast even most basic attempts to measure digital skills. But the simple transposition of existing measurement frameworks to developing countries may not be useful: it risks conditioning the answers by developed countries' digital frames rather than genuinely measuring digital skills; and it also risks being prohibitively costly. Second, except for the recently updated EU Digital Competence Framework (Carretero et al. 2017), none of the reviewed measures explicitly include measurements of skills needed to access and exercise work through online platforms and mobile applications (such as Deliveroo, Uber, and the like); and even the EU Digital Competence Framework does so with certain limitations. Existing large-scale enterprise surveys do not distinguish between may be termed "digitally-born" enterprises, which rely almost exclusively on connected workers, from other traditional enterprises that are adopting digital technology to augment their analogue-based productivity. As such, they disregard some of the key and growing parts of the digital economies.

These limitations call for the development of measures enabling a global assessment of digital skills. Ideally, they should have the following features (some of which are also outlined in Australian Council for Educational Research 2016, for UNESCO; and ITU 2018):

- be based on a clear conceptual definition of "digital skills", including different components and levels of competency, allowing for a comparability of digital skills across occupations, sectors, and countries;
- be independent of a specific software or device that is used and measure skills rather than frequency of activities;
- be sufficiently flexible to allow for the inclusion of new aspects in any future assessments, without substantially compromising comparability over time;
- be sufficiently comprehensive yet sufficiently simple, in order to facilitate the translation of concepts and operationalization at relatively low cost in all countries, including low-income countries;
- be free of social desirability bias: measures need to ensure that they measure actual and not desired or appropriate skills levels;
- be able to include the dimension of digital skills for the gig economy, which respond specifically to the instantaneous need to remain connected to a platform or an app in order to access and perform work.

5

Impact of digitalization on skills within and across sectors

The following chapter is largely based on case studies collected prior to the outbreak of the COVID-19 pandemic. As a result, the empirical information collected does not reflect the impact of the crisis caused by the pandemic. The empirical findings have been only lightly contextualized, based on recent findings and literature review in the introductory parts to the subsections on each sector. The sectors covered by the case studies were services; tourism; manufacturing (construction; automobiles and electronics); art and creative industry; ICTs; agriculture; retail and e-commerce; transport and logistics (see Annex 1). The low and middle income countries covered by this study across different geographical regions were, in Africa: Ethiopia, Morocco, Uganda and the United Republic of Tanzania; in Asia: Cambodia, India and Viet Nam; in Europe: Georgia and Ukraine; and in Latin America: Argentina, Costa Rica and Mexico. Some sector studies overlap across different countries, making possible cross-country comparisons for tourism (Georgia, Morocco); manufacturing (Ethiopia, Viet Nam) and services (Mexico, Costa Rica) and are included in this chapter. The case studies were mainly conducted through in-depth interviews and surveys of relevant sector stakeholders, experts, employer's associations, trade unions and training providers and additional supporting evidence was complemented through secondary research and literature.

Photo by ThisisEngineering RAEng on Unsplash

▶ 5.1. Sector focus 1: Agriculture

5.1.1 Context of the COVID-19 pandemic

The global agricultural markets continue to remain relatively stable amid the COVID-19 pandemic and this health crisis is less likely to induce a global food crisis (FAO 2020a). The global production levels for staple crops such as rice, wheat and maize are set to reach a record high in 2020, and the global cereal stock-to-use ratio is expected to reach a twenty-year high in 2020/21 (FAO 2020b). Food production prospects are favourable and ample cereal stocks highlight the comfortable supply future (FAO, 2020a). In addition, the agriculture and agrifood sector has been designated as essential in the context of the pandemic in most countries and exempt from business closure to keep up with food demand, the most fundamental needs of people. Yet, this does not mean that the agriculture sector is immune to the negative impacts of the global health crisis.

The measures implemented to curb the spread of COVID-19 infections, such as confinement restrictions, social distancing and closure of borders, have led to labour shortages in the labour-intensive crop production and processing sector (ILO 2020a). For example, before reopening of the border, many European countries had urgently to find ways of mobilizing the workforce to address labour shortages in the agriculture sector owing to limited movements of seasonal migrant workers, on whom they rely heavily in general (ibid.). Direct disruptions by the pandemic to the labour supply may not be limited to high-income countries, relying on seasonal migrant workers, but also to low-income countries with labour-intensive agricultural systems, as they employ higher shares of labour for primary agricultural production (FAO, 2020c).

The pandemic may also affect the livelihoods of millions of workers engaged in particular in export-oriented agricultural production in developing countries, as a consequence of job destruction, loss of incomes or reduced trade (ILO 2020a). Transport and logistical challenges such as cargo disruptions, increased air freight costs, port closures and new non-tariff measures (SPS and TBT measures), attributed to COVID-19 related restrictions, are causing serious problems for the export of certain agricultural commodities, especially higher-value perishable food products (OECD 2020d). For example, shipments of tropical fruits from South-East Asia were disrupted by the high-volume of traffic at the ports of Shanghai and Tianjin, with reefer containers that cannot be discharged on time, and this has caused considerable losses due to the perishable nature of produce (FAO 2020c).

In addition, the collapse in consumption of food at restaurants, hotels, business and schools as well as shifts in consumer demand from higher value items towards staple foods are negatively affecting the market for some commodities such as fresh fruits and vegetables, seafood, dairy products and flowers (OECD 2020d; MGI 2020b). For instance, farmers in many countries have been unable to sell their harvested crops in local markets or restaurants, schools and hotels due to their temporary closures (ILO 2020a). As a consequence, dairy farmers had to dump tons of milk in Wisconsin; farmers in India were forced to throw away tons of grapes; and many more farmers around the globe had no option but to destroy their harvests as they could not find buyers. Furthermore, the floriculture sector in Kenya, which accounted for 85 per cent of flower exports from sub-Saharan Africa in 2018, was hit hard in the second quarter owing to reduced demand from European consumers (MGI 2020b). This has already resulted in job destruction in the sector, affecting between 70,000 and 100,000 direct jobs (ibid.).

The socioeconomic impact of COVID-19 will ultimately be felt more strongly by the vulnerable labour force, namely smallholder farmers, informal workers, youth, migrants and women, and if timely support is not provided, it will render them even more vulnerable to the economic shocks generated by the pandemic. Given this background, COVID-19-induced disruptions in the agriculture sector are calling for inclusive and innovative solutions that can transform global agriculture to better support the agricultural workforce, improve environmental sustainability and build resilience against future shocks. One of the solutions would be to tap the full potential of the digital revolution to provide better market information and access to farmers, facilitate sustainable agricultural production and income generation, and help the sector to prepare better for any future disruptions from pests, climate change and health crises (WEF, 2020f). In the following section, current digital trends and benefits of further embracement in agriculture, together with its implication for skills, will be discussed.

5.1.2. Digitalization trends, impact on skills and cross-country comparison

Across the world, one fourth of all workers are employed in agriculture and farming (ILO STAT 2018). Agriculture is also the sector with the largest share of the working poor. One of the main challenges faced by workers in the acquisition of digital skills and by enterprises in sourcing the relevant digital skills in this sector is posed by the generally poor foundation skills of workers and high degree of informality (both in employment and in learning), especially in developing countries. Work in this sector is also largely self-employed in nature, meaning that skills are acquired mainly on the job, often through informal and non-formal channels, and often at the cost of the worker.

The agriculture sector includes many occupations, ranging from crop, livestock and tree farmers, to agronomists, agro-engineers, aqua-ecologists, irrigation specialists and agro-meteorologists. Over the past century, mechanization of tasks has cut employment in this sector to a massive extent. Many countries find it difficult to boost productivity any further by layering automation on top of the existing mechanized processes. Moreover, the sector remains among the least digitalized, even in developed countries (MGI 2015). It is nevertheless expected that employment in this sector can be affected by digitalization. In the United States, for instance, the introduction of automation in agriculture, forestry, fishing and hunting is expected to eliminate 223,000 jobs by 2022 (West 2015). Automation risks in developing countries, however, remain lower for the nearest future, mainly because of the relatively high costs of their adoption as compared to abundant labour.

Nevertheless, agriculture everywhere is becoming increasingly digitalized and digital knowledge-intensive. In least developed countries, farmers can access weather forecasts and real-time market prices thanks to mobile phone texting, videos, simple applications and internet kiosks. These technologies can halve the search costs of this information, as is the case in Nigeria (Chomitz 2015), and can induce market participation of farmers in remote areas producing perishable crops (Muto and Yamano 2009). Digital technologies have empowered farmers in the marketplace by connecting them to people who may buy or sell their products, and even support their use of digital financial services, such as loans (Aker et al. 2016). These technologies have also saved crops from being wasted and the livelihoods of farmers during the pandemic. For example, desperate farmers, who were faced with throwing away tons of their harvests owing to low demand amid the health crisis could find buyers and sell the produce over digital platforms (World Bank 2020a). Digital technologies are helping farmers to pivot to e-commerce and to maintain some businesses and more digital adoption in agriculture is expected across the globe.

Transition to digital agriculture also helps farmers to increase their yields and incomes as they can be better informed and advised about soil conditions, crop health and various inputs such as seeds and fertilizers to make optimal decisions for farming (WEF 2020f). For example, a vast array of sensors are deployed in the fields to collect data about plant health, yields and soil composition, which allow farmers to take prompt remedial action if necessary (ibid.). This helps to enhance farm profitability and sustainability. Examples at a national level include the agricultural hot line launched by the Ethiopian Agricultural Transformation Agency in 2014, which by 2016 had received almost 6.5 million calls (box 3). The Agency also regularly sends text messages and automated calls with up-to-date agronomic information to 500,000 users, helping them to improve their farming practices (Foreign Affairs 2016).

For smallholder farms, estimated at 570 million worldwide (Lowder et al. 2016), digital technologies can be used to create farmer profiles, which would allow farms to be accessed in real time by multiple service providers. Those can include financial services providers, input suppliers, agroprocessors and farmer cooperatives, enabling them to engage with farmers better, with the aim of helping farmers to mitigate risks, strengthen their position in value chains and coordinate value chain stakeholders (USAID 2018).

▶ Box 3. Examples of technological penetrations into the Ethiopian smallholder agriculture sector include:

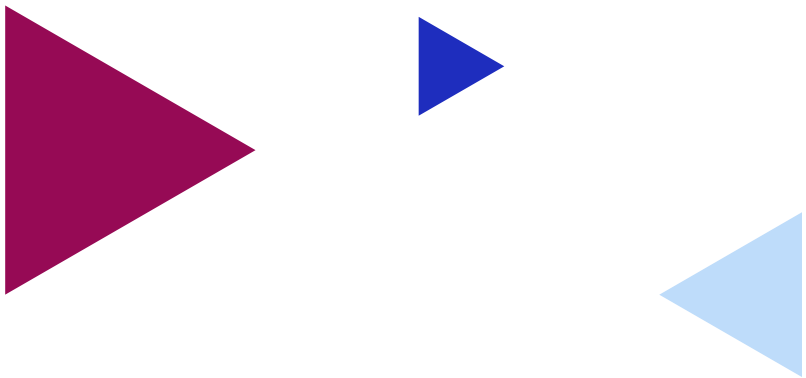
- Agricultural Transformation Agency (ATA) developed a mobile phone hotline to connect more than three million farmers for extension services in Amhara, Oromia, Tigray and the Southern Nations, Nationalities, and Peoples regions.
- Farm Radio International, through partner local radio stations in Ethiopia, reaches a total of about 32 million potential listeners mainly using community radio listening groups. Topics include the production of teff and consumption of high-protein maize.
- M-Birr mobile money service reaches millions of smallholder farmers to connect them with the largest microfinance institutions in the country and to conduct financial transactions over mobile phones.
- Using mobile technology, analytics and the internet of things, AI is used to track as many as 5 million bags of coffee through all stages of the supply chain.
- Digital Green provides advisory messaging and produces localized videos (using a participatory approach with fellow farmers) on critical sustainable practices improving farm-level conservation measures and livelihoods among the rural communities.

A particular challenge for smallholder farmers is posed by climate change, which increases their exposure to crop losses due to less predictable weather, soil degradation and water constraints. Specially developed apps can help farmers to take pictures through the cropping season to better monitor their fields. These data can further be used by the farmer not only to make decisions about solutions such as targeted irrigation, mulches and fertilizers to use, or seeds to plant, but also to assess and predict losses at farm level and effectively communicate with insurers. Examples of such apps are being deployed in India and Kenya (FAO 2019). As many of the farmers in developing countries lack even basic literacy skills, such interventions work best when they are simple (World Bank 2016). Development of foundation skills and basic literacy will thus remain key for access to digital technologies.

For other workers, such as for example precision agriculture workers, higher skills levels and their lifetime upgrading will be continuously required. Precision agriculture is a data driven subsector of managing and optimizing the production of crops. Workers in this field need appropriate methods and tools to calibrate applications of herbicides, pesticides, irrigation and fertilizers to avoid overuse or underuse. The required new digital skills include the ability to apply remote sensing; and to use digital soil maps, satellite imagery, geographic information systems (GIS) and global positioning systems (GPS) (ILO 2011; Accenture 2017). Piloting a drone will soon be trending as a new skill, as drones can plant seeds, spray pesticides, help analyse crop fields, estimate yields, detect crop diseases and pests, and provide early warnings to better manage crop health. Already in use in countries such as Germany, and in the test phases in countries of East Africa, their mainstream adoption is a matter of a few years' time (ibid; Technoserve 2018). The application of big data in this field is also becoming increasingly important and necessitates specialized skills for its effective use. Professionals in this field will require a university degree, possibly in hybrid occupations, combining digital technical skills with the subject knowledge.

For agricultural meteorologists – a relatively new occupation brought into existence by climate change and increasing weather variability – the key required skills include applying meteorological information to enhance crop yields and reduce crop losses caused by adverse weather. These specialists combine knowledge of plant physiology and pathology, meteorology and agronomy, common agricultural practices and remote-sensing techniques. They collect satellite images and remote-sensing images, including vegetation indices from centres that monitor the evolution of rainfall, and make projections about weather, river flows and pest infestations (ibid.). Some technology firms specializing in this area are pioneering the provision of agro-meteorological services for early warning of weather and climate risks (World Bank 2016).

New developments in the sector will also include the application of the internet of things and internet of living things in agricultural processes (Clark 2017; Fraser and Charlebois 2016). Those are represented by sophisticated sensors embedded in fields, waterways and irrigation systems that connect with machine-learning systems, and are set to maximize production in an environmentally friendly manner. This is an area where new occupations will emerge to develop these technologies. Existing occupations, such as occupational technicians, will require new skills for their operationalization.



▶ 5.2. Sector focus 2: Manufacturing

5.2.1. Context of the COVID-19 pandemic

The manufacturing sector, which employs 463 million workers around the world, is identified as one of the key economic sectors most affected by the COVID-19 pandemic (ILO 2020b). A significant drop in consumer demand, disrupted global supply chains, deferred orders and closures of plants is widely observed in key industries such as automobiles, electronics, aircrafts, textiles and garments. These consequences of the global health crisis have caused a sharp contraction in output in the manufacturing sector and placed the sector's workforce at high risk of displacement (ibid). At the same time, manufacturers of consumer staples and personal protective equipment (PPE) such as masks, gowns and face shields are struggling to keep up with a sudden surge in demand caused by rising needs, panic buying and stockpiling.

As a response to the crisis, manufacturing leaders have taken different measures to resolve immediate challenges and keep the business as stable as possible. These observed responses have been varied across industries and countries. While some manufacturers are cutting back on production and furloughing or laying off workers, others are shifting and repurposing their production. For example, automobile manufacturers are switching production lines from mass-producing cars to making much-needed ventilators, masks, visors and other PPEs, and distillers are producing hand sanitizer and disinfectant (WEF 2020g). Manufacturers are pivoting to support urgent healthcare needs and fight against COVID-19 while keeping production lines operational, maintaining some output and generating moderate revenues in times of low demand (ibid).

The disruption on manufacturing is forcing industries to rethink their entire operation models from production systems and supply chains, risk management to workforce training and safety protocols. Recognizing this need, more flexible and agile solutions enabled by Industry 4.0 technologies are actively sought by manufacturers. Such responses are likely to accelerate the adoption of advanced manufacturing technologies and digitalization in manufacturing processes. Given changing consumer demand, and growing needs for remote work and distancing protocols for on-site jobs, it is imperative for manufacturers to invest more on digitizing their operations to ensure business continuity and build resilience for future disruptions. In the following section, a range of digital technologies that the manufacturing industries could leverage to prepare for recovery and future crisis and its implication for skills will be discussed.

5.2.2. Digitalization trends and impact on skills

Manufacturing has been undergoing unprecedented transformation induced by the Fourth Industrial Revolution. At its core is not simply the wide adoption of technologies such as robotics, the Internet of Things, cyberphysical systems, advanced sensor technologies, 3D printing, AI, virtual and augmented reality, but the convergence of these technologies and the amplification of their effects allowed by combination of big data, analytics and physical technology.

One of the main novelties of digitalization, as compared to traditional automation, is that it "gives intangibles a more prominent role in income generation, including along value chains" (UNCTAD 2018). Such intangibles include R&D, design, blueprints, software, market research and branding that are empowered by big data. As those intangibles are often more closely identified with service activities, however, services increasingly penetrate the goods sector, blurring the traditional boundaries between goods and services in the manufacturing (ibid.).

Similarly, various production industries and their segments are becoming more closely linked. For example, in addition to its application to manufacturing, digitalization has the potential to help manufacturing firms to manage their value chains, improve visibility in supply chains, and reduce risks. Examples of the latter include using AI and advanced analytics tools to predict demand patterns and alter supply chain and manufacturing operations accordingly; equipping vehicles with GPS trackers and sensors measuring the physical properties of the cargo; or using blockchain technology to enable companies to manage supply chains more efficiently by collecting reliable information from where the goods are manufactured to the point of delivery to the client (ILO 2018c).

In the coming years, a number of these digital technologies are likely to have a transformative effect on both production and work in the manufacturing industries. While some jobs will be destroyed as a consequence of automation, others will appear or enjoy an increased demand (table 4).

▶ Table 4. Manufacturing: Examples of digital technologies' applications and skills needs that they create

Selected sections in a value chain / production phases	Examples of digital technologies and their applications	Examples of enhanced future labour demand
Research and product development	▶ Identifying customer needs and predicting market trends through big data analytics and AI ▶ Connectivity allowing for customization and servitization	▶ High-skilled workers in the product design and development ▶ Data analysts and scientists, big data specialists
Design and engineering	▶ Prototyping using computer-aided design, 3D printing and additive manufacturing	▶ High-skilled workers with specialized STEM background (university level), and with hybrid specialization (such as engineering, fine arts or computer science) ▶ 3D printing technicians
Production and assembly	▶ Autonomous robotic fabrication, induced by machine learning and AI ▶ Collaborative robotics ▶ Additive manufacturing (3D printing) ▶ Predictive maintenance ▶ Advanced analytics on breakdowns ▶ Laser cutting ▶ Sewbots (sewing robots) ▶ Radio-frequency ID and sensors	▶ High and medium-skilled workers with specialized STEM background (university and vocational level) ▶ Technicians and engineers who can operate, service and maintain new technologies and robotics ▶ Process automation specialists ▶ Electrotechnology engineers
Packaging	▶ Smart packaging (packaging material containing an intelligent component to detect changes in freshness, keep live records and ensure traceability)	▶ Software and applications developers and analysts
Logistics (transportation, warehousing and distribution)	▶ Use of ubiquitous networked sensors (IoT) to remotely connect, track and manage products, systems and grids ▶ Digital logistics, such as predictive analytics, route optimization, resource aggregation platforms, logistics portals to connect trade and logistics partners ▶ Autonomous transport (driverless cars), fully automated warehouses ▶ Blockchain and distributed ledger technology based on cryptographic systems to manage, verify and publicly record transaction data, helping to manage supply chains	▶ Medium-skilled workers in hybrid occupations ▶ Supply chain and logistics specialists ▶ Blockchain specialists

Source: Authors' own elaboration based on WEF (2018a and 2018c), WEF and Accenture (2018) and ILO (2018c and 2019c).

As discussed earlier, however, the extent to which this employment potential will be realized depends on numerous factors. One of these is the degree to which manufacturing industries are already automated. For example, in chemical and pharmaceutical industries, automation is already highly advanced in much of the production process, with large facilities operating with little human intervention. The newer phenomena of digitalization and other innovative technologies will come on top of this traditional automation of plants; they will mainly concern additional gains in productivity, while employment destruction effects are expected to be relatively low. In contrast, the textile and garment industry is one that relying heavily on the physical workforce, employing 123.4 million workers in its value chain globally (WEF and Accenture 2018). In this industry, the transformative effect of digital technologies is more likely to manifest itself in the automation of mass production, introduced by laser cutting, robotic sewing systems and other related technologies (ILO 2019c).

Another factor is how global value chains of different manufacturing industries are organized, including the extent to which the various stages of production are knowledge-intensive. For example, in contrast to the textile and garment industry, the automotive industry is considered to be knowledge-based, with companies competing in design, engineering and the ability to manage highly complex production systems and supply chains (ibid.). Moreover, the sector is being reshaped by emerging technologies, such as electric cars, driverless cars and net-based applications. In consumer electronics, the key competition elements, in addition to low-cost production, are innovation, product development and R&D. More workers in automotive and consumer electronics industries are thus likely to benefit from new information technologies than in the textile and garment sector. This will especially concern high-skilled workers in design and engineering segments of value chain creation (WEF and Accenture 2018). By contrast, low-cost and low-skilled labour, employed in such value chain segments as packaging, processing and logistics, regardless of the industry, is strongly threatened by automation and replacement by robots more generally.

Various value chain segments and worker skills are unequally distributed across countries. Lower value work in consumer electronics, textile and garments is outsourced partly or almost entirely to China, India and South-Asian countries. By contrast, R&D, design, innovation and product development jobs are centred in North America, Western Europe and East Asia (Japan, the Republic of Korea and Singapore). These geographical differences exacerbate employment, occupational and skills inequalities resulting from the adoption of digital technologies, although they may be mitigated by shifts in value chain segments caused by technologies.

The adoption of digital technologies to varying degrees and its heterogeneous effect on employment and skills in the manufacturing sector is further examined through two case studies, on Ethiopia and Viet Nam, below.

5.2.3. Case studies

Case study: Ethiopia

Major technological changes, effects, and challenges

In the Ethiopian manufacturing sector, technological change was manifested, at least to some extent, in the automation of production lines, triggering changes in production, productivity and skills demand. For instance, a metal and metal products factory introduced state-of-the-art and high-speed machines that use Programmable Logic Controlled (PLC) systems, digitized their cutting machine in the slitting line, and automated the structural pipe manufacturing process. Similarly, most textile and garment firms have automated their spinning, weaving, finishing and garment machines. Some firms use social media and websites to promote their products, and their efforts to embark in e-commerce are progressing in line

with the national policy. A fingerprint-based time-control system that connects employees' production data to finance and human resources departments has started to be adopted in the sector.

By contrast, paintings and leather products firms still depend largely on labour-intensive production systems and seem to be little affected by technological changes and digitalization. Respondents identified such factors as the lower sophistication of the production of paintings, the potentially huge labour displacement effects of automation (mainly in the leather industry), the lack of skilled personnel to operate and troubleshoot digital machines, and the innovation lag in shoe production machinery as main reasons for the lower level of digitalization in one or both of these industries. In this regard, one of the respondents indicated that the technological gap between the leather industry and its counterpart in advanced countries could be in the range of 20–30 years. Unlike firms in the textile and garment sector, however, and metal and engineering industry, some firms use Enterprise Resource Planning (ERP) software to integrate production, human resources, logistics and marketing departments, and use digital communications.

While the effects of technological changes and digitalization vary across industries, almost all firms in the textile and garment industry, and metal and engineering industries have experienced the effects. Comparing this, however, to the trends in the same sector in advanced countries, these changes could be considered as just the first steps towards the digitalized manufacturing industry, where the applications of advanced cloud computing, robotics and real-time data analytics play bigger roles. Yet, the level of digitalization and technological changes in the Ethiopian manufacturing sector is promising and well set to move forward, compared to some other sectors in the country, such as agriculture and agrifood processing.

The Ethiopian case study points to the fact that in the Ethiopian manufacturing sector technological change faces a number of barriers, such as limited access to the internet, poor connectivity, network interruptions due to power blackouts, and shortages of foreign currency. Digitalization has, however, reduced the time required to replenish stocks, added new ways of product promotion on social media and websites and hence enabled firms to reach new customers. It has also speeded up communications between stakeholders and introduced cheaper money transfer systems. The effects of technological changes on the value chain in the Ethiopian manufacturing sector vary primarily in terms of the extent of the level of digitalization in the firms, their target markets and the type of industry. The firms and value chain segments that target international markets tend to adopt new technologies more quickly, under competition pressure.

Effects of digitalization on jobs and skills demand

Following production automation in the Ethiopian manufacturing sector, there is an acute need for experts in advanced digital technology such as PLC systems and air-jet machines. These include software engineers, experts in the data analysis to interpret the messages from digital machines, and skilled personnel to control, maintain, troubleshoot and re-adjust digital machines. In some firms, digital machines remain idle owing to the lack of these skilled personnel. Factories that automated their production lines rely mainly on the machine manufacturer for technical support and this means that the machines must be connected to the internet and diagnosed remotely by the manufacturer for advice. Currently, firms employ TVET graduates and provide them training to work with these machines. In one of the textile and garment factories, it is reported that a single operator works with six air-jet machines and six of these operators are managed by a single senior staff member. Since they are high-speed machines, any technical problems significantly affect the production process and firms do not have skilled technicians to fix the errors.

There is also increasing demand for basic digital skills such as the ability to source information from the internet, work with computers, email, programme and manage databases, and promote products on the internet with the use of social media and other websites, with a view to moving towards e-commerce. Textile factories are also opening new units such as design departments, following new customers in

their value chains and acquiring the supportive technologies and applications for this purpose, and they require digital skills to use these and other applications and software.

While there is an increasing demand for technical skills, firms in all industries report that the need for workers with non-technical skills, such as discipline, has also increased. Firms indicate that core skills have become crucial as jobs tend to be highly team-based and workers are required to manage risks effectively, have good interpersonal skills, and be critical and creative. In addition, the demand for such non-digital skills as product sorting, work speed, focus and the ability to heed orders from plant managers and colleagues is still high, in particular in labour-intensive industries such as those of textiles and garments, leather and leather products and metal and engineering.

Responsiveness of education and training to changes in skills demand

Respondents indicate significant digital, technical and core skill gaps between the needs of firms, on the one hand, and the curriculum and approach of the education system, on the other, and repeatedly point out that the current education and training systems prepare students only theoretically and not practically. For example, the technical knowledge imparted to chemical engineers is not up to date with the advancement of the current textile industry. In the manufacturing sector, firms have to make costly investments to retrain workers. Respondents also mentioned, however, that one of the strengths of current graduates is that they are often computer-literate and can be shaped, coached by senior experts, and easily cope with their jobs.

Usually firms fill the gaps in their capacity with a variety of training measures, such as in-house training, external courses and coaching. The in-house training provided by firms includes induction sessions orientation sessions, in addition to specialized skills training for newly hired staff members. They also provide on-the-job training based on training plans and staffing needs assessments. Once newly hired staff members receive the necessary in-house training, they will be paired with and coached by experienced workers to fill any remaining practical skill gaps. Respondents also pointed out, however, that trained experts tend to leave their firms, and that high turnover has been a major challenge. External courses are provided in collaboration with public training institutes in the respective sectors and in TVET to deliver on-the-job and off-site courses. Machine manufacturers provide training when installing new machines in machine operation and problem solving. While most of the floor and low-skilled jobs in factories are dominated by women, however, the off-site courses are usually provided to relatively higher skilled workers, who tend to be male. This means that women in the sector who have lower skills, and lower digital skills in particular, are likely to be marginalized following the introduction of more sophisticated machines whose operation requires more skill than can be imparted by short in-house training measures.

The respondents were asked how the education and training strategies and policies could be improved to address the changes in skills demand in their firms, and the manufacturing sector in general. They suggest the following measures:

a. to align and update education and training strategies and policies with the needs of the industry through periodic manufacturing skills demand assessments;

b. to include IT and computer skill training in all fields;

c. to encourage students to make more use of technologies in their everyday lives, including by searching for information on the internet, posting contents on social media and applying for jobs;

d. to establish flexible training institutes which can update themselves and take on the responsibility to train new graduates before they join the labour markets (university curricula should still introduce the science to the students);

e. to introduce new curricula to train advanced machine technicians and technologists;

f. to change perceptions about industry jobs and profession;

g. to redesign apprenticeship programmes and to use them as a means of forging industry-university linkages so that universities fill the gap between theoretical concepts and practice, and equip students with practical skills.

Case study: Viet Nam

Major technological changes, effects, and challenges

The study of the Vietnamese manufacturing sector focuses primarily on electronics and automobile industries. The electronics industry in Viet Nam is mainly affected by three technologies: robotic process automation (RPA), IoT and 3D printing (or additive manufacturing), which enhance automation levels, services connectivity, digitalization of production systems and advance manufacturing systems. At the same time, however, the electronics manufacturing value chain in Viet Nam has diverse levels of digitalization. While the international lead companies such as Samsung, LG and Foxconn have already started adopting automation in their manufacturing processes, their suppliers, primarily Vietnamese local companies, have not yet done so as they do not currently need advanced automation. Over the past few years, however, the value chains between lead firms and their suppliers have become more tightly integrated, requiring the suppliers to adopt more advanced manufacturing processes in the future.

The automobile industry in Viet Nam has also adapted production processes to some of the latest technological trends and developments. For example, VinFast, the country's first high-volume car manufacturer, has adopted the Siemens holistic portfolio of software and automation solutions and has digitalized its entire value chain. The company reports having benefited from the application of connected digital twin across both design and manufacturing processes, resulting in increased speed and flexibility in development and optimization of its manufacturing processes, and has produced its first cars ahead of schedule. VinFast has also started using robots in its electric car manufacturing in an attempt to attain the upgraded status of a designated "factory of the future".

Across the world, automotive and electronics industries are increasingly adopting collaborative industrial robots (cobots) and some companies in Viet Nam are also benefiting from such adoption. Thus, Vinacomin Motor Industry Joint Stock Company, which manufactures parts for mining vehicles, was an early cobot adopter, aiming thereby to improve quality and productivity for two tasks: picking and placing, and machine tending. The advanced safety features of the cobots have enabled their employees to work alongside them safely, and two to threefold improvements have been reported in both product quality and productivity. At the same time, the study found that the lack of skilled labour remains a constraint on the further adoption of digital technologies in both the automobile and electronics industries in Viet Nam.

Effects of digitalization on jobs and skills demand

The changes in manufacturing technology have driven the demand for skills upgrade among existing workers in Viet Nam. At the same time, newly hired graduates from technical institutes also need to be trained before they can be inducted into operations as the curricula are not aligned with the changing industry requirements. Most of the existing courses in the technical training institutes are not equipped to provide requisite training for the students. In-house training programmes are run for local staff members and, as a coping strategy to fill the skills gap, some big firms hire either expatriates with requisite skills or recruit key management and skilled personnel from other firms in the automobile industry. In the electronics manufacturing sector, it is reported that every company needs to provide on an average 2-3 months on-the-job training to new recruits.

Responsiveness of education and training to changes in skills demand

The Government of Viet Nam has begun the process of modernizing the country's teaching and learning system. A significant step towards this, and , as required by companies, has been made through the funding the acquisition of high technology training equipment, training teachers and improving overall training delivery quality in 16 selected TVET institutions. Six of these institutions are under the Ministry of Industry and Trade and offer advanced skills training geared, among others, to the electronics, mechanics, biotechnology and automotive sectors, all of which are priority development sectors for Viet Nam.

5.2.3. Cross-country comparison

Major technological changes, effects and challenges

Both the Ethiopian and Vietnamese case studies suggest that technological change had an impact: in Ethiopia, this was on the automation of the production lines, especially in factories producing metal products and textile and garment fabrics, and, in Viet Nam, on the automobile and electronics manufacturing value chain. In both countries, however, the level of digitalization differs across international and local firms, since the former are more technologically advanced. As for barriers to the further adoption of digital technologies, in Ethiopia, challenges are related not only to the lack of available skilled workers but also to the lack of appropriate infrastructure, such as scarce access to the internet, poor connectivity, power blackouts and shortages of foreign currency, while in Viet Nam, the challenge is related more to the availability of skilled labour than to infrastructure.

Changes in labour and skills demand

The case studies demonstrated that, in both Ethiopia and Viet Nam, the adoption of new technologies in the manufacturing sector changed skills demand and job profiles. There is a growing demand for technical skills, in particular where automatized production processes have been introduced. To meet the increasing need for technical skills, firms in the manufacturing sectors in both countries have to provide on-the-job training to new hires as current university curricula are not aligned with the changing requirements of industry. In addition, the respondents from Ethiopia highlighted an increase in the demand for both hard and core non-technical skills and observed that skills shortages are preventing some firms from using the technologies adopted.

Responsiveness of the education and training institutions

In both Viet Nam and Ethiopia, respondents in the manufacturing sector indicated that the current training system and education curricula and approaches do not equip students with the practical skills demanded in the labour market. To cope with this skills gap, in both countries, firms in the manufacturing sector provide training to newly hired workers, both on the job and off-site, sometimes involving external institutions such as public institutes and machine manufacturers.

▶ 5.3. Sector Focus 3: Services

5.3.1 The context of the COVID-19 pandemic

All service sectors have been massively disrupted by the COVID-19 pandemic and the ensuing plunge or surge in demand, resulting from the necessary containment measures to combat the pandemic. Within services sectors, the tourism sector, which includes hotels, restaurants, tour agencies, airlines and other passenger transport services and leisure industries, is undoubtedly the sector hardest hit by the crisis so far, as travel bans and quarantine measures have discouraged non-essential international travel and domestic tourism activities (UNWTO 2020). Even with the easing of some travel restrictions, many destinations kept borders closed to international tourism. As a consequence, international tourist arrivals fell by 56 per cent in the first five months of 2020 compared to the same period in 2019, representing 300 million fewer international tourist arrivals, and $320 billion losses in export revenues (UNWTO 2020, issue 4). This put millions of workers at high risk of loss of livelihoods due to working hour and job losses, especially affecting informal economy workers (ILO 2020c).

By contrast, workers in the health-care sector are facing long working hours and heavy workloads due to high demand for health services following the COVID-19 outbreak (ILO 2020d). As many health and care workers, especially women, are in the front line of the pandemic response, they are also exposed to various risks, including COVID-19 infections, mental distress, exhaustion, and physical and psychological violence (WHO 2020b). In addition, the already existing shortages of health workers, in particular in low-income countries, are accentuated by the pandemic, which put even more pressure on the current workforce. At the same time, hospitals are seeing revenue losses during this period as they are being asked to defer non-emergency medical treatments to preserve capacity for a potential surge in COVID-19 cases (ILO 2020d). Hospitals are also paying additional costs for medical supplies, including PPE for their staff (World Bank 2020b). In combination, these factors are increasing the financial strain on hospitals, especially small hospitals in low and middle-income countries, forcing some to curtail their operations and lay off staff (ibid.).

Along with the health sector, the ICT service sector has faced a sudden surge in demand as governments, businesses and individuals have rapidly adopted more digital solutions to cope with the health crisis. Since the outbreak of the pandemic, a significant proportion of the global workforce has been teleworking, and distance learning solutions have been embraced by almost all education systems to mitigate the impact of school closures. Confinement and social distancing measures have increased the demand for digitalized financial services and e-commerce. The use of digital health technology such as telemedicine and mobile health has also increased. The ICT services sector has made efforts to meet this sudden rise in demand, for example broadband providers relaxed or lifted data usage limits and expanded capacity to keep the population connected at no additional cost (WTO 2020; ITU 2020c). In collaboration with the WHO, the ITU and the United Nations Children's Fund (UNICEF), telecommunication companies are reaching out to billions of people without stable internet connection by sending vital health text messages directly on their mobile phones to help protect them from COVID-19 (WHO 2020c). Given the role that ICT services can play in mitigating the negative impacts and enabling and sustaining business operations in many other sectors during the pandemic, this trend of digital technology adoption and high demand for ICT services will continue into the recovery period. In other words, the workers with adequate skills to work in the ICT services sector will continue to be in high demand.

As illustrated, the impact of the pandemic varies from one services sector to another. Sectors which require direct contact between service providers and customers for service delivery, such as tourism, live entertainment, beauty salon establishments, real estate, cinemas and transport, have undoubtedly been shaken up by confinement and social distancing measures. Education, restaurants and the retail sector, which also involves customer-facing activities, have also been adversely affected, owing to the closure of

shops and schools, but those with sufficient infrastructure have been able to continue providing services through alternative modes such as online or offline distance learning, e-commerce and takeaways. The crisis is leading to a greater emphasis on digital solutions which have played an important role in mitigating the impacts of the pandemic and this trend may even strengthen further to prepare for future shocks. In the following section, current digital trends and the benefits of the adoption of further such solutions in the services sector and also their implications for jobs and skills will be discussed.

5.3.2. Digitalization trends and impact on skills

Services sectors heavily rely on ICT and are being swept into the tide of digital transformation (Gruber 2019). Digitalization of many services, including the development of e-banking, e-commerce and the online media and audiovisual industry, means that nearly all finance, sales, marketing, communication, media and culture professionals in developed countries use ICTs in their daily work (ibid.; OECD 2016c). Internet platforms, apps, cloud computing, on-demand digital services also disrupt traditional services provision, modify interactions between companies and customers, and profoundly affect business models and work practices. Yet, the pace and degree of digital technologies adoption by services sector differs within and across countries (see box 4 and Annexes A, B, C and D).

Two examples of the heterogeneous effect of digital technologies on employment and skills include tourism and hospitality, and professional IT services, are examined below. In the following section, two sectors are further examined through case studies of three countries (Morocco, Georgia and Cambodia) for tourism sector and two countries (Uganda and Ukraine) for the ICT sector. The studies were mainly conducted through in-depth interviews and surveys of relevant sector stakeholders, experts, workers, employer's associations, trade unions and training providers and additional supporting evidence was complemented with secondary research.

Tourism and hospitality

Before the COVID-19 pandemic, the tourism and hospitality sector had been one of the most rapidly growing sectors of the global economy in the previous three decades, owing both to the global increase of wealth and to technological developments. Between 2000 and 2006 outbound travel from China alone grew by 22 per cent annually, and this growth, though at a slower pace, was expected to continue well into the 2020s (UNWTO 2016). Globally, between 2011 and 2018, the growth of international tourism outpaced growth in world merchandise trade. The growth of international arrivals alone reached 7 per cent in 2017 and 6 per cent in 2018, led by Asia and the Pacific (UNWTO 2018).

These developments were accompanied by (and also made possible thanks to) technological improvements, including those of a digital nature, such as development of low-costs airlines thanks to digital advancements in cost management, digital trade and big data analytics; development of software for online reservations, electronics payments, personalized leisure and tourism; proliferation of websites for information sharing through customers' ratings of quality of services and for accommodation rental. In all, 95 per cent of large multinational companies of the aviation, travel and tourism formal sector in countries accounting for 70 per cent of the world's GDP have already adopted technologies such as IoT and app and web-enabled markets, and 89 per cent have adopted user and entity big data analytics (WEF 2018a). It is estimated that companies embracing AI and other digital technologies will see a revenue boost of up to 40 per cent in the next five years, along with higher levels of profitability and employment (Accenture, 2018).

The tourism sector is not only technology intensive, it is also very labour intensive. In 2010, it accounted for 8 per cent of all direct and indirect jobs globally, over 60 per cent of which were taken by women (ILO 2016b). While many jobs, such as those in physical travel agencies, have been discontinued because of the rapid transformations and digitalization of the sector, others have rapidly emerged. Expectations of

▶ Box 4. Services sector in two countries of the Latin America region: case studies from Mexico and Costa Rica

Major technological changes, effects, and challenges

The adoption of new technologies in the service sector of Costa Rica is already very diverse and ranges from the use of smart phones to more advanced technologies such as web applications, e-learning, use of artificial intelligence, IoT and cloud-based working. The Mexican case study also suggests that the service sector was highly affected by digitalization, even if some firms are still using very basic technologies such as Google Maps. At the same time, the use of social networks to advertise and contact customers enables firms to reach larger markets, and at a lower price, than using traditional flyers. Yet, the size and level of development of the company has an impact on firms´ propensity to adopt new technologies in Mexico. Both case studies suggest that further technology adoption in the Latin American region's services sector could increase productivity, which is generally considered low.

Effects of digitalization on jobs and skills demand

Both the Costa Rican and Mexican service sectors provide similar insights on the change in skills demand due to digitalization. The new job profiles are characterized by a more visible interaction between technical knowledge and core skills and digitalization is leading companies to constant changes, both in skills and in knowledge demand.

The Costa Rican case study suggests that the skills demand in the country varies according to the sub-sector under consideration: a highly dynamic sector integrated into the international economy (free trade zone regime) is more aware of skills deficiencies and also invests in skills more heavily, compared to a sector oriented towards domestic markets and micro, small and medium enterprises (MSMEs), concentrated in traditional sectors, with low productivity and producing low value-added goods. Even if the country's commitment is to generate quality jobs in knowledge-intensive sectors, in practice, the offer of the education system is biased towards traditional professions.

The Mexican case study suggests new profiles that are needed in the services sectors in the digital era. For example, workers must be able to perform data analysis and interact with professionals from other areas. One of the clear trends in skills demanded in the labour market is the increase in collaborative and multidisciplinary work, along with greater work autonomy and an ability to use digital technology such as apps, specialized software and big data. New skills profiles require significant upskilling to adapt and stay up to date with the necessary skills for the labour market.

Responsiveness of education and training to changes in skills demand

Both case studies suggest that the education systems have not promptly responded to the changes in skills demanded by firms due to technological changes. In Mexico, the education sector requires a longer-term vision for educational policy and adaptation to the challenges of the twenty-first century with the inclusion of digital skills and competencies in curricula. Companies train their employees themselves, either using their own e-learning platforms, or engaging private organizations involved in digitization, and contribute to the dissemination and understanding of the benefits that digitization brings to the economy. The organizations interviewed highlighted the need for the education system to develop core skills and values such as hard work and responsibility, and also a stronger orientation to STEM-related careers.

In Costa Rica, the country's TVET system also needs to catch up with the needs of enterprises. The process of updating occupational profiles in collaboration with the private sector is slow. These procedures prevent TVET institutions from taking quick decisions to respond in a timely fashion to the constant changes in the labour market. Yet, efforts are being made to ensure that the recently approved dual education approach will enable the Instituto Nacional de Aprendizaje (National Learning Institute – INA), the public institution in charge of apprenticeship training, to offer an appropriate combination of theoretical and practical approaches such as hands-on learning and experience in enterprises. In order to respond quickly to the current changes, Costa Rican respondents suggested that bureaucratic procedures, requirements and other burdens should be reduced, to enable public institutions to facilitate the adaptation of programmes to the new needs of companies. Professionals from the private sector should also be able to enter the educational system for a limited time to share their first-hand, practical knowledge with students and then return to their professional activity. In this way, students can be exposed to the best practices that are implemented in the market today in addition to the more theoretical education.

multinational companies of the sector with regard to automation were varied, with half anticipating a need to reduce their workforce due to automation, and half planning to expand (WEF 2018a).

The development of the tourism sector led by technological developments has several implications for skills. On the one hand, work processes within large chains and firms operating under franchises (such as hotels and catering) are highly standardized and simplified, and require little training. As such, they can be performed by casual and part-time employees (the possibilities on which the business models of the sector usually rely), who are often low to medium-skilled workers (ILO, 2016b). The majority of jobs created indirectly also have low skills requirements and a high level of informality with a high share of migrant workers. Overall, this means that relatively lower skills levels can still be in demand in this sector, even though these jobs often exhibit significant work quality deficits.

On the other hand, insufficient skills in the local labour markets are identified as the major barrier to the adoption of new technologies by nearly nine in ten formal multinational businesses operating in the sector (WEF 2018a). There is a growing demand for general and operations managers, data analysts and scientists, user experience and human-machine interaction designers, sales and marketing professionals, information security analysts, to name a few (ibid.). AI is expected to work alongside humans, as a kind of co-worker, collaborator and trusted adviser (Accenture 2018). New developments, such as M-tourism (the use of smartphones throughout the entire customer experience, including to present travel documents, passports and visas, or digital identities), will require professionals to develop applications that are accessible and easily used in both local and international destinations; professionals to develop devices enabling the use of these applications (such as interactive terminals, machine-learning enabled scanners, data processors and others); and professionals to support the wide adoption of these devices by businesses and customers and to conduct their trouble-shooting. New tasks and occupations will include programming and securing driver-free passenger transport or managing interactive cobot-operated terminals. Many of these jobs will require either a specialized technical or university education, or substantial retraining. Development of skills for hybrid occupations and tasks will become a priority for mid-skill and high-skilled workers.

The sector also generates many jobs in related occupations, such as the provision of driving services, tourist guiding, production and sale of gifts and crafts, or photography (ILO 2016b). Many of these jobs have been boosted by developments of the sharing economy and social networks. For these jobs, basic foundational skills can be significantly amplified transversal generic digital skills to bring economic rewards. For example, basic internet skills make it possible to participate in the sharing economy and reach out for local and international clients. Basic digital skills can also be amplified by skills related to quality content generation and writing; social networking; photography editing; website development and management; and a client-oriented disposition, to name a few. Many of these jobs are also informal. Skills development and upgrading often take place on the initiative of workers, with large reliance on informal forms of learning, such as YouTube videos, online lectures, and massive open online courses (MOOCs).

Professional IT services

The IT services sector has been enjoying some of the fastest long-term growth, fuelled by the continuing penetration and improvement of digital infrastructure, technology adoption by businesses and individuals, advances in computing power, technology sophistication, and growing digital transformation.

The sector is highly globalized. For example, it is estimated that 70 per cent of demand for software development services through outsourcing in 2016–2018 came from the United States and Western Europe, while over 80 per cent of supply is met by China and India (AVentures Capital et al. 2019). At the same time, technical innovation, as manifested in R&D spending and patents, is concentrated among a small set of countries including the Germany, Japan, the Republic of Korea and the United States (Ernst et al. 2018).

The top ten growing occupations of the past decade have been software applications developers and analysts, and ICT operators and user support technicians (repeatedly listed among the top ten growing occupations in the EU but also elsewhere: see CEDEFOP 2017). The most sought-after occupations in this field include data analysts and scientists, AI and machine-learning specialists, software and applications developers and analysts, user experience and human-machine interaction designers (WEF 2018a).

In addition to specialized IT skills, core skills of effective communication, organizational adaptability and creativity are particularly valued in this field. For example, in order to develop successful digital solutions, businesses seek apps and software developers who are able to work in partnership with professionals in other fields, so that the proposed IT solutions can adequately reflect the realities of these fields and help in boosting them. Supporting digital transitions through the implementation of digital solutions at the enterprise level, reassuring personnel faced by new technologies, teaching personnel to use them, and providing continuous technical customer support also necessitates a client-oriented approach, empathy, communication, and time-management skills.

There is also a growing demand for hybrid specialists, combining professional specialized IT skills with specialized hard skills in finance, banking, insurance, accounting, procurement, marketing, or law. The last-mentioned is an increasingly sought-after area of expertise in view of the burgeoning of legal regulations in this field and the growing volume of cyber-litigations. The development of new digital technologies is creating demand for blockchain developers, IoT architects, and cognitive computer engineers (Balliester and Elsheikhi 2018).

Over the past years, digital security, data privacy and trust in the digital technology have emerged as critical factors for the further development of the industry. The increasing digitization of the economy, of monetary transactions, of provision of public goods and services, and of private information-sharing through digital media have created fertile ground for attacks on ICT systems and their users (De Zan 2019). Cybersecurity has become a necessary condition for the prevention of such cybercrimes as data breaches, monetary fraud and personal information and identity theft; but also as an issue of broader corporate and national security and defence necessary to avert the mass disruption of public and private lives (Kaspersky Lab 2017). This has stimulated demand for cybersecurity specialists, but also exposed their shortage: it is estimated that, globally, there will soon be over 3.5 million unfilled cybersecurity positions (CVHG 2017). Jobs in the cybersecurity field are diverse. They range from security analysts, auditors, architects, engineers, digital forensic analysts, or threat analysts to incident handlers and network monitors.

Despite some efforts led by countries such as the Australia, Estonia, France, the United Kingdom and the United States to assist the development of specialized university programmes for cybersecurity specialists, progress elsewhere remains limited. Challenges to the development of such programmes include the shortage of teachers able to develop and deliver sufficiently comprehensive curricula. Another challenge is the lack of cooperation between university and vocational training systems and employers in this domain, as many employers do not have entry-level positions for such specialists and also rely excessively on outsourced specialists. Indeed, 53 per cent of companies looking for such specialists prefer to recruit experienced security professionals externally (Kaspersky Lab 2016). As a result, currently, professional certification and hands-on experience are the most preferred skill-upgrading option in this field.

5.3.3. Case studies

Case study: Morocco – tourism

Major technological changes, effects, and challenges

Digitalization has revamped the tourism sector of the country through increased connectivity, dematerialization, automation and the enhanced use of and access to data. The industry stakeholders have capitalized on mobile connectivity across the globe, enhanced customer experience and the improved value chain of tourism services. Digitalization optimizes service production timeframes and provides the fast and smooth circulation of information, resulting in swift and sound decision-making. The rise of digital platforms has also increased the variety and volume of booking options, tourism products, services and experiences. Interviewees in the sector stakeholder interview agreed that digitalization offers more opportunities than challenges as it makes it possible to optimize tourism services with tangible results at all points of the process.

Both the interviews of the sector stakeholders and background research on the tourism sector in Morocco confirm that automation and access to big data are the technologies with the greatest impact on the Moroccan tourism sector in terms of the composition of employment, as they replace humans at the operational level while creating development and monitoring jobs. An effective digitalization project lightens the value chain, optimizes processes, and allows swift transactions, which lead to more satisfactory customer experience. The tourism sector in Morocco is facing some challenges, however, relating to the quality of digital tools and their usage rather than to their adoption. The challenges currently faced by firms in the tourism sector are how to have the best platforms, the most optimized processes, and a qualified workforce to run, monitor and carry out tasks.

Effects of digitalization on jobs and skills demand

According to the interview with stakeholders from the Ministry of Tourism, the tourism sector in Morocco is by design a major creator of jobs. Thus, one in six jobs were created by travel and tourism in the country in 2018, not far behind the worldwide trend of one in five. Yet, there is a concern that automation may result in job losses, exacerbated by the skillset discrepancies that may not be offset or outnumbered by the emerging opportunities. Concerns are also voiced about the issue of inequality among workers in the context of digital transformation. In addition, the sector currently faces some challenges in guaranteeing a smooth transition allowing for the maximum redirection of professionals and informal workers, through extensive training programmes in all relevant skills, and working closely with training institutions and sharing current insights to ensure that the skills of future graduates are up to date.

The advent of digitalization has opened the door for new occupations and skills needs in the tourism sector in Morocco. As the implementation of analytics, monitoring apps and AI has a significant impact on tourism, relevant digital skills are badly needed and the demand for such specialists as business intelligence analysts, marketing analysts and data analysts is increasing. Along with digital and technical skills, the importance of core skills, such as communication skills, a client-oriented disposition, and problem-solving ability is highlighted. Workers in the tourism sector are now required to update their technical skills, and to acquire digital skills for the performance of their operational and managerial tasks.

Responsiveness of education and training to changes in skills demand

Currently in Morocco there are over 150 training organizations that provide vocational programmes in tourism and hospitality, and 16 education institutions under the Ministry of Tourism. As both the Ministry of National Education and the Ministry of Tourism acknowledge the need for adjustments to keep up with the transformative nature of the sector, they have pushed for curriculum changes to take into account rising job profiles, with a focus on modules on digital marketing, digital transformation,

ICT and organizational transformations, e-tourism, and so on. The tourism industry stakeholders in the country are aware of the extent to which ICT skills can be taught and implemented in the sector. In order, however, to improve curricula and develop appropriate training strategies it is necessary to get all stakeholders on board, to maximize the advantages of digitalization and to build action on the base of shared insights.

Case study: Georgia – tourism

Major technological changes, effects and challenges

Technology adoption in the tourism sector in Georgia varies across companies. All the tourism companies interviewed are aware of the importance of digitalization and technological changes in the sector. The importance of modern technologies in their value chain, first of all, is related to the proper usage of international online services, such as booking systems of both hotels and flight tickets. Moreover, most of the companies interviewed use modern communication tools and pay particular attention to social media. They also highlighted that the important immediate opportunities offered by digitalization are worktime reduction and more work autonomy, together with new forms of collaboration and cooperation between workers and machines.

The great majority of the representatives of tourism companies reported that that they faced no infrastructure obstacles in adapting their businesses to technological changes and in using new technologies. Computer infrastructures are, in general, appropriate and are systematically updated. Firms do, however, face some challenges when implementing the technological changes in the sector because of lack of capacity, such as scarcity of digital skills and insufficient usage of computer tools. In addition, increased competition between companies to reduce costs, for example using online platforms and work intensification, is perceived as a challenge generated by digitalization.

Effects of digitalization on jobs and skills demand

Most of the companies interviewed in the Georgian case study mentioned that the adoption of digital technologies is not a problem for them. Training modules are well integrated in the working process of experienced companies and the Georgian State agencies provide opportunities to learn basic business skills through special programmes to support entrepreneurship and help beginners in the tourism business to learn how to use the most up-to-date digital tools. Workers in the Georgian National Tourism Administration are also systematically trained and they provide training themselves in the sector where they operate.

The introduction of digital technologies has changed the occupations profile and the skill needs in the Georgian tourism sector. It has changed the way in which people work and customer relationships that before were more informal. The representatives of tourism companies pointed out during the interviews that, with these new digital technologies, all the working processes have to be documented. Where before, verbal agreements were acceptable, now all the business communication with partners and consumers is documented through emails, reservations are made online and advertisements are made on social media such as Facebook, Instagram and hotel websites. In some hotels a designated employee is responsible for these tasks, in others this is the sales manager, or special IT companies are contracted, depending on the size of the hotel.

Responsiveness of education and training to changes in skills demand

In Georgia, according to the information obtained from the National Centre for Education Quality Enhancement, the standards for the economic sectors of the country are chosen in a centralized way by this agency, operating together with the Georgian Ministry of Education and Science. Accordingly, all the subjects related to digital technologies are defined by this agency in the “Information technology”

module. For the purpose of ensuring compliance with the European Higher Education Area, the Centre is constantly working on the improvement of the country's national qualifications framework.

Higher educational institutions in Georgia choose for themselves which subjects to introduce in each module of their teaching curricula. Thus, the list of disciplines is different across Georgian universities. The interviewee from the Ministry of Education reported, however, that IT technologies are taught in all Georgian universities as a core course. The National Centre for Education Quality Enhancement monitors the implementation of authorization and accreditation standards for the purpose of external quality assurance by educational institutions and prepares relevant recommendations.

Moreover, according to established standards, it mandates all Georgian educational institutions to develop all transferable skills, including digital competencies, through appropriate training courses at all levels of education in the country. Currently universities are teaching new subjects in their curricula related to digital technologies such as new booking and reservation systems. The Georgian National University introduced a course of geographic information systems (GIS) in the tourism programme. Looking to the future, they plan to introduce in the course of studies a front-office management system in tourism, teaching the reservation systems used for the reservation of hotel rooms for conferences.

Interviewees from firms, however, gave mixed answers and suggested that the real challenge for all universities now in Georgia is to introduce more practical training in the process of teaching the students. They suggested that universities should look for candidates with deep and varied knowledge, not only those who possess a particular digital skill. Some of the interviewees suggested that Georgian university graduates are not adequately qualified, and this is a matter of concern for the quality of services offered by the sector. For example, they find that university graduates are often not familiar with the use of formulas in Excel programs to keep the financial records of tourist tours and not aware of computer design programs, such as Photoshop and PowerPoint, which are needed now for preparing good presentations using the tools of modern technology and taking an appropriate place in a new digital world.

Case study: Cambodia – tourism

Major technological changes, effects and challenges

Digitalization in the tourism sector of Cambodia offers access to global clients, to new markets and better and easier access to information, increasing the number of tourists and the number of new customers of creative agencies. Digital transport booking services like Grab and PassApp, and the online booking system for bus and boat tickets make it easier for independent travellers to move around by themselves, encouraging them to visit places that were off the map in previous decades. E-visa services and social media made easier to arrange trips, tours, food and accommodation. The Ministry of Tourism in Cambodia is playing an active role in promoting technological change in the sector. It has developed a special app, called "Tourist Cambodia", which provides more local choices and options and a portal in which hospitality providers can register and renew their certification online, without having to travel to the capital. The Ministry highlighted that the use of ICTs is urgently needed to manage the tourism industry in the country's new Tourism Master Plan over the coming years.

Effects of digitalization on jobs and skills demand

The main challenges in the tourism sector relating to the adoption of new technologies in Cambodia pertain to the lack of properly qualified professionals, the lack of familiarity with online applications and platforms, the intermittent electricity supply and very low access to broadband internet, provided that users even have access to a computer. Lack of basic digital literacy hinders local operators, in particular older workers, who do not have access or lack the capacity to learn how to navigate online Another widely

mentioned challenge is the inability of many tuk-tuk drivers to use digital maps, which is an essential skill for drivers operate under Grab or PassApp, local ride-hailing apps.

Yet, tripartite discussions in Cambodia are currently focused rather on minimum wages and on creating and maintaining proper working conditions than on challenges related to changes in required skillsets. The current solution to skills shortages is to import the required skills together with the machines. According to the country's National Employment Agency, while there is a Labour Advisory Council that deals with non-financial benefits to the workers and that is supposed to discuss issues related to skills development, the inputs of the private sector in this regard are still limited. Trade unions in Cambodia often operate at the level of a single enterprise and are yet to have a more unified and proactive voice regarding skills development.

Responsiveness of education and training to changes in skills demand

According to the Ministry of Tourism, there are about 10 universities that offer bachelor's degrees in tourism, but these programmes are known to be highly theoretical. The graduates are not equipped with the necessary set of professional skills to be able to properly accommodate the growing demand for tourism services. Of the country's 62.000 tourism-related workers, currently only one fourth have recognized qualifications in tourism. In response, in 2019, 18 institutions signed a memorandum of understanding with the Ministry of Tourism with regard to developing TVET in tourism-related occupations.

Case study: Uganda - ICT

Major technological changes, effects and challenges

The ICT sector is growing and generally having an effect on employment. This effect can be assessed in two dimensions, namely, the number of jobs created and the effect on existing jobs through the improvement of quality or quantity. The 2016 Uganda Manpower Survey, covering of 6,800 business establishments across the country, found that over 60 per cent of them had introduced the use of ICT tools at work, the highest level being 62 per cent in private businesses. Respondents said ICT was mainly used in production, communications and human resource management and budget accounting functions (UBOS 2018). The survey further found that the introduction of ICT had enhanced performance for both employers and employees.

The ICT sector in Uganda has started to develop, albeit at a slower pace and in a smaller scale than in advanced economies. While the use of ICTs penetrates primary or traditional industries, the emerging ICT sector in Uganda is dominated by small organizations and start-ups typically employing between 10 and 20 individuals. The growth in employment is therefore not as strong as would be desired. Start-ups generally do not have the resources to hire many people. Instead, due to the short-term work that they perform, they depend significantly on outsourcing rather than hiring permanent staff. As a result, firms are limited by either the capacity to hire or the scope of the work that they can do.

Effects of digitalization on jobs and skills demand

While the sector and its associated employment are growing, there is still a lack of critical skills in the market. Many employers find that the available university training does not meet market needs (Mercy Corps 2019). Instead, many of the current market leaders are self-taught individuals. The lack of quality skills is mainly attributed to the education system that still favours traditional careers and provides few opportunities for interest-based career guidance. In addition, those with technical skills often lack non-technical skills such as a work ethic, critical thinking and other skills required in the labour market. Because of these limited skills, even for those who are technically skilled the labour market remains small.

There will be a need to change training curricula at universities and other training institutions to meet the demands of the market.

The challenge might not, however, be confined to university training, but applicable to the general education system that does not expose students to computer and IT-related studies. Incoming university students, therefore, enrol with insufficient foundational skills. Challenges and educational gaps experienced in early learning in primary and secondary schools have later ripple effects on the labour market. Critical players in the tech landscape are concerned about the quality of graduates holding ICT degrees and diplomas, but who are as ill-equipped for the demands of the market.

Responsiveness of education and training to changes in skills demand

Over the last few years, ICT education has been included in Uganda in school curricula and the subject "Computer studies" is taught at the ordinary level and "Subsidiary ICTs" at the advanced level. In addition, some companies are supporting the education sector by piloting ICT curriculum development and staff training in schools. For instance, MTN, a leading telecommunications company, is carrying out a project entitled "Skilling for the Future" in support of the education sector, by piloting ICT curriculum development and staff training in 15 schools. In addition, the Government is substantially increasing its support for ICT education as well. For example, for over a decade, the Rural Communications Development Fund (RCDF) has supported the construction of computer laboratories, the provision of computers and the installation and deployment of internet connectivity in schools, tertiary colleges and universities.

In addition, changes in education are happening at the university level. Most of the universities in the country are currently offering ICT-related disciplines. Moreover, other business, technical and vocational training institutions provide ICT-related courses. As a result, the number of job-seekers trained in ICT entering the labour market is increasing. Interviewees pointed out challenges to the adaptation of the education sector to the skills demand in the country. Some stated the view that the education system was slow in adapting, delaying the possibility of reaping the benefits of better skills and preparation. Other respondents observed that the Ugandan education sector still needed to overcome infrastructure challenges, especially in rural areas where electricity, equipment and software were not always available.

Individuals working in ICT have opportunities for further retraining and some on-the-job training opportunities are available. At the same time, as a typical ICT firm in Uganda has fewer than 20 employees, reaching scale might not be easy. In addition, specialized ICT training is not readily available and organizations providing it often have to send trainees to other countries. This heavily increases the cost of training, hence limiting the available opportunities. In addition to job training, however, individuals in ICT can take the opportunity of mentorship and support offered in the emerging ICT hubs. There are several such ICT hubs in Kampala, each providing different services, such as office co-sharing and start-up mentoring and training. The hubs are run privately but government support for them is growing. The Government is currently constructing a hub of its own, with the aim of enhancing support for the innovation industry.

Case study: Ukraine – ICT

Major technological changes, effects, and challenges

The Ukrainian case study suggests that the IT sector has become one of the drivers of technological changes in the Ukrainian economy and society and that the development of the IT industry is currently supported by changes in the Ukrainian legislation and taxation system. The existing IT infrastructure is relatively well developed. The automation of business processes, the introduction of cloud technologies, AI, cybersecurity and digital platforms are significantly influencing and accelerating the development of the IT sector. IT companies, as the main providers of technological changes, are involved in developing software for the digital transformation of businesses and government, primarily through the introduction

of electronic document management, e-governance and e-services and providing access to open data. In addition, Ukraine's role as the global IT outsourcing destination has been growing and ICT services account for more than 20 per cent of all Ukrainian service exports, making it the country's third largest export service industry.

The interviews suggested that the major challenges impeding development of the IT sector in Ukraine are the deterioration of the business environment and of the political situation in the country, the ineffectiveness of both legislation and fiscal policy, the worsening quality of human capital, the lack of investment and the need to upgrade the IT infrastructure.

Effects of digitalization on jobs and skills demand

Stakeholders in the Ukrainian IT sector responded in the interviews that they expected an increase in job creation in project-based, temporary and freelancing spheres, with corresponding contractual arrangements and employment relations. As productivity increases thanks to technological changes and digitalization, so does the dynamic growth of new job profiles. The influence of digitalization on the specific characteristics required for a given job (level of education and training; complexity of the occupation; field of education and training; knowledge, skills and competences) varies extensively. A specific feature of employment in the IT sector is that both formal and informal education and training (short-term courses organized by IT companies) are useful for finding a job in the sector.

Digital transformation enables the evolution of skills diversity. The introduction of robotics and automation will reduce the number of jobs that do not require soft or advanced cognitive skills (such as problem-solving and creative and critical thinking). Changes to the content of occupations and the array of skills required mainly depend on the degree of digitalization. In Ukraine, following the migration of most companies from their own IT infrastructure to cloud-based services, a new profession has emerged: the so-called "DevOps engineer" who is a specialist in the deployment of information systems in the operating environment.

Responsiveness of education and training to changes in skills demand

Top universities in Ukraine offer education of a traditionally high quality in the sphere of engineering, with a view to forming a talent pool in STEM. This can be regarded as one of the assets of Ukraine, which has endeavoured to specialize in the delivery of higher end ICT services. Educational institutions have engaged in coordination and cooperation with IT companies to improve the quality of education and training, with the aim of providing a range of ICT skills. This requires the organization of internships, involvement in the elaboration and implementation of curricula and educational programmes and the training of teaching staff and trainers in companies. The Ministry of Education and Science is responsible for the approval of education standards and curricula, State training standards for specific occupations, and for accreditation of training institutions. The ministry submits, in consultation with the Ministry of Economic Development and for consideration by the Cabinet of Ministers of Ukraine, proposals on State priorities for the training of educational, scientific, and training specialists and staff in related occupation, and for the further training and retraining of employees in various occupational and specialized fields.

Stakeholders in the Ukrainian IT sector pointed that IT companies organize non-formal education and training on a systematic basis (training by firms and by universities). They suggested that Ukrainian training institutions need to introduce a new format – an integrated project approach to teaching (based on a practically-oriented approach). IT companies that organize training cover all the expenses for retraining and advanced training. IT specialists have developed a training programme for employees of the country's Business Automation Union, which covers more than 500 IT companies serving Ukrainian enterprises in various industries.

5.3.3. Cross-country comparison

Tourism sector

Major technological changes, effects and challenges

All three case studies show that digitalization has transformed the tourism sector: the rise of digital platforms has increased the variety and volume of booking options, tourism products, services and experiences. As for the challenges regarding increased adoption of technology, the issues vary somewhat among the three countries. With regard to Morocco, firms within the tourism sector are not currently facing any barrier to the adoption of technology; the challenge lies more in the quality and usage of the digital tools available. In the case of Georgia, the degree of technology adoption varies across firms in the tourism sector of the country, with some firms facing constraints when adopting digital technologies due to a lack of capacity in such fields as scarcity of digital skills. The tourism sector in Cambodia faces similar issues in that the lack of properly qualified professionals hinders the adoption of new technologies, but challenges are also raised by infrastructural obstacles such as intermittent electricity supply and very poor access to broadband internet.

Changes in labour and skills demand

Both the Moroccan and the Georgian case studies show that digitalization has changed the way in which people work in the tourism sector, altering the occupations profile and the skills needs. The Moroccan interviewees noted that the skills needed as a consequence of digitalization in the tourism sector are digital, non-digital, technical and core skills, while the Georgian interviewees emphasized that there was an increasing need for jobs within the business communications sector using online platforms. In the case of Cambodia, despite the shortage of skills in the tourism sector, too little attention has been paid to addressing the issue at the level of systems creation and through social dialogue.

Responsiveness of the education and training institutions

The respondents from all three countries agree that various training institutions and stakeholders, such as ministries, are currently pushing for changes in the curriculum that will reflect changing job profiles in the tourism sector. It is essential, however, that all stakeholders become involved so as to successfully provide the skills needed by the industry that can be achieved through an improved curriculum and training strategies. The respondents from Georgia and Cambodia highlighted the importance of providing more practical training to students to equip them with the necessary set of practical skills to accommodate the needs of the sector in an effective manner.

ICT sector

Major technological changes, effects and challenges

In Uganda and Ukraine, the ICT service sector has grown at a much more rapid pace than the rest of the economy, although the pace is somewhat slower in Uganda. The main forces for growth, however, differ between the two countries. While Ukraine, to a great extent, has been exporting ICT services, there is mostly a domestic demand for such services in the case of Uganda. In Ukraine, e-government has been one of the driving forces for domestic demand for ICT specialists and for the ICT service sector. In general, Ukrainian IT companies specialize in data management, telecommunications, cloud, e-commerce, gaming, media, e-healthcare and fintech. As the ICT services sector in Ukraine enjoys a large share of the country's export market, it is more diversified and more innovative than that of Uganda. In the case

of Uganda, while digitalization of the economy is still limited due to ICT infrastructure barriers, the ICT sector has started to develop and grow as demand for ICT services grows across different sectors.

Changes in labour and skills demand

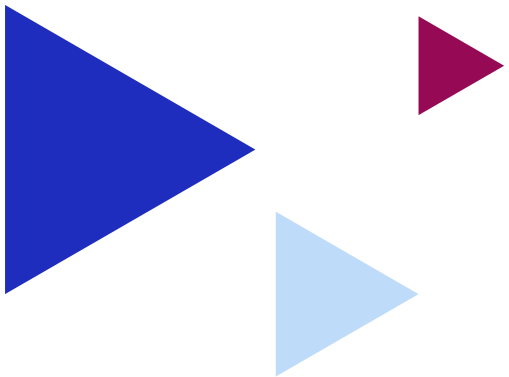
The Ukraine case study shows that digital transformation induces changes in the profile of occupations and skills needs in the ICT services sector, whereas in Uganda the change in the labour market is less dynamic. It is notable that the lack of critical and technical skills in the market limits the growth of the ICT services sector and the skills gaps take root in all levels of the education system, starting at pre-primary school education in Uganda.

In both countries, employment growth among ICT specialists is not confined to the ICT sector, as other sectors also employ ICT specialists. Even though the share of ICT employment is significantly higher in the Ukraine as compared to Uganda, the ICT sector in both countries features outsourcing, project-based work and freelance work, with significant skills deficits. The principle skills gaps noted in both countries include a lack of multi-disciplinarity, critical thinking and problem-solving.

Responsiveness of the education and training institutions

Challenges for both education systems involve improving and developing their training programmes at all levels to keep pace with technological development and current technology skills, not forgetting the development of non-technological skills. Many of the current market leaders in Uganda are self-taught individuals. The educational system lacks sufficient flexibility to integrate the formal and informal pathways of ICT education; moreover, it does not have the capacity to provide adequate career guidance. In the case of Ukraine, the combination of formal and informal or non-formal training formats to acquire ICT skills are perceived to be essential for employability.

Cooperation between companies and higher education systems is essential for ICT, as technologies have a tendency to develop rapidly. This cooperation may happen through the offering of internships by large companies, as is the case in Ukraine. As we have seen, in both Ukraine and Uganda there are examples of larger ICT companies organizing training, sometimes in cooperation with universities, or as a means of supporting school education. In both countries it is recognized that there is need for students to be trained in more practical skills.



▶ 5.4. Digital transformation is uneven across sectors and countries

Case studies across countries of different income levels: low-income such as Ethiopia, Uganda and the United Republic of Tanzania; lower-middle income such as Cambodia, India, Morocco, Ukraine and Viet Nam; and higher middle-income such as Argentina, Costa Rica, Georgia and Mexico, and also involving the various sectors such as agriculture, ICT, tourism, art and creative industry, retail and e-commerce, transports and logistics; and the manufacturing sectors such as automotive, electronics and construction, all lead to the drawing of some important conclusions.

While the adoption of technology has had an impact on all the sectors analysed in low-income countries, this happened at a much slower pace than in more advanced economies. The majority of the case studies dealing with low-income countries point to the existence of barriers to the adoption of digital technologies due to the lack of appropriate infrastructures, namely limited internet access; poor connectivity, power blackouts and financial services – in the cases of Ethiopia and Uganda – and the level of automation, in the case of the United Republic of Tanzania. The low-income countries case studies suggest that digitalization has had an impact on skills demand. The demand for soft and non-technical skills has increased while at the same time new technical skills came to be required, especially where automatized production processes have been introduced, such as in the manufacturing sector in Ethiopia. Current job profiles are becoming outdated, while new job profiles are rising in demand. Automation may well affect the number of workers at shop-floor level, but only at a somewhat later stage, as investing in labour is often more cost-effective than in technologies. In low-income countries the current issues related to the change in skills demanded due to digitalization are: the shortage of technical skills which slows down productivity and delays the introduction of new technologies, and the increasing necessity for training and upskilling current employees to respond to the appropriate changes in skills that are needed.

All the economic sectors analysed in middle-income countries are currently characterized by relatively high levels of the adoption of technology, with some, such as the tourism sector in Morocco, being completely transformed by digitalization. In these countries the challenges faced when adopting new technologies are more similar to those of advanced economies, such as how to use the best and most efficient digital tools (Morocco) or how to reach homogeneous levels of digitalization across firms within the sector (Viet Nam). Nevertheless, although the sectors analysed in case studies were highly affected by technological change, other sectors in the same countries may not yet have reached the same level of digitalization, as is the case with the manufacturing sector in Cambodia, which is still facing the challenges of automating production, or the construction sector in Argentina. Moreover, the case studies highlight that the challenges to the adoption of new technologies are not so much related to infrastructure and connectivity but rather to other issues, such as the abundance of the labour force in India and Viet Nam that makes it impossible for the adoption of technologies to be cost-effective, or the challenges associated with the political and business environment and the quality of the human capital in Ukraine, to mention only a few. The effects of automation on the labour force is nevertheless expected to increase in coming years, leading to a downsizing of workers at the shop-floor level in India. Occupations at management and specialist levels are not likely to be affected, as these are in short supply in many countries, where firms often have to resort to hiring foreign specialists.

Analysis of the case studies in middle-income countries suggests the increasing importance of reskilling and upskilling. Training curricula are not aligned with the technical skills demanded on the labour market and current graduates need to acquire new technical skills to enable them to stay in the market. These gaps are often dealt with by the provision of on-the-job training by the private sector to their workers. The development of hands-on apprenticeship training programmes is also considered high on the agenda in some countries as a way to bridge the skills gap, as is the case in Costa Rica and Morocco. The demand for general soft and non-technical skills and the shortage thereof is widely recognized,

especially in certain sectors such as the ICT sector in Ukraine. Working conditions also contribute to hiring and retention difficulties and skills deficits. The platformization of the economy increases the number of freelancers with temporary and seasonal contracts, or informal workers with challenging employment conditions and lack of access to training, for example in Ukraine and Cambodia. It is to be hoped that social dialogue and improved organization of the sector will afford protection to workers in the expanding IT sector within Ukraine.

In middle to high-income countries the level of adoption of technology varies across sectors and across countries. In Argentina technological advances in the construction sector are implemented gradually and face challenges such as the lack of qualified human capital, initial costs of implementation and the lack of adoption by other firms in the value chain, while in Costa Rica and in Mexico the service sector, and in Georgia the tourism sector, have already adopted advanced digital technologies, even if there might be differences among firms within the same sector, with the larger exporting firms being more technologically advanced. In Mexico, the interviewees suggested that to benefit from technological change in the long run, firms have to adapt their business models. Overall, the case studies of middle to high income countries suggest that the current challenges in adapting the demand for skills in response to digitalization are similar to those faced by low-middle income countries. It is noticeable, however, that in some of these countries digitalization can bring benefits other than increases in productivity and job creation. In Mexico, where labour markets are still characterized by high gender inequality, some respondents highlighted that digitalization has increased job opportunities for professional women in the automotive industry, creating new jobs with flexible hours and an acceptable level of security.

All the case studies also confirm the importance of combining core and technical skills alongside good foundational skills, including basic digital literacy, as a key prerequisite for further learning. Similarly, all the case studies confirm that the predominance of MSMEs and family-owned companies, especially in the sector of services and in lower income countries, contribute to an informality of atmosphere and constitute an obstacle to technological advancement. Social dialogue, better governance, coordination among stakeholders and adherence to policies are seen as possible solutions.

Lastly, in the context of the COVID-19 pandemic and the increased trend towards digitalization across sectors, we may expect that the trends identified through the case studies will be accelerated in the coming years. Policies should therefore facilitate the transition of workers to new jobs, supporting and facilitating upskilling and reskilling to mitigate job displacement – one of the consequences of technological change. At the same time, social protection coverage should cover freelance and temporary workers whose numbers have increased with digitalization. The education system has to adapt to new skills requirements to prevent skills shortages and skills mismatches. To this end, bureaucratic barriers to the changes in university and TVET curricula have to be removed and collaboration between firms and schools should be encouraged to facilitate the acquisition of practical skills through apprenticeship training.

6

Conclusions and policy recommendations

Digital transformation affects various sectors and countries at different levels of development in a diverse but profound way. Manufacturing, but especially services sectors, are affected more than those of agriculture and construction. Low-income countries experience major barriers in digitization due to infrastructure and digital connectivity issues, unlike middle-income countries where digitization occurs at the same pace as in more advanced economies. Even though digitization does not occur to the same degree across economies and geographies, the effects that it has on skills demand are experienced everywhere. Skills shortages prevent enterprises from deploying new technologies, prevent governments and sectors from implementing their digitization strategies and eventually become a barrier to individual employability and career progression towards the achievement of productive decent jobs throughout the digital economy. The COVID-19 pandemic, with its new role for digital teleworking and online learning, has further accelerated the digital transformation and revealed related skills shortages.

[...]

[...]

It has been several years now since the development of digital skills through education and training with the aim of improving economic and social outcomes, has emerged as a key concern for international organizations (Broadband Commission 2017a). Governments and their development partners recognize the importance of skills development and lifelong learning in creating a level playing field allowing for a more equal distribution of the benefits of digitalization within and across societies and economies. The international community has made strong commitments, including the G20 directive for Member States to "promote digital literacy and digital skills in all forms of education and lifelong learning'" (EC 2017). Similarly, the 2016 OECD Ministerial Declaration on the Digital Economy (the Cancun Declaration) included a strong commitment to enable all people to acquire the skills needed to participate in the digital economy and society, through policies that improve the capacity of educational and training systems to identify and respond to the demand for generic transversal and specialist digital skills; that facilitate upskilling and reskilling through lifelong learning and on-the-job training; and that promote digital literacy together with the inclusive and effective use of ICTs in education and training (OECD 2016e).

The sweeping but highly unequal digitalization across the world will require a twofold adjustment of the skills development systems. First, these systems will need to deliver a solid and yet agile mix of skills required for the digital economies, including digital skills themselves, to all citizens. Second, skills development systems will need to create an enabling environment for dynamic active learning over the life cycle to ensure that people keep pace with digitalization (ILO, 2018d; WEF, 2018a). Technological change, by accelerating the obsolescence of existing skills, means that the vast share of the future skills adjustment must take place during one's working life, including in the workplace (CEDEFOP 2017).

▶ 6.1. Getting skills right, including digital skills

In order to meet the challenge of translating the demand for digital skills into the required skills for a current and future workforce, the educational and training systems should adhere to the following baseline principles and policy measures:[11]

- Ensuring the correct mix of basic, core work and technical skills as a foundation for the further development of digital skills through lifelong learning;
- Incorporating digital skills as one of the foundational skills into early education, including pre-primary, primary and secondary school curricula;
- Reorienting teaching methods to deliver digital and core work skills;
- Giving the right tools to the teachers;
- Adapting TVET;
- Supporting the necessary skills delivery through tertiary education;
- Activating skills response at the enterprise and industry levels;
- Supporting strategies for effective lifelong learning;
- Integrating skills policies with other labour market policies;
- Carrying out digitalization and coordination with other policies;
- Supporting developing countries in overcoming barriers to digitalization.

11 In addition to the literature review and case studies, the recommendations draw on Broadband Commission (2017) and ILO (2011).

▶ 6.2. Right mix of basic, core work and technical skills as a foundation for the further development of digital skills throughout lifelong learning

Possessing foundational skills, such as reading, writing, and numeracy skills, is one of the necessary conditions for acquiring digital skills and embracing changing technological opportunities. These are the skills that make further learning possible. The role of early learning, primary and secondary education in providing these skills will remain paramount.

Despite the considerable progress made over the past decades to guarantee universal access to education, over 260 million children, adolescents and young adults remained out of the school system in 2016 (UNESCO 2017b) and the COVID-19 crisis has aggravated the situation. More than half of all these excluded children and youth are between the ages of 15 and 17 (ibid.). Moreover, despite the considerable progress that has been made in recent years, there is still a gender gap in access to education. According to the UNESCO eAtlas of Gender Inequality in Education, before 2030, almost 16 million girls between the ages of six and eleven will be denied the chance to learn to read or write in primary school, as compared to about eight million boys, if current trends continue. Gender disparities remain highest in the Arab States, sub-Saharan Africa and South and West Asia.

In addition, the quality of formal education remains uneven, with many pupils not properly acquiring even the basic skills and competencies. Continuous efforts will be needed to improve the general quality of schooling, and access thereto, and also to reduce the number of school dropouts (ILO 2018d), in particular in developing countries and rural areas. As illustrated by the case studies of low-income countries, the poor quality of compulsory schooling and the high dropout rates contribute to skills shortages and become a major barrier to public and private sector digitalization strategies.

Beyond reading, writing, and numeric skills, the proliferation of digital technologies will generally continue to feed the demand for skills related to analytical thinking, problem-solving and innovation, particularly in STEM-related occupations. STEM education should be fully integrated into the national school curricula wherever this is not yet the case. Here again, girls are less likely to participate in STEM subjects, across developed and developing countries. According to UNESCO (2017a), gender differences in STEM education begin as early as primary schooling.

The educational needs that will cultivate lasting human qualities such as adaptability, curiosity, a learning mindset and social intelligence are being increasingly emphasized (Muro et al. 2017). Although there is as yet no real development of a curriculum for teaching or enhancing such non-cognitive qualities, early childhood interventions, cooperative learning models and project-based learning approaches in schools are known to foster such qualities (ibid). These will lay the groundwork for students to maximize the ability of humans to add value beyond the value that machines can add in the future to work (ibid.). There will also be an increasing demand for the knowledge of foreign languages, especially English. This is because English is the main language of digital technologies and also is the language that enables greatest access to digitally-based learning opportunities. Moreover, this is the language that will allow access to the greatest number of work opportunities posted through digital platforms and digital value chains.

At the same time, an effective combination of basic, soft core work and hard technical skills is the prerequisite for a successful transition from school to productive decent work and transitions between jobs. That is why adapting what the TVET and tertiary education has to offer, and ensuring the responsiveness of skills development systems will be just as important as incorporating digital skills into all levels of training, as further explored below.

▶ 6.3. Incorporating digital skills into early learning, compulsory and secondary school curricula

Digital skills will increasingly have to be incorporated into early childhood learning, primary and secondary school curricula, where this is not yet the case. This presupposes changing the existing curricula by updating existing courses and creating new ones. Since digital skills are very dynamic and evolve rapidly, school curricula also need to be continuously adapted and demonstrate the flexibility to incorporate new teaching concepts and methods. Dropping unnecessary bureaucracy and establishing flexible ways for adapting curricula, including granting more autonomy to teachers and schools, will have to be combined with quality assurance, and the establishment of evaluation and monitoring mechanisms.

The extent to which such changes can be made rapidly is determined by and large by the level of embeddedness of adaptation in education and training systems. Throughout the world, primary and secondary schools have not sufficiently kept pace with the changing skill sets that students need in the digital world. Moreover, where changes have happened, the teaching quality needed to impart these skills has sometimes lagged behind. Systems that have a strong tradition in updating qualifications and curricula, such as Australia, Denmark, France and Germany, will follow existing pathways, including strong social dialogue with the use of related institutional mechanisms at national, sectoral and local levels, to include skills for digital economies. Some countries have been involved in this process of change for many years. In contrast, many developing countries' institutions still lack the appropriate resources and structures to tackle the issue. It is no wonder that, in such countries, digital skill responses are often formulated outside their existing training systems. Access to digital skills, however, remains highly unequal, and the evaluation of quality is random at best.

Teaching digital skills starts with the inclusion of standard teaching modules focusing on basic digital skills that are relevant to all learners. Those include button knowledge, such as the use of simple text-processing programmes and of internet search engines. Such skills will serve as a basis for developing more generic and specialized digital skills at higher levels of education but also outside of the formal schooling systems.

At a higher secondary level, teaching digital literacy in a more general way may also be incorporated by updating the content of existing courses. For example, STEM courses are increasingly updated to include programming, 3D design, robotics, and concepts of cybersecurity. Biology and health, history and civilization, and social studies courses can be updated to include topics of behaviour in the digital space, digital safety, knowledge of digital rights, and general awareness of how digital technology, big data and algorithms shape society.

Digitalization also calls for creating fundamentally new courses in compulsory level education. Those include, but are not limited to, coding and software development. In some developed countries, such as Denmark, Estonia and the United Kingdom, such courses have already become compulsory. The Singaporean Code@SG initiative, for example, aims to establish coding as a national capability, starting from early education and continuing through secondary school. While exposing children to coding and basic ICT concepts will not influence career choices for many of them, it has great potential to impart a basic understanding to many others on how technologies have been created, how they can be reprogrammed, and how decisions are reached. (World Bank 2016). Those understandings will be particularly important for future non-coders who will work alongside technologies, including re-programmable robots. At the same time, rather than focusing on teaching specific programmes or coding languages that are currently in existence but may become obsolete tomorrow, digital education should also strive to focus on students' awareness of digital technologies, and on their operational principles, putting stress on general digital problem -solving ability and computational thinking.

Apart from becoming part of the school curricula, teaching digital literacy for all is also expanded through extracurricular courses and clubs, competitions and campaigns, and in some cases the subsidized distribution of low-cost computers equipped with preloaded courses and applications. Becoming increasingly more popular are annual Code Weeks, coding competitions and hackathons designed to promote the development of coding skills among young people. Examples include the Africa Code Week initiative, the Young Scientists Kenya (an exhibition which, in 2018, showcased 93 scientific projects created by secondary school students in over 80 schools from 10 East African countries), the national and global worldskills competitions, or the worldwide technovation competition.

There are significant challenges involved in teaching digital skills. For example, digital skills are often considered technological, hence belonging in the male domain in many countries, and boys and girls remain unequal in the face of digital skills acquisition. When girls do acquire digital skills, they still tend to specialize in generic rather than specialized digital skills as compared to boys, which means that the gender earnings gap is likely to persist and even increase in the future. Particular attention thus needs to be paid to ensuring parity in digital skills acquisition, not only through the inclusion of girls into such courses, but also through changing social and cultural attitudes.

▶ Box 5. UNESCO programmes to develop the digital skills of girls and women

In order to reach those in remote places and outside of the formal education system, to help close gender gaps in science and maths, and offer new employment opportunities for women and girls, UNESCO has been implementing several initiatives, including through public-private partnerships. For example, in Nigeria, UNESCO has trained 60,000 illiterate women and girls in the use of ICTs, and with the company Procter and Gamble, will further deploy ICTs to empower an additional 50,000 illiterate women and girls facing difficulties accessing formal education. In Ethiopia, with support from the HNA Group and Cihang Foundation, UNESCO is strengthening the institutional capacity of teacher training institutions to harness the use of ICT for quality, gender-responsive STEM teaching and learning, with wider application to other countries through UNESCO's International Institute for Capacity Building in Africa (IICBA).

In Myanmar, UNESCO is working with Ericsson, the United Kingdom Department of International Development (DFID) and other partners to build teacher capacity to deliver ICT-enriched education, ensuring that girls and boys receive a quality education that can transform their futures. UNESCO's youth mobile initiative, deployed in more than 20 countries worldwide, is also providing young girls and boys with the skills and confidence to become creators of digital innovations. UNESCO is also co-leading with the German Agency for International Cooperation (GIZ) the EQUALS Skills Coalition: the Global Partnership for Gender Equality in the Digital Age, a coalition of programmes dedicated to promoting digital gender equality. The skills coalitions aim to equalize the technological industry and arm women and girls with the skills they need to change the world.

Source: Broadband Commission, 2017b

▶ 6.4. Reorienting teaching methods to deliver digital and core work skills

As seen in previous chapters and case studies, the demand for core work skills will become increasingly important in the future. Many of these skills will be closely interlinked with digital skills. For example, online behaviour and communication, or digital content creation, closely intertwine pure digital skills with the traditional soft skills of communication, creativity, innovation, sense of curiosity and passion. Navigating the digital world also requires the ability to identify, retrieve and synthesize information. In addition, in view of the rapid technological changes, education systems should increasingly focus on a flexible approach to teaching, adaptability, and learning-to-learn as the key abilities to keep up with the rapid shifts in technology and in work places.

The old-fashioned method of knowledge transfer through passive listening to a teacher and learning by heart is increasingly being rejected as a suitable form of education for the digital future. While the knowledge transmitted in this way still has value, such pedagogy does not deliver the skills necessary for the digital economy, as memorizing is a skill that machines can do better than humans (Hussain et al. 2007; Gleason 2018). Rather, emphasis should shift to the ability to know how to ask the right questions, to being curious and open to asking them, to recognizing trustworthy and relevant information and synthesizing it, to learning new ways to manipulate content, learning how to navigate in the informational society.

In order to properly integrate the provision of such skills into the curricula, it is necessary that, in addition to school curricula, teaching methods and approaches to teaching should also evolve and that digital and core work skills for the digital world should be mainstreamed into existing courses.

This can be done by incorporating digital technology to classes and creating interlinked classes for all courses. It can also be approached by adapting teaching methods to one of the key characteristics of the digital economies – networked computing – according to which contemporary digital technologies are built around interactive forms of exchange, with content being shared in a "many-to-many" fashion (Jensen 2015). Indeed, learning in digital networks is seen by some as a modern approach to digital literacy, whereby virtual skills are taught through proficiency, using networks of people, tools, and resources (Wilson et al. 2018), and also through digital collaboration, including the use of collaborative notebooks. Examples of such new methods may include so-called "gamification" – introducing apps and games – specifically designed for education in the classrooms. The apps of today vary in their functionality: some teach keyboarding skills through games; others allow for the creation of a connected classroom, develop interactive assessments, or engage in tasks that stimulate creativity and problem solving.

Such changes usually necessitate long-term and wide-ranging educational reforms. Many countries are already fully embracing them. This is the case of Singapore, for example, which oriented its educational system away from academic teaching and examination scores, towards cultivating creativity and critical thinking. Increased attention is paid to team work, experimental and problem-based learning. Learning to learn, and failing to find a solution, so long as learners are looking for it, is viewed as an integral part of the process (The Economist 2018). The country's Framework for 21st Century Competencies and Student Outcomes is the result of two decades of curriculum development through successive masterplans for ICT in education and a long-standing focus on applied learning and learning for life (Tan et al. 2017). Similar approaches are being tested through Colombia's Escuela Nueva model, serving over five million students in 16 countries (World Bank 2016).

▶ 6.5. Giving the right tools to the teachers

Teachers and tutors are the backbone of the delivery of learning. It is their digital capabilities that are the key enablers of transmitting knowledge online or in a layered way. Adopting new models of teaching requires a different approach to teacher training, providing the right tools and offering continuous professional development.

First, it is important to make generic transversal digital skills a key component of teacher training, with reference to UNESCO's ICT Competency Framework for Teachers (2011), and to the report by the working group of the Broadband Commission for Sustainable Development (2021). This necessitates reviewing and updating programmes to enable teachers to benefit from digital technologies and improve the digital literacy of students. Teachers, however, not only need to possess the digital knowledge themselves, they also need to be taught how to change the teaching methods. Teachers can no longer be a simple source of information, they must know how to set up problems, and how to instruct students to find the information, manipulate content, and apply learnt content in a new context. They also need to know how to guide and accompany learners in these processes (World Bank, 2016). This also requires a new approach to teacher training to prepare teachers accordingly.

Secondly, development of the right tools for teachers is impossible without the leadership and support of schools and training centres, notably in the area of digital devices. Thus, the right tools not only involve teacher training, but also the provision of devices for effective deployment in class. When it comes to low-income countries, there is also a need for further support in overcoming the cost of connectivity and infrastructural connectivity issues from the management of training centres and also from government bodies.

Digital technologies themselves may also serve as a formidable tool in preparing a new generation of teachers and assisting them in teaching their classes. Moreover, non-formal initiatives involving cooperating with businesses and non-governmental organizations can also be effective in learning how to use such technologies, but also ensuring that teachers are sufficiently motivated and confident in using them. As an example of teacher-focused skills development, Google MOOC for Australian teachers, developed by Google jointly with the University of Adelaide computing department, was designed to help Australian teachers implement new national curriculum requirements for programming and coding. Another example is the French "1,2,3...Codez!" programme led by the "La main à la pâte" foundation in partnership with Microsoft, Google, publishing companies, non-profit educational technology associations, and the French Institute for Research in Computer Science and Automation. Among other activities, this programme developed free online and paper-based pedagogical resources for teachers to be used in classrooms, a collaborative website, and network-based and face-to-face training sessions. Examples from Mexico, Nigeria, Pakistan and Senegal also show the potential of using mobile phones with dedicated mobile content to upgrade teacher knowledge, especially in remote rural areas (UNESCO 2017c).

During the COVID-19 pandemic the lack of appropriate online learning platforms, the scarcity of teaching resources and related pedagogical skills prevented teachers from delivering effective online learning (ILO et al. 2021). In reaction to this situation, many new and innovative products were developed. Mainstreaming these in education and training systems will increase resilience and build the capacity of systems to deploy prompt measures in the event of future crises (ibid.).

▶ 6.6. Reinforcing TVET to deliver digital skills

The provision of solid digital skills can be easily adapted to rapidly changing needs through the provision of relevant demand-driven TVET.

The growing interest in digital skills provision by TVET is reinforced by the fact that digital skills can serve several functions. First, basic digital skills, such as word processing and spreadsheets, are still in demand across a range of occupations and in a range of industries. They can become a door opener to the middle-skill job market (Burning Glass 2017). They can also be of particular relevance to the TVET programmes that are complemented by second chance programmes and initiatives designed for young people with incomplete basic education or those who lack professional training and employment opportunities.

Second, the development of more advanced transversal ICT skills can complement non-ICT skills in other domains. It can be particularly rewarding in middle-skill hybrid occupations, combining digital skills with business or specialized technical skills. As digital technologies have been evolving, they have at the same time been lowering barriers to entry within the technology skill set, thus becoming more accessible – and more in demand – across a wide range of industries. Examples include professions within health-care technology such as medical lab technicians, telecom technicians, environmental monitoring technicians, machine maintenance operators, or digital marketing specialists.

Lastly, ICT-specialist training is a growing area within the TVET sector, offering new degrees and programmes. The skills acquired through such programmes can advance a career at least as much as the acquisition of a university degree. By providing not only theoretical education but also on-the-job training, they can be particularly rewarding. Dual apprenticeship systems, centred on the idea of acquiring both relevant skills and experience, can be particularly interesting in this regard, especially when students with advanced ICT knowledge are placed into industries with non-ICT specialization. For example, to enable its cybersecurity 2011–2016 strategy, the United Kingdom produced, as an outcome, 300 level-4 cybersecurity apprenticeships, including 50 within the Government itself, while the National Cyber Security Center (NCSC) now has its own programme called the CyberFirst degree-level apprenticeship (Cabinet Office 2016). The United States Government is urging federal agencies to use more specific programmes (pathways programme) and apprenticeships to grow cybersecurity talent. It is also planning to support the development of an elite comprehensive career technical education programme of study in cybersecurity (De Zan 2019).

More generally, in view of the digital skills that become obsolete too quickly, along with regular courses, TVET institutions should strive to teach broader specializations and adaptable skills for fast changing jobs; provide tools on how to manage one's own career and compose one's own qualification; and prepare for the market and for life rather than for a lifetime job. Aligning curriculum to industry and employer needs, and mapping curricula to learning outcomes relevant to labour market needs are keys to the successful delivery of skills that are in great demand and also to improving worker employability.

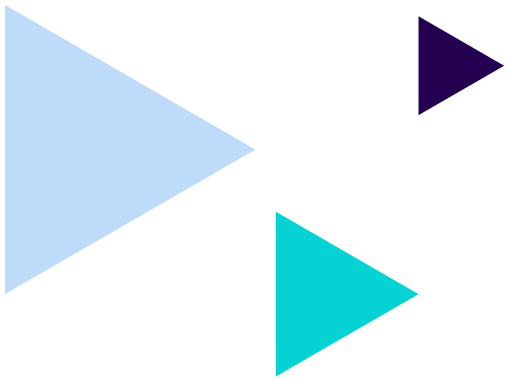
The development of such quality training necessitates high involvement and commitment from employers, in order to ensure that skills vital for the digital work are well incorporated into the curricula (ILO 2017). The success of TVET systems in equipping future workers with the relevant digital skills also relies on the relevance of the provided skills to the labour market, secure and uninterrupted financing, access to technologies (and sometimes to electricity and the internet), availability of up-to-date teaching materials (including specific online courses). Furthermore, the TVET system should take advantage of existing digital learning tools and resources, and explore options for innovative, digital pedagogical approaches such as simulators and augmented or virtual reality (UNESCO-UNEVOC 2020). This technology-enhanced pedagogy has great potential not only to facilitate the learning process and enhance the authenticity of learning, but also to train learners' digital literacy and mindset, an essential prerequisite for tomorrow's world of work (ibid.). A shift towards digitalized TVET systems is highly

desirable, in particular in the context of current social distancing. The TVET systems should capitalize on this increasing demand for digital and distance offerings.

At the national level, the development and regular review and update of qualification frameworks can provide relevant support to more systematic use of learning outcomes (Bjornavold and Chakroun 2017) and the validation and recognition of prior learning, including digital informal learning. For example, recognizing competencies that have been acquired through online coding courses may contribute to resolving coding skills shortages, especially in developing countries.

Some countries do not rely enough on TVET systems, and there is scope for leveraging the role of these systems in the advancement of digital skills. In Asia, for example, the percentage of students in upper-secondary schools who were enrolled in TVET as of 2013 was as low as 3 per cent in Afghanistan and India and less than 10 per cent in Lao PDR, Tajikistan, Bhutan, Bangladesh and Pakistan (Thang Tze Yian and Park 2019). Such a low participation rate often demonstrates not only a lack of resources and TVET structures, but also the failure of the TVET sector to provide quality vocational training and skills development for all persons.

Indeed, top quality teaching is very important and relies on the availability of professionals and also on their up-to-date skills. While some countries have sophisticated programmes in place for the professional development of teachers and trainers for TVET systems, others only have weak or inadequate programmes at best (for an overview, see Brewer and Comyn, 2015). For example, Malawi does not have any formal training of TVET teachers; ad hoc pedagogical training takes place through workshops. This is in contrast to the Philippines, which offers programmes for TVET teacher training at four levels: master's degree in innovative technology education; leadership enhancement and development programme; work attitude and values enhancement programme; team leaders' session on basic leadership skills and coaching (ibid.). But the challenge is not only to prepare TVET teaching professionals, but also to retain them. Clearly, the extent to which countries can prepare, retain and motivate their TVET teachers will determine the extent to which TVET systems can deliver the necessary skills and help close the digital skills gap.



▶ 6.7. Supporting necessary skill delivery through tertiary education

Universities have historically been at the forefront of the provision of specialized skills. This is true for advanced digital skills and for advanced specialized digital skills, the skills of most interest for the orientation of their programmes and the development of new programmes to meet the market demands for skills.

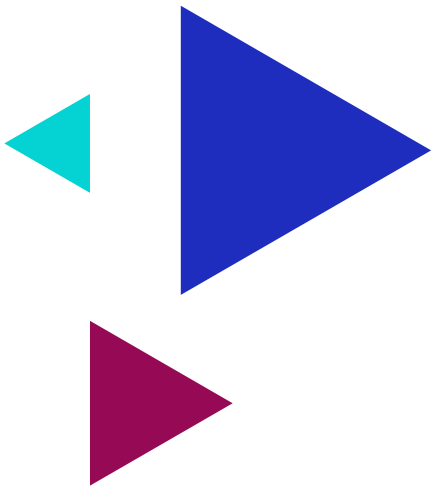
Notwithstanding significant progress over recent decades, there remain important gender differences in access to tertiary education generally, and to STEM professions specifically. Globally, female students represent only 35 per cent of all students enrolled in STEM-related disciplines in higher education, and women who enter STEM professions leave in disproportionate numbers compared to men (UNESCO 2017a). This is often related to the lower rates of enrolment in STEM-related classes in secondary school, when those are optional, but also to cultural stereotypes about gender roles, including gender parity in internet use (ITU 2017).

University systems are facing a number of challenges and need constantly to reinvent themselves. First, many universities have traditionally provided specialized digital skills and other specialized professional skills in silos. There is still an important role for such core siloed computer science and computer engineering courses to produce deep specialized skills, to ensure that there is a mix of skill profiles in graduate output. At the same time, it is the hybrid and double-track programmes, in which part of the teaching concerns the acquisition of digital skills, which are in demand as never before. The preparation of hybrid training programmes requires agility, the availability of the appropriately qualified lecturers, and strategic cooperation between departments. This often requires not only strong leadership and vision, but also resources. Private universities, especially in developed and emerging economies, and also business schools may be better equipped to address this challenge, although there are also good examples of other approaches.

Furthermore, with the quickly changing skill demands, universities need to have good up-to-date data to build new programmes and learning pathways in order to provide relevant skills securing school-to-work transitions. Improved university-industry collaboration can help in attenuating differences between the needs of companies and the competencies imparted by higher education systems. This is particularly important for new and emerging occupations, for which not only lecturers with the right skills are lacking, but also the vision of possible career paths.

Many universities are reinventing themselves by providing online courses, programmes and trainings, including by working in partnership with MOOC platforms. By 2016, there were over 100 MOOC specialized platform providers offering courses in cooperation with educational institutions (Music 2016). Examples include EdX, founded jointly by Harvard University and the Massachusetts Institute of Technology (MIT) in 2012, and featuring over 90 global partners as of 2019. EdX delivers verified certificates for a fee, even if some courses are available for free. The competition of higher educational institutions with alternative low-cost learning programmes including MOOCs is constantly growing. Alternative forms of universities are also flourishing, such as Udacity – an online university in partnership with Google, Facebook and Salesforce – and delivering credentials that are recognized by employers (UNESCO 2018b). More and more questions are being asked, however, about the completion rates of such programmes, the certificate uptake and the recognition and validation of credentials obtained on these platforms. Moreover, the traditional models of credential evaluation are being constantly challenged, as both for-profit and non-profit verification agencies step into the field, calling for new standards in credentialing (ibid.).

Last but not least, the very rapid digital developments may also carry a risk of overproducing specialists in some demanded fields. For example, in the combined 200 universities of Belarus, Poland, Romania and Ukraine, taken as a group, around 60,000 IT specialists are produced per year; more than half of these go on to work as outsourced staff for foreign companies (AVentures Capital et al. 2019). In Ukraine alone, the share of IT graduates rose from 21 to 27 per cent of all graduates between 2015 and 2017. The 51 universities of Belarus offer 70 IT specializations preparing students to work in the IT industry; with 20.5 per cent of all graduates in 2018 specializing in STEM, against 17.6 in 2014. At least 44 per cent of these specialists work for outsourcing companies exporting IT services (ibid.). The broader questions that arise are the extent to which local university systems are serving the interests of international employers rather than local economies; whether this skill bias is not void of risks in the future; and how the private benefits of the public investments in these programmes can be shared on a wider basis (ILO 2018b). It is also clear that, in order to avoid future skill imbalances, it is important to properly guide individuals (future students and their families), providing them with tailored information about training and labour market trends, and setting in place the right incentives (including financial) to direct them towards beneficial learning (OECD 2019b).



▶ 6.8. Activating skill response at the enterprise and industry levels

Digital skill needs are usually identified first and foremost at the level of the individual enterprises. An enterprise's success hinges on people, their skills, adaptability, ability to make the best of the new technologies and accomplish more with it. Business analysts agree, however, that the real deciding factor in the era of digitalization will be not only the workers' skills per se, but the company's ability to evolve its whole corporate culture to embrace the new business strategies that those technologies drive (Accenture 2016). In other words, successful companies will be those in which "corporate culture looks at technology as the way to enable people to constantly adapt and learn, continually create new solutions, drive relentless change, and disrupt the status quo. In an age where the focus is locked on technology, the true leaders will, in fact, place people first" (ibid.).

As outlined in the previous chapters, technologies bring disruptions to the existing business models. Companies, especially those relying on non-standard work, are increasingly orienting their human resource strategies (whenever they have one) to source workers with all relevant skills from the market rather than develop them in house. Moreover, subcontracting and labour outsourcing, including through labour platforms, has opened up international markets from which companies can source their talent.

Despite this, skills shortages are among the most frequently cited obstacles to further business development and companies are well aware that not every skill can be easily available on the market. In addition, serious companies increasingly value know-how and, in view of the increasing sophistication of businesses, they also need in-depth insider knowledge. Moreover, reskilling workers can actually be a cheaper option than laying off out-skilled staff and finding replacements on the market, at least in sectors such as aerospace, aviation, travel and tourism, consumer and financial services, and oil and gas (WEF 2019). Accordingly, training solutions provided by the enterprises remain an important option for many employers. As case studies demonstrate, enterprises in developing companies often have to compensate for the skill gaps resulting from the low responsiveness of education and training systems to labour market needs, and invest in digital skills training.

In the OECD countries, 82 per cent of companies with at least 10 employees provide training for their staff (OECD 2019a). According to WEF (2018a), over the 2018–2022 period, on average, the largest game-players will see half of all retraining delivered through internal departments. A third of the retraining to be delivered directly by employers is expected to result in an accreditation recognized outside the company in question. Employer-provided training is an important part of lifelong learning, with 66 per cent of all adult learning activities taking place through on-the-job training (OECD 2019a). Engaging those who do not participate, and those who have higher barriers to participation, is a "major task for all stakeholders involved" (ibid.).

At the enterprise, digital skills can be acquired informally on the job, with or without the help of colleagues or mentors. In many instances, informal learning in the workplace may be even more important for workers' human capital development than formal training courses (de Grip 2015). Catering to younger workers generally more at ease with most recent technological developments, platforms such as #ReverseMentoring represent a new trend in informal on-the-job learning, whereby older executives are mentored by younger employees on topics generally related to digital technology, social media, and current technological trends. Introduced and popularized by Jack Welch, the former chief executive officer of General Electric, back in 1999, this technique has now been formalized as an integral part of learning and mentorship in leading American and European companies (Forbes 2018). Such programmes have proved their ability to pay back not only in skills and vision exchange, but also in retaining younger workers who feel valued by the organization (ibid.). Furthermore, in the context of the COVID-19 pandemic, companies are actively establishing digital coaching and digital or hybrid workplace teams to support employees in skills, equipment and processes in the workplace or remotely.

For companies that require more specialized but fluid skills, a large variety of tools is available, ranging from in-house courses to information sessions delivered by in-house experts and by external specialists from training providers, academia, parent companies, or other private companies. Digital learning, including MOOCs, have become a formidable tool for company staff training, in particular because many online learning platforms cater for groups signing up to do a course, creating a scalable form of training, or tailoring a course to the specific needs of an enterprise. Moreover, some experts believe that the future of online learning platforms lies primarily in performing the professional development and skills upgrading role within companies, especially for small and medium companies that do not have capacities for internal training (Music 2016). Examples of the use of online learning platforms to bridge the digital gap at company level include "Udacity for Business", which targets the tech-companies corporate training market, or India's "Mobile MOOCs", addressing skills shortages in finance and accounting (ibid.).

To provide a structured response to the need for more complex digital skills and competencies, a number of large enterprises at the forefront of digital innovation and the adoption of digital technology have opened (or adapted) their own training centres. Referred to as "education campuses", or "corporate universities", some are seen as real competitors to business schools. Not only they provide the skills most relevant to the company, they also nurture and protect internal cultures. Teaching materials often include case studies based on the companies' most important decisions; they are also often taught by those who made them (CMI 2015). Examples include American Apple University, General Electric campus, or the Indian VS Motor Company's Corporate University, the Institute for Quality and Leadership.

The Global Council of Corporate Universities promotes these efforts and awards such corporate universities performance certifications. According to its founder, not only can digital skills be effectively taught through such corporate universities, but digital technologies have also created formidable learning tools and empowered such learning structures. For example, many corporate universities have created virtual environments that enable learners to transfer or to create content through multimedia, mobile phones, TV channels, audio lessons, videos posted on YouTube or external social networks (Wagner et al. 2019). They develop virtual libraries, e-books, educational games, self-development electronics tutorials with online assessments, webinars, communities of practice in blended learning, and virtual reality training programmes. By doing so, corporate universities can optimize their business models and strengthen corporate culture by reaching out to employees around the globe, adapting content to local languages, reducing travel of staff, and remotely delivering participation certificates (ibid.). Like any system in the face of technological disruptions, however, corporate universities face the challenges of staying relevant and competitive, providing holistic training (which is being challenged by the fractionalization of courses), remaining human and not isolating workers behind the screens (ibid.).

Two key challenges that companies face when providing training to their staff are, first, skills anticipation and the knowledge of which skills are most needed and, second, the financial resources to provide high-quality and relevant training.

While small and medium companies may be able to anticipate short-term skills, they often lack the capability to assess their skill needs beyond the short term (OECD 2019a). Social partners and governments can play an important role in this process. In OECD countries, employers and employer organizations are involved in the identification of skills for the labour markets in 69 per cent of the countries, and trade unions in 59 per cent of the countries (OECD, 2019c). Social dialogue at the enterprise, sector, or national level can also be an effective tool to determine which skills are missing, and what are the best ways to address this issue. For example, in Denmark, tripartite negotiations resulted in agreements to enhance digital skills training; it is also the first country to have concluded a collective agreement between a union and an online employment platform (Orlik et al. 2018).

Skill needs can also be identified at the level of the entire industries. Industry associations, sector skills councils, or chambers of commerce can all act as drivers of joint skills responses (ILO, 2011). Traditionally, such industry-led responses were more frequently found in developed countries, where industry collaboration was stronger than in developing or emerging economies, although sector skills bodies and strategies are becoming increasingly widespread in developing countries too. With the advent of new

technologies, skills assessment is also becoming possible at the global industry level. Examples include industry-wide global reports, such as the (ISC)^2 Cybersecurity Workforce Study or the ISACA State of Cybersecurity survey. Some private companies now specialize in industry-specific analytics, including on skills. Examples include EMSI Burning Glass Technologies or JobKred, which use big data and AI to monitor in real time skills demands by industry, occupation and sector; to provide workforce analytics, and to help formulate specific skill strategy responses for enterprises and education providers.

Resources are another important consideration in a company's decision to provide learning opportunities for its staff. Most often, training at enterprise level is funded by the enterprise itself. It is often seen as an investment, and, if opened to outsiders, can be an additional source of profit. In some countries, enterprises are eligible for public support to fund continuing training of their staff, including to embrace new digital technologies. For example, in the Republic of Korea, building the capacity of small and medium-sized enterprises (SMEs) to develop their staff is the main objective of the Korean Subsidies for Learning Organizations initiative. Through this initiative, employers can qualify for a range of subsidies, including financial support to hire external consultants to analyse the company's training needs, to build the capacity of the chief executive officer and managers and to support the process of becoming a learning organization, setting up learning groups and financing training (OECD 2019a).

In Finland, there is a financial incentive in place, operationalized jointly with building the capacity of companies to identify their training needs and deliver training. The Public Employment Service plays a key role in this programme, by supporting efforts by employers to define their training needs, selecting the appropriate candidates for training, finding an education provider to deliver the tailored training, and financing part of the training (ibid.). In countries with levy funds financed by the private sector, such as Brazil, France, the Republic of Korea and South Africa, companies can claim back their contributions to support the continuing training of staff. Public or private training providers may be involved. These measures are part of the national skills development system (ILO 2011).

▶ 6.9. Supporting strategies for effective lifelong learning

Lifelong learning is one of the key ingredients of SDG 4, demanding inclusive and equitable quality education and the promotion of lifelong learning opportunities for all by 2030. It is a process which continues through all stages of life, and can be related to formal and non-formal education and learning structures (UNESCO 2016). Lifelong learning strategies and educational development plans are important in providing adult learners with opportunities to improve core skills for employability, including digital skills. In addition, effective career guidance for adults can help individuals to make smooth career transitions and access lifelong learning (ILO 2021h).

Formal lifelong learning strategies are usually elaborated at a national or industry level. CEDEFOP notes that about half of the EU countries have adjusted these strategies to place more emphasis on key digital competencies or to introduce or reinforce particular ones, such as career management skills (CEDEFOP 2015).

Non-formal education is defined as "an addition, alternative and/or complement to formal education within the process of lifelong learning of individuals. It is often provided in order to guarantee the right of access to education for all. It caters to people of all ages but does not necessarily apply a continuous pathway structure; it may be short in duration and/or low-intensity; and it is typically provided in the form of short courses, workshops or seminars" (UNESCO 2011).

Technological change has revolutionized the approach to lifelong learning in general, and to non-formal lifelong learning specifically. Along with e-learning and open educational resources, open learning through MOOCs has emerged as a modern way of acquiring non-formal skills, including digital skills. MOOCs, as online distance courses that can be accessed by everyone without entry requirements, have opened up access to training anytime, anywhere, including for people in remote areas and people with disabilities. Initially developed by leading universities in the United States and Europe, they have also gained momentum in South America and Asia. By 2016, it was estimated that there were at least 4200 MOOC platforms around the world, with over 35 million enrolled users (Music 2016).

MOOCs offer a variety of training and assessment tools. They vary greatly in level and subject content, and also in their duration, pace and the demands they place on the learner (ibid.). The most popular MOOCs are related to business and management, and to STEM (ibid.). The largest and best known MOOC platform providers are based in the United States (such as Coursera and EDX), Europe (Futurelearn in English, MiriadaX in Spanish, FUN in French, or Iversit in German), but also in the Arab States (Rwaq), Brazil (veduca) and China (XuetangX) (ibid.). To take full advantage of e-learning opportunities, however, access to MOOC courses should be accompanied by proper certification and validation of credentials, and be linked to other types of training (ILO 2018d; UNESCO 2018a). Governments can play an important role in these processes, and also in providing the incentives for firms and workers to engage into these and other forms of lifelong learning.

Informal learning as non-institutionalized learning and an integral part of lifelong learning includes, among other features, open access to digital libraries, online courses or helping-hand initiatives in churches in local communities. The last of these may of particular importance in enabling disadvantaged people – the elderly, migrants, former prisoners and others – to access the internet or to use digital devices. Co-working spaces are also increasingly contributing to the knowledge economy and providing a range of opportunities for non-formal and informal learning (see box 6). The breadth of informal and non-formal digital skills learning means that systematic arrangements for the validation and recognition of acquired competences are very important for young and adult workers and job-seekers, as these may increase their employability and support career development.

There are many inequalities in access to lifelong learning. For example, adults with low skills are considerably less likely to participate in any type of adult learning, compared to those with higher skills

(OECD 2019d). This is due to their poorer ability to recognize their learning needs, and the lack of time, finance and – in particular – opportunities to do so. The role of governments in this respect cannot be underestimated: they are key agents in creating enabling environments for dynamic active learning over the life cycle (ILO 2018d). Together with social partners and the broader engagement of communities they can help reach out to disadvantaged groups through workplaces, dedicated lifelong learning centres (as is the case in Iceland), comprehensive one-stop shops for guidance on lifelong learning (as is the case in Portugal), family skill programmes, or community-based approaches (as is the case in Argentina: OECD 2019d). They are also key in legislating paid leave for educational and training purposes, and providing financial support for various forms of training (ibid.). Furthermore, as a culture of lifelong learning cannot be forced, government interventions that identify and promote workers' innate motivation to learn can play an important role in encouraging the learning mindset of the workforce (Orlik et al. 2018).

▶ Box 6. Co-working spaces reshaping non-formal and informal lifelong learning of digital workers

Co-working spaces have become a feature of digital economies. The www.coworker.com website, which operates as a hotel or ticket-booking website, counted over 9,500 formal co-working spaces in the world in 2019, with over 800 in India, 180 in the Philippines, 94 in Argentina, and 82 in Nigeria. Co-working spaces constantly reinvent themselves to compete and to attract highly skilled digital workers, often freelances, but also start-ups and small digitally-oriented businesses. These shared offices not only provide space and work facilities: some become important digital learning hubs reshaping non-formal education through training events, webinars, coding boot camps, or hackathons. For example, Projector, one of the 31 Kyiv-based co-working spaces, positions itself as a school of design training, blending work and learning. It promotes experience exchange in the field of web development. Regular users can attend design meetings in the morning, work during the day, and participate in the workshops or discussions held every evening. Another example is ProximitySpace, a United States-based co-working hub, which creates education programmes. These range from summer schools to several week-long courses for community managers or founders, with the aim of training them in the latest aspects of digital events creation, digital sales, digital layout and design, or community collaboration. Many other co-working spaces propose mentorship, incubator and accelerator programmes, bringing together industries' top experts and fostering cross-occupational digital skill sharing.

Source: Authors' own elaboration

Digital skills acquisition, whether through formal or informal learning, also remains particularly challenging in rural areas, especially in developing countries. This is due to the lack of infrastructure, poor connectivity and high cost of accessing technologies (UNESCO 2018a). For example, mobile broadband networks (third-generation – 3G – or above) cover 84 per cent of the global population, but reach only 67 per cent of the rural population (ITU 2017). Where it is available, internet access can also be unaffordable.[12] According to the Alliance for Affordable Internet (A4AI 2016), in only 25 out of 51 developing and emerging surveyed countries, did citizens earning the average national income meet the 5 per cent affordability target. Not a single surveyed country met the affordability target for those living in poverty, a group numbering 1.9 billion people. The success of digital skills transmission is thus closely linked to the access to these technologies. Moreover, in some developing countries, especially in rural areas, the benefits of using digital technologies are also not fully understood. In these settings, strategies to reach out to rural areas for improving digital skills also include general awareness-raising of what technologies are and what they can do; working with simple-to-use interfaces and mobile apps; and introducing digital knowledge through locally generated meaningful content (UNESCO 2018a).

12 Internet access is considered to be affordable if an entry-level package of 500 megabytes (MB) of data can be bought for less than 5 per cent of average monthly income (Broadband Commission 2011).

▶ 6.10. Integration of skill policies with other labour market policies

The disruptive effects of digitalization set high stakes for skills, education and training provision systems. The timeliness – or lack thereof – with which education and training systems can respond to challenges places these systems in a virtuous interaction with the world of work, or on the contrary, widen the disconnect between the demand and the supply of skills, exacerbating skill gaps and unemployment and delaying adjustment to the new context. Education and training systems will have to respond swiftly to the demand for digital skills across all sectors and occupations.

The challenges that modern educational systems face are numerous. On the one hand, they will need to deliver a solid and yet agile mix of skills required for the digital economies, including digital skills. They will also need to ensure that this skill provision is inclusive and equitable. On the other hand, skills development systems will need to create an enabling environment for dynamic active learning over the life cycle to ensure that people keep pace with digitalization and the ever-accelerating obsolescence of skills (ILO 2018d).

Among other issues, this will require focusing on managing the different transitions that workers experience during their work life, so that they can successfully enter the labour market and take breaks to reskill and re-engage in employment throughout their careers (ibid.). This life-cycle approach necessitates the active engagement of governments, workers and enterprises in making choices about when and how to reskill and upskill. It requires very sound conceptualization, and yet has also needs to be agile to respond to short-term needs, including through active labour market policies (ALMPs).

During the COVID-19 pandemic, the confinement measures caused a loss of working hours, which evolved into inactivity and unemployment, especially affecting young people, low-skilled workers and women (ILO 2020b). The composition of jobs changed, necessitating corresponding changes to the skills required by employers for the jobs that they hope to maintain or for the jobs that they hope to start refilling with new hires as the economy recovers. The ILO rapid assessments of reskilling and upskilling needs confirm that, apart from technical job-specific skills, digital skills have been the primary demand during the pandemic and will also be in demand during the recovery period (ILO, forthcoming).

Reskilling and upskilling measures require urgent action: in the ILO global call to action for a human-centred recovery from the COVID-19 crisis that is inclusive, sustainable and resilient (ILO 2021g), reskilling and upskilling were recognized as being part of the package of measures that would advance a human-centred recovery. The strengthening of public and private investment in upskilling and reskilling, including apprenticeships, and including the support of career guidance, was launched to facilitate successful labour market transitions and to reduce skills mismatches, including those affecting the low-skilled and the long-term unemployed (ibid.). Reskilling and upskilling, together with other ALMPs, need to be coordinated with the fiscal stimulus put in place to respond to the COVID-19 crisis, that until now has been heavily concentrated in countries with advanced economies. Emerging and developing economies accounted for just 13.8 and 0.4 per cent of the global stimulus, respectively (ILO 2021c). It will therefore be necessary to provide further support to developing economies with regard to crisis response measures, including helping out with reskilling and upskilling.

The identification of current skills needs and the anticipation of those of the future are important for informing those responsible for designing and providing policy, education and training and for supporting career counselling and vocational guidance services. Career counselling, often delivered through public employment services and other labour market support institutions and vocational schools, requires particularly detailed and robust information to guide individual career and training choices. The regular collection of labour market information and the translation of such information into intelligence for different target groups and policy measures are often constrained in developing countries by lack of

capabilities. Institutional capacity development in the anticipation of skills needs is a major priority and is linked to the broader processes of institution building and improved governance, coordination and social dialogue at national, sectoral and local levels.

More generally, there should also be policy coherence between the identification of skills needs, the development of skills, specific policies related to a country's digital and technological strategies, and social protection.[13] For example, workers should receive proper career guidance and be able to follow the life-course of their choice. They should be able to move from one work situation to another in step with changes in the economy and in keeping with their own changing preferences or abilities. Their income should be maintained while they retrain for a new job, either by remaining in employment or being otherwise covered by social protection. One way this can be done is by placing conditions on unemployment insurance and providing training programmes as a form of employment insurance, designed to assist workers before any job loss occurs (ILO, 2016b). Such programmes are actively implemented in some advanced countries but developing countries are also starting to follow suit. Thus, in Brazil, under the unemployment insurance programme, the Fundo de Amparo ao Trabalhador, workers whose contracts have been temporarily suspended receive unemployment benefits during their participation in a vocational training course.

Most existing unemployment insurance systems offer training to workers after they have lost their job, in some instances making the receipt of benefits conditional on participation in the training. Yet most unemployment insurance recipients would prefer to receive job-finding assistance at an early stage of their unemployment rather than participate in training, as many already have substantial work experience and skills that are transferable to other occupations or industries (ILO 2016b). Moreover, some training programmes last longer than the payment of benefits, leaving workers without an income and defeating the purpose of the unemployment insurance benefits. A system of entitlements to training, funded through a reconfigured employment insurance system, such as individual training accounts, also has the benefit of supporting workers with the greatest need for continuing education, who often do not have the resources to finance their absence from work and to undertake training on their own, as well as workers in SMEs who are less likely to benefit from employer-sponsored training. For example, in France, a system of "personal training accounts" was introduced in 2015. Workers acquire a number of hours of training rights per year, up to a maximum of 150 hours over a seven-year period. Part-time workers' rights are calculated on a pro rata basis. Since these rights are attached to the person and not the job, workers can use them with successive employers, irrespective of their type of employment contract, and also during periods of unemployment (ibid).

It would also be beneficial to enable workers who are at risk of digital skill obsolescence to have access to targeted services, by identifying them early on an individual or group basis. This can be done, for example, in the case of collective lay-offs (OECD 2019a). In such cases, it is more straightforward to provide support, including through advice and guidance, in the form of training opportunities and financial assistance for such training, including through unemployment insurance, as is the case in Estonia (ibid.).

Financial support is key to the success of such coordinated cross-country efforts to maintain and upgrade skills over the life time of workers. Public funding can support and incentivize access to learning opportunities, through such vehicles as voucher financing models, entitlements, skills guarantees, individual learning accounts, subsidies, grants, credits and tax breaks (ILO 2018d). The scarcity of public resources, however, especially in developing countries, calls for a diversification of funding sources. Consideration should therefore be given to an appropriate mix of public and private investment in all phases of delivery (ibid.). The proliferation of digital outsourcing and digital value chains, whereby developed countries are increasingly filling in their skills shortages through direct virtual collaboration with specialists scattered around the developing countries, also calls for solutions to involve skill users of developed countries into the skill development in developing countries.

13 For further discussion of articulation with other policy areas, see Ernst et al., 2018.

▶ 6.11. Digitalization and coordination with other policies

The challenge of digital skills is not the only factor affecting skills specifically and labour markets more generally. Other factors include the impact of global demographic imbalances, climate change and globalization. The development of digital skills needs to be articulated with policies designed to face those challenges.

Global demographic imbalances pose problems at both ends of the spectrum. At the one end, countries of the developed world with their increasingly ageing populations are facing a growing number of skills shortages (OECD 2019a). For businesses, the retirement of large cohorts of digitally competent professionals who took years to develop their skills will leave workforce gaps that cannot be quickly filled. At the other end of the spectrum, countries with younger populations face the challenge of improving general access to high-quality education that delivers the most relevant digital skills. They also face the challenges of school-to-work transitions, which may grow more taxing if digitally-hungry businesses do not open entry-level positions for young workers. As the global population continues to grow, urbanization, migration and social and cultural diversity will also need to be increasingly articulated not only with the delivery of the appropriate skills, but also with the transferability and recognition of those skills.

Climate change and the depletion of natural resources challenge the sustainability of numerous economic activities around the globe. At the same time, moving towards a greener economy is also creating opportunities for new technologies, investments and jobs (ILO 2011). The transition to greener economies generates a new skills shortage, as new occupations appear, and others require a new occupational profile (ILO 2019e). Many of these skills shortages are in jobs whose profiles are similar to those of digital specialists – for example, scientists and engineers specializing in green energy and with other types of specialized STEM skills usually attained either through university education or TVET and working in occupations in renewable energy and energy efficiency, manufacturing, construction and services (ibid.). Articulating the professional technical skills of these specialists with digital skills may help to leverage the benefits of digitalization in tackling climate change. It is not only professionals in green jobs, however, who would benefit from being equipped with digital skills. Given that ICT is the fastest growing sector in the field of energy use (Greenit.net 2019), many workers and businesses using digital technologies would also benefit from a better understanding of their global carbon footprint, sustainable IT behaviour, energy-saving strategies, e-waste policies, and innovative use of information technology in the workplace (including teleworking and the use of smart energy applications).

Lastly, along with technological change, trade policies and globalization have been driving economic developments over the past decades. These processes have continued to shape the model of production and consumption in industries, as these industries expanded into new markets and as supply chains became more complex and fragmented. In order to take maximum advantage of the positive effects of technological change, however, economic agents – businesses and workers – need to constantly adjust in order to remain competitive. Most recent evidence from advanced countries shows that participation in global value chains increasingly relies on professionals specializing in high-tech manufacturing industries and complex business services (OECD 2017c). By growing such professionals in-house and retaining them, businesses can secure their place and compete successfully in global value chains. Digital skills are thus an important factor enabling firms to adapt to globalization pressures and competition, economic diversification and specialization, to raise their productivity and to participate effectively in international trade (ILO and WTO 2018). Globalization is also manifested in the outsourcing of digital services. This scenario necessitates global solutions to the forecasting of global digital skill demands, and an international dialogue regarding the provision and distribution of digital skills and on reward sharing and governance.

▶ 6.12 Support to developing countries in overcoming barriers in digitalization

Low and middle-income countries face many barriers on their path to digital transformation. Poor infrastructure, including uncertain electricity supply, and connectivity issues are major obstacles to digitalization, in particular in low-income countries. If not resolved, these problems will widen the digital divide between advanced and lower-income countries and leave large shares of the population behind. Further barriers include inadequate institutional maturity and coordination among government stakeholders and social partners, insufficiently developed governance mechanisms, a lack of institutional capacity, poor funding and lack of access to capital, heavy bureaucracy in the implementation of policies and legislation, including for the adaptation of the training offer and curricula, insufficiently developed networks of effective labour market institutions and career guidance services, and a lack of social protection coverage, especially given the high share of informal employment.

In addition, inequalities across countries are further exacerbated by inequalities within countries, where those working in micro, small and family-owned enterprises, people in rural and remote areas, informal economy workers, young people, women, migrant workers, low-skilled people in developing countries often find themselves deprived of access to digital skills training and the broader benefits of digitalization.

Support for infrastructure, connectivity and the systems necessary for the digital transformation in developing countries should therefore be a primary concern for development partners and international organizations. To foster technological change, further policies could be adopted in the following broad areas:

a. investing in infrastructure; removing bureaucratic constraints to technology adoption; facilitating access to capital, in particular for small local firms that cannot benefit from foreign direct investments; and adopting supportive legislation and fiscal policy;

b. investing in policies that facilitate workers' transitions to new jobs that require digital skills by supporting and facilitating upskilling and reskilling to mitigate job displacement, one of the consequences of technological change, including expansion of social protection coverage and the development of supporting labour market institutions, including career counselling and public employment services;

c. investing in labour market information and skill needs anticipation systems to gain a better understanding of the varied impact of digitalization on key productive sectors and jobs, including institutional capacity development and the development of institutional mechanisms that facilitate signalling of labour market needs;

d. improving the governance of skills systems that facilitate the whole-of-government approach and social dialogue and strengthen the capacity of education systems to adapt to the new skills in demand, with the aim of preventing skills shortages and skills mismatches. For this purpose, bureaucratical barriers to the changes of university and TVET curricula have to be removed and collaboration between firms and schools should be encouraged, to facilitate the acquisition of practical skills through quality apprenticeships and other types of work-based learning.

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Annex

▶ A. Case study: United Republic of Tanzania – transport and logistics sector

Major technological changes, effects and challenges

In the United Republic of Tanzania both the transport sector and the logistics processes are affected by the ability of digital technologies to cover operations in terminals, shipyards, warehouses and depots globally. The technologies currently shaping the sector are automation of container terminals, autonomous trucks, self-driving vehicles (in stores, shipyards, etc.) and warehouses. As the trade volumes passing through the Dar-er-Salaam port are not so big, however, it might be some time before enterprises in the country are able to invest in these technologies. The obstacles to the adoption by traders and forwarding agents of digital technologies such as e-commerce and related big data analytics consist not only in the relatively low trade volumes but also in the level of automation and electronic data interchange systems being planned by the Tanzania Port Authority and Customs. Although automation in both these areas has increased over the years, it may take some more time for digital technologies to have a significant impact on transport operations.

Effects of digitalization on jobs and skills demand

In the United Republic of Tanzania, most of the country's transport and logistics workforce is engaged in the road and maritime transport subsectors (about 1 million in each segment, totalling 2 million). Drivers are the most critical human asset in the road trucking business. Skills gaps persist, however, in road and maritime transport labour markets, and these must be addressed to prepare the workforce for future digitalization initiatives. While air cargo operations are relatively small, the railways have the potential to scale up, following recent public investments. The transport and logistics sector is dominated by small enterprises (many of them informal) and family-owned businesses. Both entry-level and lateral recruitments are carried out through informal networks. The consequent informality in the labour market drives high turnover among workers, who are continuously seeking incrementally better terms.

Responsiveness of education and training to changes in skills demand

In the Tanzanian transport sector, the National Institute of Transport is responsible for training managerial personnel and the scope of its training functions could be expanded to include those performing operator and mechanic jobs. A key reason for the limited penetration of formal TVET programmes in the largely informal transport and logistics labour market is the employers' belief that, if workers get trained and certified in new skills, they will demand more salary and wages. Interview respondents suggested that publicly funded programmes need to focus on the training of technicians – primarily in two areas: first, the training of mechanics and equipment maintenance personnel; and, second, skills development and competency-based training of operations personnel.

▶ B. Case study: India – retail sector

Major technological changes, effects and challenges

This case study relies on the information gathered from interviews with 10 leading retail firms to assess the impact of key digital technologies on processes in store operations, customer sales and category management. All the respondents stated that those technologies enabled, first, omni-channel presence and the associated improvements; second, cashless and cardless checkouts; and, third, faster shipments for same-day delivery. Technologies such as robot-assisted customer service (AI-chatbots) and virtual showrooming, using augmented reality, are likely to be introduced soon, while others using such innovations as the spatial web, for a mix of physical and virtual processes, such as virtual changing rooms in the apparel sector, social shopping, visual search and reverse showrooming could be adopted in about three years' time. The case study also suggests that different enterprises may take different investment decisions regarding digital technologies. For example, an enterprise may invest in increasing its omni-channel presence but not adopt virtual showrooming technologies if the benefit would not offset the cost of adopting them. On the other hand, some respondents suggested that labour is going to remain more cost-effective than certain technologies that need high investments (such as robotics for customer assistance).

Effects of digitalization on jobs and skills demand

The impact of the adoption of digital technologies on job roles in three key functional areas of retail operations was analysed: store operations, customer sales, and category management.[14] The respondents were requested to indicate the number of employees that were currently working in each of the three job roles and to forecast how many employees would be working in those job roles in three years' time. An analysis of the responses reveals an interesting but consistent pattern, in line with that suggested by the current literature. Thus, nine out of ten companies showed a consistent decline in the number of jobs across store operations roles, where most of the workforce is currently employed. For some smaller stores, the number of managerial positions remained the same for the store to continue operations. The data from the companies showed a consistent decline in the number of those working in customer sales, in particular among individual sales professionals, and in business builder and retailer positions, but at the same time showed a consistent increase in self-employed e-retailer, visual merchandiser and distributor salesman roles, all of which require higher skills.

The forecasts were mixed in respect of business leader and multi-outlet retailer, and business enhancer and multichannel retailer jobs, depending on the nature of company operations. All the ten interviewees (without exception) agreed on consistent growth forecasts in the number of positions in category management, which need higher order skills in marketing and digital content creativity.

14 In store operations, the following nine most common roles are considered: retail store operation assistants, retail cashiers, retail sales associate, retail associate cum cashier, retail sales specialist cum cashier, retail team leader, departmental manager, store manager and retail trainee (associate). In customer sales, the seven most common job roles are considered: individual sales professionals, business builder and retailer, business leader and multi-outlet retailer, business enhancer and multichannel retailer, self-employed e-tailer, visual merchandiser and distributor salesman. In category management, the roles of seller activation executive and digital cataloguer.

Responsiveness of education and training to changes in skills demand

The role of e-commerce platforms and the need for digital marketing through these platforms made the Indian retail sector much more competitive than it has ever been before. Competition in today's and tomorrow's world is no longer just concerned with quality, it is about branding and differentiating products through digital marketing. Innovative branding is required to gain an edge in digital marketing, and omni-channel presence is key businesses being able to hold their position in today's markets. Firms are seeking innovative and creative employees who have excellent communications skills to achieve these objectives, but such skills are currently lacking in a workforce which has received only a basic level of training and groomed thereafter to acquire product knowledge. All respondents consistently stated that the training and education system needs constantly to update its course content, to ensure that the workforce is properly trained in the latest technological adaptations in the market.

▶ C. Case study: Cambodia – arts and creative sector

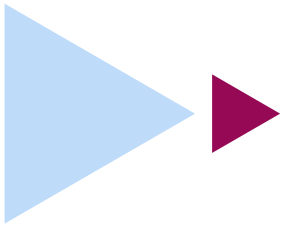
Major technological changes, effects and challenges

Several companies in the arts and creative industry emphasized how the new technologies increased the efficiency and the speed of production. Better links between different software applications enable the faster creation of art pieces, making it possible to produce them remotely, and increased data-processing speeds up production. One of the country's two main museums, the Tuol Sleng Museum, the memorial site of the S-21 interrogation and detention centre of the Khmer Rouge regime, has carried out an impressive amount of work to preserve and present pictures of the inmates, and also to create an extensive audio-guide available in 11 languages. With the help of digital technology, more than 400,000 documents, including hand-written notebooks and photographs, have been preserved. The project plan includes developing a database to index the collection in Khmer and in English. The staff was trained in preservation, digitization and indexing techniques. The museum will be able to use the website to disseminate educational resources to thousands of online visitors.

Effects of digitalization on jobs and skills demand

Most of the employers interviewed for this study reported that they provide more or less organized training for their new employees. The availability of new technology facilitates the acquisition of technical skills, provided that people speak English. All of the creative agencies mentioned that employees follow courses on online learning platforms, and also instruction videos on YouTube, in order to learn how to use new software. Some agencies use a more formal training approach for new hires, especially those without technical background, who follow courses to develop their software skills. In addition, respondents indicated that they were not interested in previous qualifications of the workforce as such. Personality and general attitude, such as curiosity and interest in modern technology, seem to be more important. There is a tendency, however, for preference to be given to hiring university graduates, suggesting that university education does have some signalling value for employers.

The general perception is that, although some technical skills are sought after and very important, such as those of developer, proper video-making and post-processing, digital marketing and new media usage, most of the software skills are relatively easy to acquire. The main bottleneck, however, is the lack of general soft and life skills. All employers identified various difficulties related to employees' lack of such qualities as initiative, personal responsibility, adherence to deadlines and timing of appointments, general leadership skills, assertiveness, ability to clearly define, present and defend their ideas, and creativity.



Responsiveness of education and training to changes in skills demand

One of the challenges relating to the professional development of artists in Cambodia is that there is currently no standard and agreed curriculum for a vocational qualification in fine arts. The Royal University of Fine Arts in Phnom Penh awards its students a higher educational degree in arts. The training seems to be very traditionally focused, however, with little attention to modern technology (see interview below). Limkokwing University (an international foundation, originally from Malaysia) offers degrees in design and software engineering with multimedia, as does the Phnom Penh International Institute of the Arts. The National Circus School in Phnom Penh struggles with low student enrolment, mainly because of the lack of performing opportunities and the unclear career perspectives for graduates. Phare Ponleu Selpak, a vocational art training school and NGO that was interviewed for this study, provides general visual arts training with specializations in graphic design and animation. Students receive training in basic operations using Outlook and MS Office applications. Among other areas where training is required by employers but is not yet available are web-design and 3D animation software applications.

> The curriculum of universities in Cambodia does not hit the point, does not provide students with valuable skills. Often companies have to hire staff from Thailand because in Thailand university graduates profit from better training. Most students study advertising and media (and know how to use it). [...] The graduates really lack creativity and innovative approach. They reproduce what they already know, do not come up with anything new.
>
> – Interviewee of a media company, Cambodia -

▶ D. Case study: Argentina – construction sector

Major technological changes, effects, and challenges

In Argentina, the process known as the fourth industrial revolution, or Industry 4.0, represents a unique opportunity to change and upgrade the construction sector, which has always been characterized by very low levels of productivity. This change revolves around two axes: first, industrialization of the construction processes; and, second, the transformation of business models through digitalization. The influx of new digital technologies into the construction sector is advancing rapidly. Experts assert that the construction sector in Argentina could increase its productivity by a factor of 5 or even 10 if the production style adopted was similar to that used in the manufacturing industry, which implements the Industry 4.0 approach.

Currently, the advances in technologies and digitalization in the Argentine construction sector are being implemented gradually, with the objective of raising productivity levels. Professionals and builders are currently using a range of software in parallel with the building information modelling (BIM) process, including CAD, AutoCAD, CATIA, Sketchup, Revit and CyberCAD. The preference for the use of BIM has been growing year by year. The BIM concept encompasses a set of methodologies, technologies and standards that enable a building or infrastructure to be designed, built and operated collaboratively in a virtual space. A set of computer software is integrated into the BIM process and each project must choose one software product and work with that product. The BIM approach may be used for a variety of applications, such as collaborative axis, non-segregated project work areas, real time information, oriented to forecasting, maintenance and operation of buildings in the long term. Yet, the expansion of BIM in the country is constrained by the absence of qualified human resources, the initial cost of implementation and the failure by some operators in the value chain to adopt the model.

The construction sector in Argentina is beginning to make use of prefabrication modelling technologies involving 3D printing. The end result is that technologies associated with evaluation and forecasting in the design of work, such as 3D designs, 360° inspection and augmented reality, are contributing to sales, promotion and marketing services, through channels and new technologies that make it possible, after the completion of the design process and layout, to check the digital prototype.

Effects of digitalization on jobs and skills demand

The Argentine case study shows that the introduction of digital technologies in the country's construction sector is very slow and that there are no great advances in the adoption of digital work processes. The technical operational profiles show some variation in the tasks even if the competencies required are very basic by comparison with those required in the construction sector in developed countries.

Responsiveness of education and training to changes in skills demand

In Argentina, some progress may be seen in the area of digital education, but it is developing slowly. Argentina has progressively incorporated the use of ICT in the curricula of formal and non-formal educational processes; their use in practice, however, is impeded by the lack of the necessary physical technology. Further obstacles to progress in this regard are posed by the speed of technological change, the lack of flexibility in regulatory frameworks, and the inertia of the country's socio-technical and administrative systems. New strategies must therefore be sought within a framework of collaborative action. Over the long term, a variety of stakeholders, and not only academic experts in education and curriculum development, must be involved in planning vocational education. Currently, training courses in digital applications and ICT are very generic. Public schools face serious budget constraints on investment in these areas, which hinders their access to digital inclusion. While some institutions are currently offering the digital training that is necessary in the construction sector, the scope of such training remains limited and uncoordinated.

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