# Digital Jobs in Moldova

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# 0 Executive summary

Digital technologies (the internet, artificial intelligence, robotics, drones) have either already become widely used, or are expected to diffuse in ways that will fundamentally change how businesses and economies operate. Could and how might Moldova take advantage of these changes? As this report presents, Moldova has an opportunity to position itself to take advantage of technological change and the ongoing digital transformation. Public policies and programs that are well defined and implemented can help here, by helping to create more, better, and more inclusive digital jobs.

This opportunity arises from the vibrant, even if relatively small ICT industry in Moldova. An active private sector, with Government support, has done well to create about 22,000 jobs and steadily increase IT and IT-enabled services exports over the past decade. However, we also find that the dialogue has focused on the digital industries at the expense of the wider digitization of the economy, including of businesses across the economy.

We thus propose to look at digital jobs with a wider lens: including ***jobs in the ICT industry*** (created by the production of ICT such as IT software and services, telecommunications, etc.), but also including ***jobs created or influenced by the digitization of sectors across the economy*** (e.g. in banking, tourism, agriculture, government, etc.). They could be jobs in firms or represent work done by individuals. Hence, digital jobs created by: (i) firms in the ICT industry; (ii) firms across sectors that digitize, and (iii) self-employed individuals engaged in digitally-enabled work. In brief, our analysis finds that the first of these has been getting most of the attention in Moldova, while the second and third sources of jobs are still nascent.

This means that the future potential of digitization to create jobs in Moldova is not fully realized, primarily due to the low level of digitization of the economy beyond the core ICT industry. But at the same time, that there is a risk of job losses and of significant changes in the skills demanded by employers in the coming two decades. Our analysis finds that about ***14 percent of jobs might be automated away***, and critically, that about ***60 percent of jobs might see significant change*** in the composition of tasks performed, and hence skills needed (due to digitization), for which workers seem unprepared.

There is little consensus globally about what can be done to respond, beyond proposing two basic principles: investing in skills, and promoting the adoption of those technologies. Workers who have an appropriate mix of skills, ranging from the foundational skills (e.g. literacy, numeracy) to more advanced soft skills (e.g. critical thinking, teamwork), and technical skills will likely be better prepared to face technological change. And even though digital technologies might pose challenges to employment, they are also the means for economies to remain and become more productive and competitive.

Our analysis highlights three overall messages, building on these basic principles: ***Continue support to the digital industries***, including to make it more inclusive and promote innovation and entrepreneurship; ***Do more on digital literacy*** and skills beyond the IT industry, for today's workers and for tomorrow's workforce; and ***Accelerate the digitization of businesses*** across the economy to capture the benefits of increasing productivity, access to markets, and innovation.

Implementing these means moving along three directions of work to position Moldova better to take advantage of digital technologies and the changes they will enable: investing to ***prepare the workforce*** of the future, ***prepare firms for the digital futures***, and ***promoting digital employment*** among individuals. The report closes with a discussion of what such programs could look like, based on international examples and emerging best practices.

# 1 Introduction

Digital technologies (e.g. information technologies, telecommunications, robotics, AI) are reshaping economic opportunities for individuals, businesses, and countries globally. The improving capabilities of these technologies and their increasing adoption globally may lead businesses to automate some tasks or jobs, or shift work to new locations. This could imply job or wage losses, but also shifts in the patterns of global trade. It is also these technologies that create opportunities for individuals and businesses: they reduce transaction costs, connect firms and individuals to each other and to markets, enable innovation, and support improvements in productivity. In sum, technological change will affect different businesses, individuals, and economies differently, depending on their level of preparedness.

As a small, open economy with a declining population, Moldova would need to consider steps that prepare it, its workforce — of today and of the future –, and its businesses for this uncertain future. This report presents the results of an analysis of what Moldova could do to prepare for (and take advantage of) the increasing digitization of economic activities across sectors in and outside Moldova. It points to some of the directions that could be integrated into upcoming programs, financed by development partners, or considered for action by the Government.

The report has three main sections. It begins with an overview of the ways in which digitization is influencing employment, globally and within Moldova. It then speculates about how Moldova might experience digitization in terms of the risks due to automation (as caused by digital technologies), identifying the occupations and sectors in which risks of job losses are the highest. Based on this analysis, we identify possible responses to prepare both Moldova's businesses and its workforce for these changes.

# 2 Global trends: Looking to 2030

This section considers the global technological trends that could influence economic prospects for Moldova, and then discusses the status quo of digital technologies' adoption in Moldova.

We frame this analysis in the context of a digital future for Moldova, considering the period until 2030 at least. This is because the extent of digitization of the economy — and of every occupation — will likely only grow during the coming decades, and that the futures of the workforce is already being determined.

Consider the following: a child starting kindergarten in 2018 will be entering the workforce in the late 2030s, and working at least until the 2070s. The educational and skills development choices available to her today, through systems built based on curricula and methods from the 20th century, will shape their and their country's futures over the coming many decades, exactly when the technologies we consider "futuristic" today (artificial intelligence, self-driving vehicles, 3D printing) may be widespread.[2]

## 2.1 Technological change and work

Recent analyses have suggested that technology could automate or change some tasks within occupations, and hence, workers would see significant changes in task-content of their jobs.[3] Other analyses have found that labor markets are

[2] Consider, for instance, that the internet became publicly available in the early 1990s, and as of 2018 connects over half of the world's population. Or that mobile telephones serve over 5 billion people now, 40 years after their commercial introduction in Japan.
[3] Carl Benedikt Frey and Michael A. Osborne, The Future of Employment: How Susceptible Are Jobs to Computerisation? 2013, p. 44, available at: http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf; Arntz, M., T. Gregory and U. Zierahn (2016), "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis", OECD Social, Employment and Migration Working Papers, No. 189, OECD Publishing, Paris. http://dx.doi.org/10.1787/5jlz9h56dvq7-en

**Table: The Dimensions of Technology's Impact on Jobs**

| | Positive effects | Negative effects |
|---|---|---|
| Quantity of jobs | Access to markets and resources, due to improved connectivity; helps firms grow and create jobs, or attract work to new markets that are more competitive.<br><br>Product innovations, created and distributed using various technologies; give rise to new industries, firms, and jobs. | Susceptibility of today's jobs increases, due to automation, as machines can take on more tasks, or due to innovation reshaping industries and firms.<br><br>The nature of jobs changes, as technology reshapes and alters connections among workers, work, and employers. |
| Quality of jobs | Productivity increases due to the augmentation of workers' capabilities through automation; leads to related increases in wages, and improvements in working conditions. | Workers bear more risk, as connectivity reorganizes where work is done and by whom, diffusing the traditional formal employer-worker relationship.<br><br>Wages stagnate or fall, as technology allows employers to automate or trade more tasks; this could lead to wage polarization and inequalities depending on task content of jobs. |
| Distribution of jobs | Inclusion of previously disconnected workers, as connectivity and automation lowers search costs and helps workers overcome physical and social barriers; allows firms to overcome skills constraints to grow, creating jobs. | Exclusion or lagging participation occurs, as workers, employers, and economies could suffer missed opportunities and degrading competitiveness. |

*Source: Raja & Christiaensen, Digital Technology and the Future Of Work, World Bank, 2017*

polarizing, that wage growth might be stagnating, and that middle-skill jobs are being automated away or are being outsourced.[4]

But the outcome of technological advancement and adoption do not need to be negative. Indeed, there are significant benefits to be had from increasing innovation, productivity, and connectivity that result from the increasing use of technology (see Table). These benefits can be greater if the analog complements of these digital tools – rules, skills, institutions, and complementary infrastructures (e.g. logistics) – will also develop.[5] Moreover, much of the discussion about technological change and its implications for work have focused on technologies of automation, while they have not considered as deeply the implications of technologies of connection (e.g. the internet) or of creation (e.g. 3D printing); see Box for a discussion of these technology types.

## 2.2 Drivers of impact

The foregoing shows that the effects of technological change will not be one-dimensional. Rather, much will depend on how technology diffuses — among firms and individuals within an economy, and across economies — and on the social and economic context within which those changes occur. Outcomes would depend on factors such as "the extent of technology diffusion, the demographic composition (aging versus youth bulges), the enabling business environment (skill mix, supportive infrastructure and institutions), the

[4] Autor, David, H., David Dorn, and Gordon H. Hanson. "Untangling trade and technology: Evidence from local labor markets." The Economic Journal 125.584 (2015): 621-646

[5] World Bank, World Development Report 2016

**Box: Technological change is about more than just automation**

A range of digital technologies has made their way into our homes and workplaces. These can be broadly classified into three types of technologies: **automating**, **connecting**, and **creating**. While automation (which includes robotics and AI) could substitute human effort in some tasks, connecting technologies (such as the internet) network and distributing work in ways that have varying implications for businesses and individuals. Finally, some digital technologies enable human creativity, which could create or transform sectors and firms through product innovation.[1] These are described in the Table below.

**Table: Different capabilities of technologies and their implications for employment**

| Technology type & trend | | Employment trade-offs | Examples |
|---|---|---|---|
| ***Automating*** | Machine effort replaces human effort; the capability of machines is increasing to cover a wider range of tasks | Labor productivity increases; but labor may be augmented by or substituted by capital; workers with skills to create and use these machines benefit, while others might lose out | 98,900 robots were installed in the automotive industry worldwide in 2014; IBM's Watson computer assists oncologists to diagnose lung cancer; AI systems are replacing call-center workers in some tasks |
| ***Connecting*** | Networks connect over five billion people globally, reducing transaction costs and enabling access to information | Productivity increases; information gaps reduce; collaboration and distribution of work is possible; work could be displaced due to competition within or across markets | Mobile phones ease farmers' access to market information, improving earnings; 'car sharing' services link riders with underutilized drivers but may put traditional taxis out of work |
| ***Creating*** | Digital tools allow humans to create and test new objects and ideas, reducing the costs and risks of innovation | Product and process innovation potentially creating new sectors, firms, and jobs, but could also make some jobs redundant | 3D printing helps manufacturers cut prototyping and testing costs; computer animation has created 80,000 jobs in India and 64,000 jobs in the U.S. but displaced traditional animator jobs |

*Source: Author analysis.*

reigning labor market regulations, and the trading environment."[6]

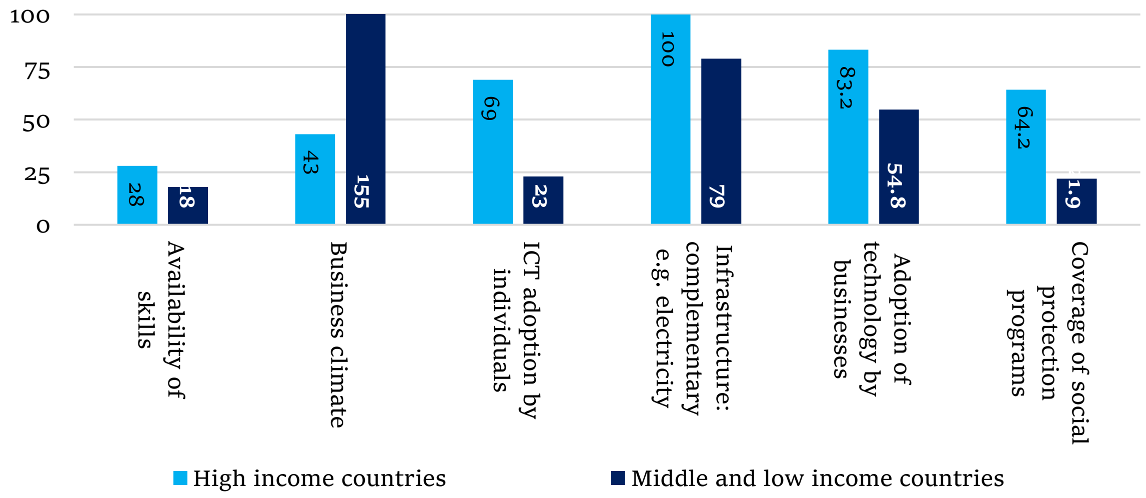
Moreover, the divergences across high- and medium-and-low-income countries in technological adoption and use reflect and reinforce divergence in other key socioeconomic development indicators, including access to finance, to core utilities (e.g. electricity), skills acquisition, and social protection schemes (see Figure on next page). Without these complementary and analog foundations, digital technologies will not accelerate development or change how businesses function (or create or displace jobs) in a significant or transformative manner.[7]

There are such differences within countries; major cities and towns are often better connected and with more skilled workers than rural or remote communities. Divides in access to technology and skill levels also appear across different demographic groups. As the World Bank's World Development Report for 2016 (WDR16) shows, there is a higher likelihood that rural and remote communities, women, people with disabilities, social and

[6] Raja & Christiaensen, Digital Technology and the Future Of Work, World Bank, 2017

[7] See World Bank, World Development Report 2016: Digital Dividends (henceforth WDR16), Overview (Chapter 0)

**Figure: Comparing HICs with MICs & LICs on enabling environment**




*Source: Authors' analysis based on World Bank data, c. 2016*

ethnic minorities, and older people lag in access to and use of digital technology.[8]

Coincidentally, these are the very groups that could benefit significantly from being able to access digital tools. Similarly, many businesses in rural and remote areas cannot access these technologies. Unconnected workers and employers are unable to access the various e-payment systems, online work platforms, or even e-commerce services that those in connected areas might take for granted.

But there is an important message here: the slow adoption of technology might have a short-term benefit in that firms might not automate away many skills, tasks, or even jobs. However, the risk is that those economies and firms that do not adapt will end up being less competitive than those who do (e.g. the larger firms, more advanced economies). They will be limited in their scope or scale or be rendered non-competitive. Moreover, the possibility of innovation, which would lead to growth and job creation, will be restricted given the lower likelihood of low-technology firms innovating.[9] And such innovation will drive the economic growth that funds safety nets for affected individuals or create opportunities for the workers of the future.[10]

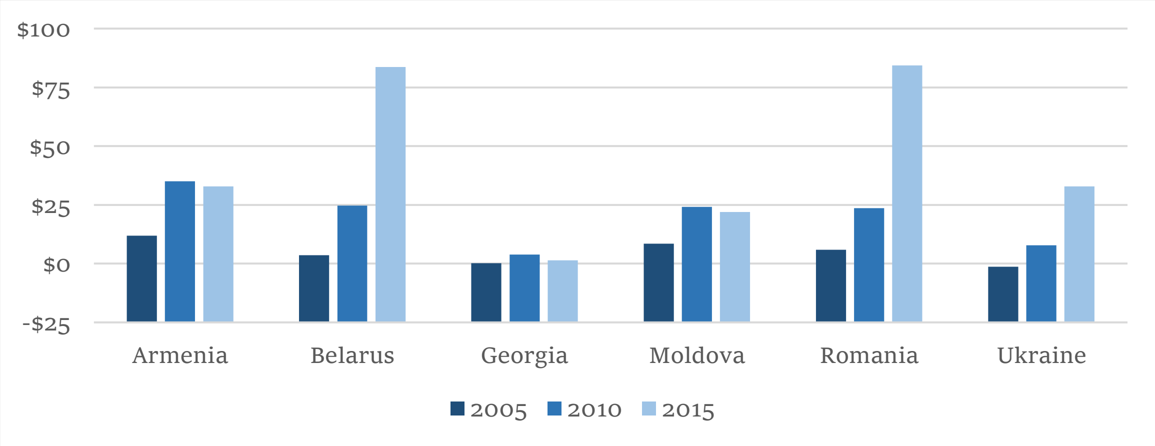
The history of technological progress in the past few centuries suggests that some workers will bear the costs, but that overall economic growth and job creation will continue.[11] In sum, while technological advances and their adoption could lead to some jobs being lost and other jobs changing, there is scope to adapt (as we discuss later). However, the implications of lagging in adoption are probably more taxing in the long term.

# 3 Digital jobs in Moldova: Opportunities, and constraints

Digital jobs include jobs in the **ICT industry** (created by the production of ICT such as IT software and services, telecommunications, etc.), and those created or influenced by the **digitization of sectors across the economy** (e.g. in banking, tourism, agriculture, government, etc.). They could be jobs in firms or represent work done by

[8] See WDR2016, Chapter 2
[9] Branstetter, Drev, Kwon, Get With the Program: Software-Driven Innovation in Traditional Manufacturing, NBER Working Paper No. 21752, November 2015
[10] https://www.technologyreview.com/s/603465/the-relentless-pace-of-automation/
[11] Mokyr, Joel, Chris Vickers, and Nicolas L. Ziebarth. 2015. "The History of Technological Anxiety and the Future of Economic Growth: Is This Time Different?" Journal of Economic Perspectives, 29 (3): 31-50.

**Figure: Net exports of information, computer, and telecommunications services (per capita, in current US$)**




*Source: World Trade Organization*

individuals. These are jobs created by: (i) firms in the ICT industry; (ii) firms across sectors that digitize, and (iii) self-employed individuals engaged in digitally-enabled work.[12] In brief, our analysis finds that the first of these has been getting most of the attention in Moldova, while the second and third sources of jobs are still nascent.

Hence, the potential of digitization to create jobs in Moldova is not fully realized, and this is primarily due to the low level of digitization of the economy beyond the core ICT industry. Box on page 7 provides a summary comparison of Moldova with regional peers, of some of the key aspects of digitization related to the discussion in this report.

## 3.1 Firms in the ICT industry

Moldova's ICT industry has evolved rapidly over the past decade. WTO data shows that Moldova's net exports in telecoms, computer, and information services have reached US$78m in 2016. These exports have more than doubled on a per-capita basis over the past decade, but there is scope for further growth when compared with regional peers (see Figure).

This has contributed to job creation, especially in the services sector. About 22,000 people work in the ICT sector, and the various public and private sector stakeholders believe that more jobs can be created in the coming years. The IT industry alone employs about 7,000 workers, and half of those work in the software industry. [13] Consulting firm IDC found that "Moldova is particularly well positioned for core activities, such as web development and basic coding, and high-value activities, such as analysis and design and software development and testing." [14] Many of these jobs are available for well-paid, highly skilled workers.

Opportunities for growth are present; the EU-Moldova Association Agreement could help to grow trade links, and the country is starting to receive attention from global industry analysts. Many stakeholders (public and private) agree that there is potential for employment within the IT industry to more than triple over the next decade, if infrastructure (e.g. IT parks), the business climate, and skills training programs keep up. Various actors have launched initiatives to grow labor demand

[12] These individuals could be working for firms or other individuals located in or outside Moldova. For example, in ride-sharing services serving other Moldovans, or doing graphic design for employers located elsewhere.

[13] Stakeholder interviews; ATIC 2016; IDC 2015

[14] IDC, Moldova Moving into the Premier League of IT Nearshoring, March 2015, page

**Box: Comparing Moldova's ICT sector with regional peers**

| | Armenia | Azerbaijan | Estonia | Finland | Georgia | Ireland | Latvia | Lithuania | **Moldova** | Romania | Ukraine |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Availability of latest technologies, 1-7 (best) | 4.4 | 5.0 | 5.8 | 6.6 | 4.3 | 6.1 | 5.8 | 5.8 | **4.4** | 4.6 | 4.3 |
| Venture capital availability, 1-7 (best) | 2.5 | 2.7 | 3.5 | 4.5 | 2.2 | 3.2 | 2.9 | 3.0 | **2.1** | 2.4 | 2.4 |
| Individuals using Internet, % | 46.3 | 61.0 | 84.2 | 92.4 | 48.9 | 79.7 | 75.8 | 72.1 | **46.6** | 54.1 | 43.4 |
| Households w/ personal computer, % | 51.5 | 51.7 | 82.5 | 91.9 | 45.8 | 84.0 | 73.5 | 68.1 | **52.4** | 63.8 | 52.4 |
| Households w/ Internet access, % | 46.6 | 54.6 | 82.9 | 89.8 | 41.0 | 82.2 | 73.4 | 66.0 | **47.5** | 60.5 | 43.0 |
| Fixed broadband Internet subscribers/100 pop. | 9.1 | 19.9 | 28.9 | 32.3 | 12.2 | 26.9 | 24.7 | 26.7 | **14.7** | 18.5 | 9.3 |
| Mobile broadband subscribers/100 pop. | 34.2 | 61.5 | 117.0 | 138.5 | 21.8 | 81.0 | 61.2 | 63.4 | **49.4** | 49.4 | 7.5 |
| Firm-level technology absorption, 1-7 (best) | 4.1 | 4.7 | 5.4 | 5.8 | 4.2 | 5.6 | 5.0 | 5.4 | **4.1** | 4.4 | 4.2 |
| ICT use for business-to-business transactions, 1-7 (best) | 4.7 | 5.2 | 6.0 | 5.9 | 4.6 | 5.4 | 5.4 | 5.8 | **4.2** | 4.5 | 4.4 |
| Impact of ICTs on business models, 1-7 (best) | 4.5 | 4.8 | 5.6 | 5.9 | 4.0 | 5.6 | 4.8 | 5.2 | **3.8** | 4.2 | 3.8 |
| Knowledge-intensive jobs, % workforce | 26.9 | 23.4 | 42.7 | 45.2 | 22.2 | 40.3 | 39.6 | 42.6 | **28.7** | 21.5 | 33.7 |

*Source: World Economic Forum, 2017*

and supply, with the hope that Moldova's digital economy, including both the firms that produce ICT goods and services and ICT users in other sectors (e.g. financial services, healthcare, tourism, government), can contribute to the job creation that Moldova needs to continue sustainable economic growth.

This growth has been due to a vibrant and organized private sector, and due to support from the public sector. Moldova's active ICT industry association, the Association of Information and Communications Technology Companies (ATIC) has been a significant player in this space. For example, it has recently set up 'Tekwill', an IT industry center of excellence. Another IT Park, promoted by a private company, with donor support, is also being established.[15]

However, Moldova has some weaknesses that could hold it back, especially when one might compare its position on various dimensions vis-à-vis regional peers (see Box).

For example, many stakeholders note that a limited talent pool is a major constraint on the growth of established firms in the ICT sector. IT industry representatives note

[15] This facility has been set up with support from various development partners and from the Government. This is part co-working space, part training center, part exhibition space. It has the potential to become a hub for innovation and entrepreneurship in the sector. It already hosts many digital startups, and is expanding. Another private initiative – led by a local ICT company and with financial support from the US Government – is setting up a sophisticated IT park in Chisinau (expected to begin operations in early 2018). Together, these types of facilities have the potential to provide the appropriate facilities and physical environment for digital startups to locate and grow. As these are entirely or partly private initiatives (or seek to be commercially sustainable), they have some of the basic elements seen before as critical for success.

that it is getting more difficult for firms to find talent in Moldova. And they speculate that the problem will get worse as technological change accelerates, shifting client demand and hence skills needed. There are growing concerns that many qualified (especially young) professionals are leaving the country; some digital firms estimate that half of the technical staff that have left their jobs over the past few years have left the country. Limited supply is also manifested through anecdotal evidence that many companies engage in "poaching" of IT professionals from other firms; this could also drive up wages.

There is realization of the need to address the skills constraint. But few local companies invest in training their existing staff, either due to limited means or limited interest. Efforts by the private sector coordinated by ATIC, and supported by the Government are seeking to remedy this. For example, the Tekwill facility also host training programs – organized by the industry association – for those who seek trainings and certifications, for up to 1,000 people a year. It will also host startup acceleration and events. These trainings are also directed towards newer technologies and trends.

Discussions with stakeholders suggest that recent years have seen a rapid increase in the number of digital startups being set up in Moldova. The Tekwill facility is starting to become a hub for startups, and ATIC believes that there is scope for many more companies to emerge in the coming years around financial services ('fintech') or in gaming, for instance. Interviews with stakeholders also suggest that supporting IT professionals and graduates to set up businesses in Moldova could encourage them to remain in the country.

The Government has been responsive, and aims to promote growth of the IT industry through tax incentives, new IT parks, and training programs for specialists. The Parliament has recently approved a new "startup visa law," which simplifies access to Moldova's labor market for highly qualified IT specialists. But private sector stakeholders remain unsure about its acceptance by international workers. The Ministry of Economy and Infrastructure is defining new ICT industry competitiveness roadmap (for the period until about 2023), and a significant focus is - apart from improving infrastructure – on capacity development, the business and startup ecosystem, and investment promotion.[16]

The education ministry is also working to upgrade the ICT curricula and infrastructure in schools, and seeks to develop human capital. The number of graduates in ICT related fields – about 6,500 annually – are also higher as a share of graduates compared with regional peers, such as Bulgaria, Hungary, or Romania. However, the share is smaller than the EU or OECD average. Employers and industry representatives are critical of the quality of many of these graduates and the relevance of their skills to industry requirements.[17] Some policy restrictions also limit the potential for improved industry-academia collaboration. For example, IT industry professionals are not formally allowed to teach at universities (even part time) unless they have advanced degrees and pedagogical certification. And concerns remain that a focus on improvements in higher education alone cannot make up for the weaknesses in primary or secondary schooling; efforts are increasing to expose younger students to digital technologies, but these are yet *ad hoc* and not fully integrated into the curriculum or teaching system (we return to this subsequently).

Hence, we find that the Government, with the support of donors, and coordinating with the private sector, has begun to address

[16] Based on discussions and draft documents provided by the MITC

[17] For instance, a 2013 analysis of Moldova's ICT sector found that, "the lack of skilled staff is a quality not a quantity problem. The education system produces enough IT graduates; however, their skills do not match the demand of employers. This is due to outdated curricula, lack of access to modern equipment and software and teaching staff who often do not meet international standards. Those problems are aggravated by a serious lack of practical experience in higher and vocational education." See German Economic Team Moldova, Realising the Potential of Moldova's Information Technology Sector, 2013, page 12.

some of the gaps on both the demand and supply sides. For example, there are plans to support more digital startups, and offer them financial and technical support to grow. Plans are also in development to extend the Tekwill model to other cities, to make the digital economy more inclusive.

## 3.2 ICT use by firms across sectors

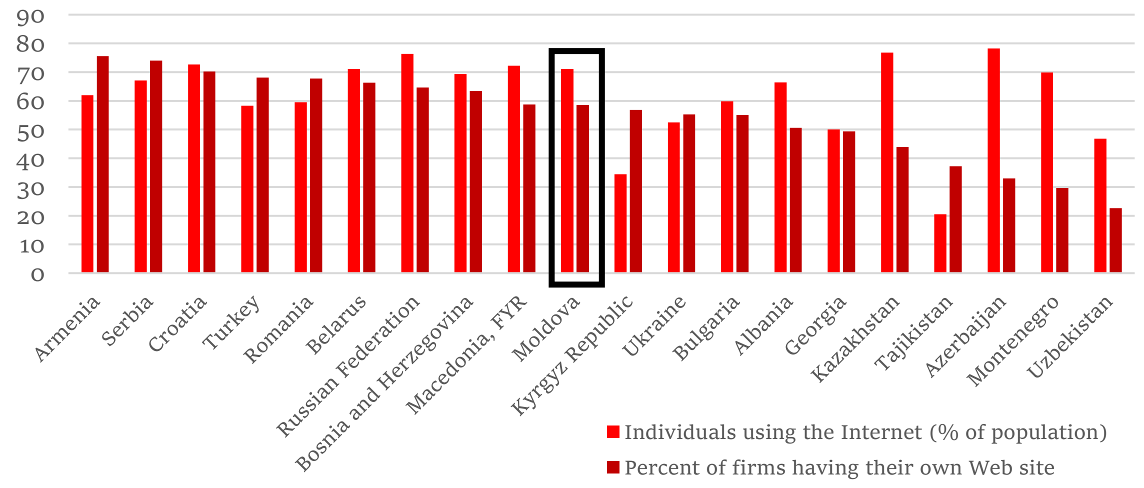
And apart from workers, technological changes imply challenges for firms. If they are to sustain growth, Moldova's firms — especially exporting firms across sectors — would need to invest in and upgrade their technology to remain competitive. Indeed, recent research by the World Bank has found that developing countries face the increasing possibility of losing out on productivity gain due to lagging innovation – including adoption of technology – due to missing managerial capability and weak enabling environments.[18]

There is little data available on the 'horizontal' use of digital tools and technologies across other sectors (e.g. banking, tourism, agriculture). What is available suggests that Moldova's businesses lag in the use of digital technologies. For example, only about 60 percent of Moldova's firms (survey included 360 formal firms with 5 or more employees), of those surveyed in the most recent Enterprise Survey, have websites or use e-mail to transact business. This compares poorly with other European countries, such as the Czech Republic (over 90 percent) or Poland (over 80 percent).[19] See Figure.

Digital engagement by individuals – which can drive business' adoption of digital – is also relatively low. For example, one analysis by the U.S. International Trade Administration notes that "E-commerce is still in its infancy, with a few merchants offering this option in Moldova and a few Moldovans used to ordering on-line."[20] This means that Moldova's firms are losing out on the opportunity to access new markets through tools such as e-commerce.

Limited adoption of digital technologies by firms across the economy implies another missed opportunity apart from those of

**Figure: Percentage of firms having their own websites, compared with internet use by individuals**




*Source: World Bank Enterprise Surveys (firm data, c. 2016), World Development Indicators (Internet use data, c. 2016)*

[18] Cirera, Xavier; Maloney, William F. 2017. The Innovation Paradox : Developing-Country Capabilities and the Unrealized Promise of Technological Catch-Up. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/28341

[19] http://www.enterprisesurveys.org/data/exploretopics/innovation-and-technology

[20] https://www.export.gov/article?id=Moldova-eCommerce

productivity or access to markets: a lower likelihood of digitally-enabled product innovation. Given the unpredictable nature of such innovation, it is difficult to predict its likelihood or effects in Moldova, yet, there is potential for product innovation to drive job creation in the long run.[21] And there is scope for product innovation to emerge as a driver of economic growth and job creation in Moldova. A 2017 survey by the National Bureau of Statistics has found that about nine percent of surveyed enterprises reported making some type of product innovation. Half of all were in the manufacturing sector and again half were in Chisinau. Seven percent of innovative enterprises were in the information and communications services sector.[22]

Estimates based on data from the National Bureau of Statistics of Moldova suggests an even lower level of technological diffusion. As indicated in Table, only about four percent of the legal entities—the survey included 6,500 enterprises with 10 and more employees and turnover more than 3 million Lei—have webpages (as of 2016). There is also a wide variation among firms by sector of economic activity, ranging from 52 percent in the case of entities engaged in education, to 2 percent in agriculture, forestry and fishing.

The potentially lower level of ICT adoption in the economy is also reflected in the share of ICT goods imports as a share of all good imports. See Figure. Moldova has one of the lowest shares among comparator countries, and is significantly lower than Central European and Baltic averages, at about a third since 2010.

Global indices do suggest that Moldova's readiness to engage in the global digital economy has improved slightly in recent years. In 2012, Moldova ranked 78, with a score of 3.78 in the World Economic Forum's Network Readiness Index (measuring the propensity for countries to exploit the opportunities offered by ICT, out of a maximum of 7). In 2016, Moldova was ranked 71 of 139 countries with a score of 4.0. The country's score on skills over that time has remained flat at about 5.03, but Moldova's ranking globally fell from 65 to 70.

The Government has also invested significant effort (and resources) to digitize public services and processes. This will create the foundations for future growth,

**Table: Legal entities that have web pages (estimate, by economic activity)**

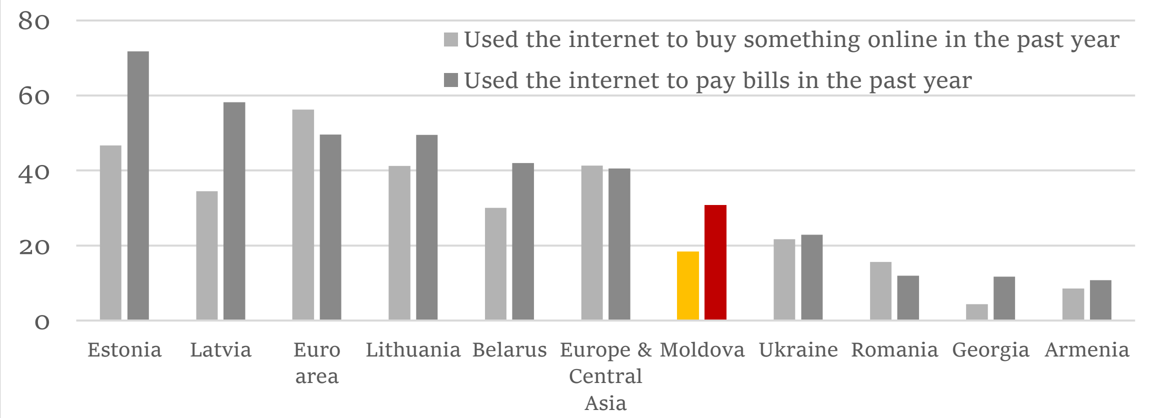
| ***Estimated among total of 53,738 legal entities*** | 4% |
|---|---|
| Agriculture, forestry and fishing | 2% |
| Mining and quarrying | 5% |
| Manufacturing | 7% |
| Electricity, gas, steam and air conditioning supply; Water supply; sewerage, waste management and remediation activities | 10% |
| Construction | 3% |
| Wholesale and retail trade; repair of motor vehicles and motorcycles | 2% |
| Transportation and storage; Information and communication | 8% |
| Accommodation and food service activities | 3% |
| Financial and insurance activities | 5% |
| Real estate activities | 0% |
| Education | 52% |
| Human health and social work activities | 11% |

*Source: Moldova National Bureau of Statistics, c. 2016*

[21] See, for example, Vivarelli, M. Innovation and employment. IZA World of Labor 2015: 154 doi: 10.15185/izawol.154

[22] http://www.statistica.md/newsview.php?l=en&id=5882&idc=%20168; http://www.statistica.md/newsview.php?l=ro&id=5882&idc=168

**Figure: Use of digital financial services**




Source: World Bank, Financial Inclusion Index, 2017 data

and spur local demand, apart from improving public service delivery.

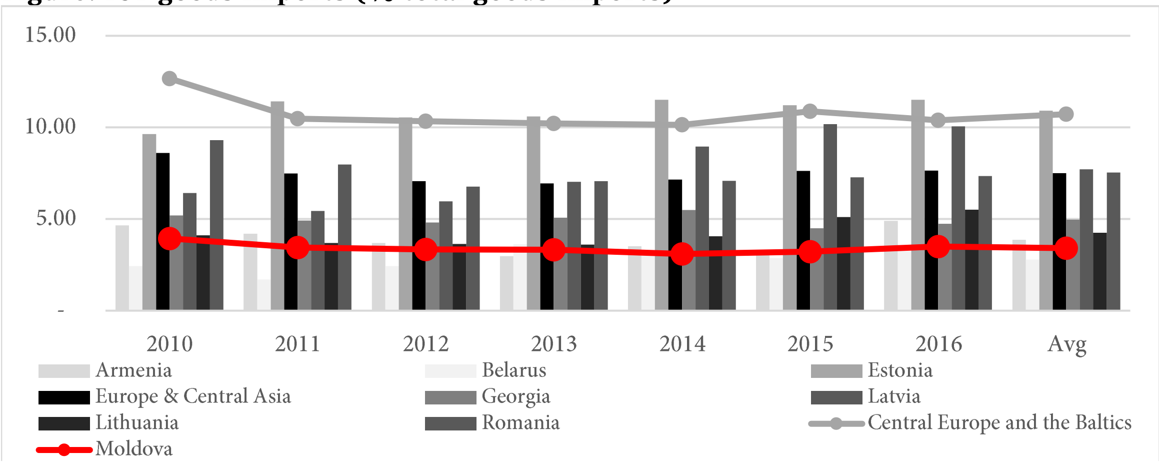
The global evidence about digital technology adoption by businesses suggests a few challenges relevant for Moldova, which have been validated with local stakeholders. Moldova does not have an appropriate supply of digitally-qualified workers, the ecosystem for firms to acquire and maintain digital capabilities is weak. For instance, one analysis finds that business adoption of digital technologies lags due to "the weak capacity of companies to absorb new technologies and modest efforts to train their staff." [23]

In many cases, firms might not feel the need to absorb these innovations either due to low levels of competition in their markets or due to their low evaluation of net benefits. There might also be constraints on access to financing needed for these upgrades, apart from information issues such as knowing which vendors or IT firms to trust.

## 3.3 Individual use of the internet, and digital work

There has been a steady increase in regular use of the Internet by individuals over the past decade. In November 2009, 12 percent of survey respondents reported using the Internet every day. By October 2017 this has increased to 46 percent. More than weekly use is now reported by 62 percent of respondents. Many Moldovans also use the internet to source their news; 47 percent reported using the internet to source political information (compared to

**Figure: ICT goods imports (% total goods imports)**




[23] ATIC, ICT Sector in Moldova: Policy White Book, 2012, page 8

87 percent via television).[24] Others have found that about 71 percent of the population accessed the internet in 2016.[25] When it comes to social media use, as of 2017, Moldova had about 20 percent of people actively using social media. This was lower than global use, which was at 37 percent, or Romania at 49 percent and Ukraine at 36 percent.[26]

But few Moldovans seemingly use the internet for economically productive purposes. For instance, less than a fifth of Moldovans (over 15 years of age) surveyed in 2017 reported using the internet "to buy something online in the past year," and only a third "used the internet to pay bills in the past year." Internet use is also focused in Chisinau. Data from a 2014 survey found that about half of the population used the Internet at that time, and of that about 45 percent resided in the capital Chisinau. (At that time, 16 percent reported using internet banking services.)[27]

On the other hand, Moldova does have a sizeable number of "online workers" that are digital freelancers. These individuals seek and do work online, working as freelancers for employers that could be located anywhere in the world. The matching of supply and demand is done online via a range of online work platforms (e.g. Freelancer.com, Upwork.com). As early as 2012, estimates were that over one thousand Moldovans were working on just one of these platforms, and earning up to US$20 million (which was paid in the form of remittances). Reliable estimates do not exist on this population of users, but anecdotally, stakeholders have suggested that there are many such digital freelancers. However, this 'gig economy' has not extended much to other services (e.g. ridesharing or delivery services), which have become very popular even if controversial, in other countries.

There are ongoing efforts to support increasing the capacity of individuals (outside of the digital industry) to use digital tools and technologies, and the Government is interested in finding ways to expand such programs. Indeed, the Digital Moldova 2020 strategy included "Capacities and utilization – strengthening literacy and digital skills to enable innovation and stimulate usage" as a pillar. Within this overall framework, the program sought to ensure that "graduates of the educational institutions have the necessary digital skills to activate in an information society," that "public sector employees possess digital skills required for a competitive management," and that "appropriate conditions are created for social inclusion based on electronic services."[28]

One notable program in this regard is "Novateca," where the Government has been working with IREX, an international non-profit, to position public libraries to become hubs for access to the internet and to digital literacy training.[29] The program covers a network of about 1,000 public libraries in each administrative region. Key aspects of this program include training locals on e-government and other digital services, the training being conducted by librarians and e-Ambassadors.[30] Reports from the program suggest that surveyed visitors of these libraries have been engaging in buying and selling products or services online, searching for government or other information, and accessing public services.[31]

Of the other initiatives in the country, one that stands out is the 'GirlsGoIT' program. This program "provides girls and young

[24] https://www.iri.org/sites/default/files/wysiwyg/2017-11-8_moldova_poll_presentation.pdf
[25] https://freedomhouse.org/report/freedom-press/2017/moldova
[26] https://www.slideshare.net/wearesocialsg/digital-in-2017-eastern-europe
[27] http://www.moldova.org/en/1-7-million-moldovans-use-internet/
[28] https://www.itu.int/en/ITU-D/Cybersecurity/Documents/National_Strategies_Repository/Moldova_2013_strateg_857_en.pdf
[29] Novateca is a seven-year national program supported by the Bill & Melinda Gates Foundation in partnership with USAID. See https://www.irex.org/success-story/connecting-moldovans-digital-public-services-libraries
[30] https://www.irex.org/project/novateca-global-libraries-moldova
[31] http://novateca.md/en/impact/stats-reports/reports-and-surveys

women with entrepreneurial start-up, digital tech and IT skills and encourages them to pursue a career in IT, long a male-dominated sector in Moldova." Started in 2015, this program – supported by UN Women, Moldova's eGovernment Center, ATIC, and others – trains a cadre of ambassadors from different districts of the country who then set up local chapters. The idea is for each of these ambassadors – and then the local chapters – to build their capacity and skills to identify specific challenges in their communities and work on technology solutions that could address them. Yet, women remain less present in the ICT sector, with the share of women employees being eight percent less than the proportion of economically active women. [32]

## 3.4 Analysis of opportunities, and challenges today

We can make a few observations based on the foregoing. On the supply side, most of the ongoing efforts to develop digital skills are focused on the IT/digital industries, rather than building broader digital readiness of all workers. The IT industry has been more responsive to short- to medium-term needs, as one might expect given their incentives. The programs offered by ATIC (especially hosted at Tekwill) appear to align more with the longer-term shifts in technology advances and shifts in global trade patterns, and are seeking to be more inclusive, but need to be scaled up to prepare a broader-based digital workforce adequately.

We also reconfirm that the limited talent pool could be a significant constraint on the growth of the ICT sector, and indeed, might already be holding it back. The output of Moldova's universities in the ICT-related fields remains constrained in terms of quantity and quality. Employers often complain about how job seekers are not job-ready and need significant investment in training, increasing firms' costs. There are growing concerns about young professionals emigrating.

One specific policy constraint to focus on may be to simplify or expand the eligibility of industry specialists to teach in the formal education system. While these specialists might not be full-time staff in the universities, for example, part-time participation in industry-oriented seminars or courses will help expand the pool of experienced faculty, in line with international practices, and bring real-world experience into the classroom.

The demand-side of the labor market also has some gaps. For one, job creation — in the digital industry but also more broadly across the economy — has not been inclusive, with it benefiting mainly the capital Chisinau. There is an opportunity to scale up existing programs to cover new locations (e.g. there is interest in opening Tekwill-type facilities in other cities) or more beneficiaries. Furthermore, there seems to be an absence of support to digital startups in Moldova in terms of financing or technical support. And, complementing the focus of skills development initiative on the IT industry, there is little effort to accelerate digitization of firms in other sectors.

# 4 The risks from digitization for Moldova into the future

This section summarizes the results of analysis of the impact of digitization, primarily automation, on the Moldovan labor market. Currently, nearly two-third of the workers are based in rural areas, employed mostly in agriculture-related occupations. The remaining one-third of the workers – in the urban areas – are employed in more diverse sectors. Hence, our analysis focused on workers in urban areas.

This analysis suggests that the current workforce lacks certain skills that could prepare it for the threat of automation of

[32] Magenta consulting, Assessment of the private sector skills demand and the extent of private sector engagement in creating demand-led skills ecosystem in Moldova: Volume 2, 2017

the coming decades.[33] We estimate that about 14 percent of the jobs will be lost to automation, and that nearly 60 percent of the jobs will see significant transformation in terms of the tasks performed, implying a need for those workers to acquire new skills.[34] See Figure.

The distribution of risk varies across sectors and occupations. The risk of job loss is highest among the Manufacturing sector whereas Agriculture, Forestry and Mining may experience the biggest transformation of jobs among the major sectors. Both low-skilled (e.g. Plant and Machine operators) and middle-skilled (e.g. Craft and related trade workers) occupations face much higher risk of job-loss and significant changes in the task-structure of the jobs.

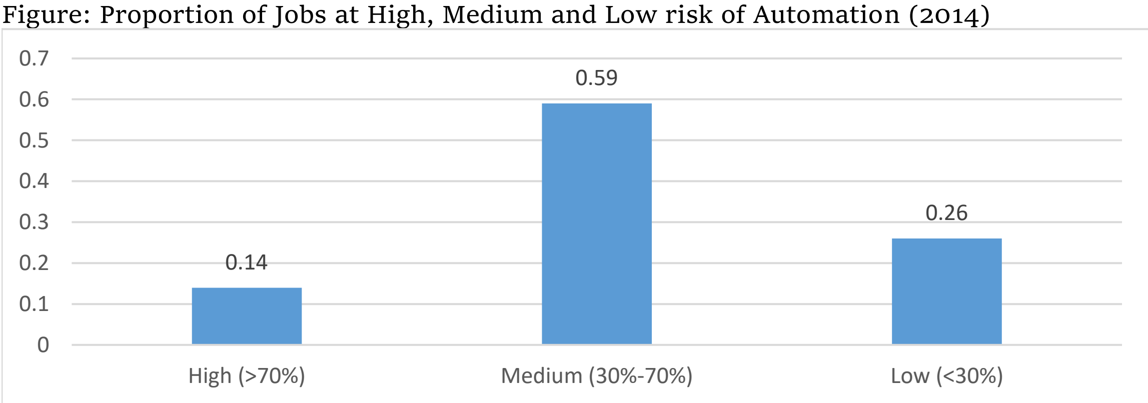
High-skilled workers do not face significant risk of job-losses, though nearly half of them could experience significant changes in their work. Similarly, the threat of automation also varies by the educational attainment of the workers. The workers with Lyceum or Gymnasium education are at the highest risk of losing jobs. Even half of the workers with Higher than Secondary level of education face significant changes in their workplace.

These results suggest that even the high-skilled or highly educated workers in Moldova's current labor force could lack the skills and competencies needed to retain their jobs in the future. The key competencies like advanced quantitative skills, presentation skills, or digital skills like advanced computing skills and internet usage, are essential to tackle the threat of automation.

However, these competencies are ranked relatively lower in use, even by high-skilled workers (e.g. Professionals and Technician and Associated Professionals). On the other hand, competencies like physical prowess, basic quantitative skills or the ability to perform repetitive tasks that are very easy to automate are ranked among the top in usage by the workers (especially low-skilled).

Hence, along with improving its physical infrastructure and business climate, Moldova will have to improve its human capital as well, for it to be competitive in the future. The scarcity of relevant skills and competencies among the current workforce require immediate attention from the Government. Keeping in mind the timeline for these possible changes — over the coming two decades — Moldova would need to immediately start equipping today's workers with relevant digital and soft skills, through short trainings, to help them retain their jobs in future. Additionally, the Government may need to accelerate efforts to update the education system to ensure that the workforce of the future is competitive.

Figure: Proportion of Jobs at High, Medium and Low risk of Automation (2014)




Source: Authors' analysis.

[33] The analysis in this report has focused on the urban areas due to the lack of availability of task-related data for the rural areas from the World Bank STEP surveys.

[34] Two main approaches, namely Occupation-Based and Job-Based, have been used to assess the threat of Automation to urban workforce in Moldova. The numbers presented here are estimated using Job-Based approach which is more reliable as well as conservative.

## 4.1 Overview of the labor market

This report uses data from the Labor Force Surveys for 2014, 2015 and 2016. Table 1 (see next page) suggests that the labor force participation rate is about 40 percent for Moldova which is comparatively lower than the neighboring countries like Romania (about 55 percent) and Ukraine (about 60 percent).[35] Table 2 suggests that there is not much difference in labor force participation among male and female workers. Table 3 highlights that nearly two-third of the workers are employed by an enterprise and receive salary for their work. Our analysis will primarily focus on the risk of automation to these employees in the urban areas.

Looking at the distribution of employees across different sectors in urban areas, one can see that nearly 80 percent of the workers are employed in the services sector (Commerce and Other services), as indicated in Figure A on page 27. On page 27, Figure B shows the distribution of all workers across major occupation groups. High-skilled workers (Managers and Professionals) account for nearly 40 percent of the workers whereas low-skilled (Craft and related trade workers, Plant & Machinery operators and Elementary occupations) accounts for 25 percent of the workers. Figure C (page 27) presents the education level of the workers employed in urban areas. Moldova has a relatively high higher literacy rate in comparison to its GDP per capita ranking. Nearly half of the workers in urban areas have Higher than Secondary education.

## 4.2 Risk of Automation for jobs in Moldova

This analysis uses two data-sets to assess the potential risks of automation, i.e. the 2014, 2015, and 2016 Labor Force Survey for Moldova (LFS) and STEP surveys for Armenia and Georgia.[36] As there are currently no surveys that collect task-related information for Moldova, this analysis has to rely on other countries' data for the task-related information.[37] Among all the developing countries that have conducted a STEP survey, Georgia and Armenia are of similar population size, share a somewhat similar economic and political history with Moldova, and have similarities in economic structure. Although imperfect fits, they are the most similar of the available countries and hence were chosen for this analysis.[38]

The Labor Force Surveys collect detailed information related to employment and socioeconomic variables about the randomly selected individuals across Moldova. As we want to focus on the workers employed in urban areas, we will drop all other observations about those who are not employed by some enterprise or are economically active in rural areas.

This analysis focused on assessing the threat of automation to workers in Moldova by using the Occupation-based approach[39] and Job-based Approach.[40] The Job-based approach uses the variation in tasks across different occupations to assess the threat of automation. Every job is a combination of many different tasks which require soft-skills – like client interaction, or interacting with co-workers, or managing workers –,

[35] Labor force participation rises to about 45 percent if the age is between 15 and 65 years. This also includes many workers who might be working on the family farm and does not earn regular salary from their work
[36] STEP (Skills Towards Employment and Productivity) survey is conducted by The World Bank to assess the supply and demand of job-related skills in the developing countries
[37] STEP Household survey has already been approved for Moldova, though, it will take a couple of years before the results are publicly available
[38] It is possible that Georgia and Armenia, having higher GDP per capita or a different distribution of workers, might have different task-structure than Moldova. Hence, we also used Sri Lanka, Lao PDR, Viet Nam, Yunnan (China), and Bolivia as well to perform the same analysis to check for variations. However, the results were similar.
[39] Frey, C.B. and M.A. Osborne (2013), The Future of Employment: How Susceptible are Jobs to Computerization? University of Oxford.
[40] Arntz, M., T. Gregory and U. Zierahn (2016),"The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis", OECD Social, Employment and Migration Working Papers, No. 189, OECD Publishing, Paris; Arntz, M., T. Gregory and U. Zierahn (2017), "Revisiting the risk of automation", Economic Letters 159, pp 157-160.

Table: Labor market status

| Year | Inactive | Employed | Unemployed | Total |
|---|---|---|---|---|
| 2014 | 50,811 | 30,918 | 1,037 | 82,766 |
| 2015 | 29,872 | 18,512 | 817 | 49,201 |
| 2016 | 28,305 | 18,044 | 636 | 46,985 |
| Total | 108,988 | 67,474 | 2,490 | 178,952 |

Table: Gender distribution among the employed

| Year | Male | Female | Total |
|---|---|---|---|
| 2014 | 15,720 | 15,198 | 30,918 |
| 2015 | 9,288 | 9,244 | 18,512 |
| 2016 | 9,019 | 9,025 | 18,044 |
| Total | 34,027 | 33,447 | 67,474 |

Table: Salaried vs Non-Salaried workers among the employed

| Year | Non-Salaried | Salaried | Total |
|---|---|---|---|
| 2014 | 12,101 | 18,817 | 30,918 |
| 2015 | 7,433 | 11,079 | 18,512 |
| 2016 | 7,871 | 10,173 | 18,044 |
| Total | 27,405 | 40,069 | 67,474 |

Table: Rural vs Urban among the employed

| Year | Rural | Urban | Total |
|---|---|---|---|
| 2014 | 20,563 | 10,355 | 30,918 |
| 2015 | 12,042 | 6,470 | 18,512 |
| 2016 | 11,841 | 6,203 | 18,044 |
| Total | 44,446 | 23,028 | 67,474 |

and hard skills – like computational skills, quantitative skills or physical strength.

The Occupation-based approach does not accommodate for the variation in task structure within the occupation code, whereas Job-based approach assumes that within the same occupation code, the workers might perform different set of tasks to perform their daily work. The Occupation-based approach hence overestimates the threat of automation, as it does not acknowledge the variation in task-structure of the occupation.

On the other hand, the Job-based approach paints a relatively more conservative (and more nuanced) picture of the automation threat. The Job-based approach was developed as the Occupation-based approach's results were biased upward. it should be noted that both these approaches are speculative in nature. The level of threat from these estimates should not be taken at face-value, rather, the more important take-away is the estimated relation (positive or negative) between the different tasks and the probability of automation.

Table A: Job-based vs Occupation-based Approach

| Bank Accountant[SOC code: 13-2011] | Restaurant Accountant[SOC code: 13-2011] |
|---|---|
| Analyze financial statements | Manages books for Restaurant |
| Knowledge of Basel III | Knowledge of restaurant business |
| Advance communication skills | No communication skills |
| Bachelors degree or higher | High school or above |
| Interpersonal skills | Basic quantitative skills |
| Advance computational skills | |

To highlight the difference between the two approaches, let us consider a simple example. The Standard Occupational Classification (SOC) system code for an accountant is 13-2011. Using the Occupation-based approach, any worker who is an accountant irrespective of whether they works in a small restaurant or for a multi-national bank, their probability of automation is 0.94. However, in order to estimate the probability of automation using the Job-based approach, we need to analyze the worker's task structure. Table A above describes the variation in the task structure of the two accountants employed in different sectors who manage the accounts for two different types and sizes of entities. It is evident that it might be relatively easier to replace the accountant managing the books for the restaurant as compared to the accountant for a multi-national bank. When using the Job-based approach, this variation in tasks will result in a different probability of automation for these two accountants.

As mentioned above, the LFS data does not collect information about the tasks being used by workers in their jobs. In order to use a proxy for tasks being performed by workers, we will match the LFS data with the STEP data for Georgia and Armenia. Since STEP collects information about individuals between 15 and 64, we also dropped all workers above 64 in LFS data. We used gender, education level (ISCED level), major industry (single digit) and the occupation code (3 digit level) to match the tasks to workers. This will generate duplication for each observation in the LFS data. We randomly drop duplicates for each LFS observation which we were able to match with STEP data. We also drop the unmatched observations from the STEP data.[41]

Table B (next page) show the results for the Job-based approach by regressing the probability of automation against a set of tasks usually performed by workers.[42] Thus, Table B helps identify the tasks/skills which are more prone to be replaced by the upcoming technologies and which are more complementary to the new technologies, resulting in increased productivity. It can be seen that the jobs which require physically demanding tasks or are repetitive in nature will be adversely affected (positive sign in regression) by automation, whereas jobs that require more technical or advanced digital skills or more people-managing skills will be difficult to automate.

Using the regression results in Table B, the Job-based probability of automation can be predicted for each worker in the Labor Force Survey by using the task variables. In order to calculate the Occupation-based probability, we will match the four digit International Standard Classification of Occupation (ISCO) code to the 6 digit SOC code and assign the average probability of automation for the matched 6 digit SOC codes.

In order to compare the results, we plot the estimated kernel density for both the Job-based and Occupation-based approaches as shown in Figure (next page). Kernel density curves show the distribution of workers at varying risk of automation using these two

[41] It should be noted that we do the similar exercise for each year of LFS data since we have three years data

[42] A more detailed description of the methodology can be found in the Appendix

Table B: Determinants of Probability of Automation (Job-based Approach)

| VARIABLES | (1) Coefficient | (2) Standard Error | (3) P-value |
|---|---|---|---|
| Cognitively Challenging | -0.0556*** | 0.00721 | 0 |
| Physically Demanding | 0.0307*** | 0.00552 | 2.78e-08 |
| Operate heavy machinery | 0.393*** | 0.0264 | 0 |
| Level of Repetitiveness | 0.114*** | 0.0165 | 0 |
| Requires Experience | -0.311*** | 0.0126 | 0 |
| Requires Supervision of others work | -0.208*** | 0.0140 | 0 |
| Coordinating with Other Workers | -0.0597*** | 0.00603 | 0 |
| Client Inter. Intensity | -0.156*** | 0.0152 | 0 |
| Makes presentations at work | -0.112*** | 0.0161 | 0 |
| Using Computer | 0.0479 | 0.0330 | 0.147 |
| Reading Forms | -0.119*** | 0.0165 | 0 |
| Advanced Reading | -0.517*** | 0.0167 | 0 |
| Filling Forms | 0.375*** | 0.0151 | 0 |
| Writing Articles | -0.415*** | 0.0145 | 0 |
| Basic Maths Skills | 0.347*** | 0.0146 | 0 |
| Advanced Maths Skills | -0.167*** | 0.0196 | 0 |
| Internet | -0.149*** | 0.0302 | 7.84e-07 |
| Data Processing | 0.351*** | 0.0272 | 0 |
| Advanced Computation Skills | -0.139*** | 0.0217 | 1.78e-10 |
| Communication Devices | 0.0875 | 0.0611 | 0.152 |
| Constant | 0.541*** | 0.0690 | 0 |
| Year-Fixed Effects | Yes | | |
| Observations | 29,845 | | |

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Source: Authors' own calculations using the Pseudo-STEP survey data for Moldova.

different approaches.[43] Unsurprisingly, we do not see a considerable difference throughout the years since no major change to the workforce would occur within three years. This report will focus on the results for the Job-based approach since it acknowledges the variation in task structure within the same occupation and shows more conservative estimates.[44] The risk of automation can be classified into three levels i.e. low (less than 30 percent), medium (between 30 and 70 percent) and high (greater than 70 percent). If the probability of automation is less than 30 percent, such jobs are relatively safe and will not see any major changes in the near future. If the probability is between 30 percent and 70 percent, such jobs are classified as medium risk. These jobs will not be fully replaced by machines, but will experience major transformation in the tasks performed. If the probability is above 70 percent, these jobs will be obsolete in the next two decades and will be replaced by machines.

This analysis suggests that by 2040, nearly 14 percent of jobs will be replaced by machines, whereas about 60 percent of jobs will experience major changes in the task structure. The proportion of jobs at high risk of automation in Moldova is similar to

[43] Total area under the curve is 100 percent

[44] Since the results are similar across the years, we will use only 2014 as it has nearly 60 percent more observations as compared to other years.

Armenia and Georgia, though, the number of jobs at medium risk is 10 percentage points higher as compared to the referenced countries. It suggests that Moldova is currently lagging in the region as regards tackling the threat of automation to the workers at medium risk.[45]

However, the threat of automation is not evenly distributed across sectors and occupation groups. Figure D (page 27) indicates that the low skilled workers face relatively high risk of automation whereas highly skilled workers face the least risk. One can also see that workers with a higher level of education are exposed to lesser risk of automation. Figure E (page 28) shows that the majority of workers in jobs with a high and medium risk of automation are employed in the manufacturing and commerce sector in urban areas. Similarly, different occupation groups also face varying risk of automation. Figure F (page 28) shows that among the different age groups, young workers (under the age of 30) hold the highest share of jobs at high risk of automation. These results and figures show that the most vulnerable group of the Moldovan labor force are the young unskilled workers who are employed in low-skill occupations.

Despite being a lower middle-income country, Moldova has a relatively high literacy rate. Nearly half of the workers hold Higher than Secondary level of education. Though, most of these highly literate workers do not possess any technical or digital skills. As a result, most of these workers end up in low-skill occupations. Most of these low-skilled jobs depend on the physical strength of the worker or consists of rudimentary tasks which are neither cognitively challenging, nor require any advanced digital skills (e.g. assembling, packaging or data entry etc.). These tasks will positively affect the probability of automation as they are easy to automate.

Table 7 (next page) ranks the tasks by their utilization across major occupation groups. The task which is performed by most of the workers in the occupation group is ranked first whereas that task which is reported to be employed by the least number of workers is ranked 19th. It can be noted that, irrespective of the occupation group, workers have reported the use of communication devices to be the most common task in their work.

Intuitively, this table portrays the current supply of variety of skills among workers. If we compare it with the regression results, it appears that the skills which are difficult to automate or the ones which are complimentary to new technologies are ranked lowest among all occupations. Soft-skills like Supervising skills or Presentation skills, or technical skills like advanced quantitative/computing skills, have a negative effect on the automation probability, whereas they are the least utilized skills, even among the highly skilled workers. Similarly, most of the low-skilled workers mainly employ basic quantitative skills or require physical prowess, which will become obsolete in the near future.

## 4.3 Implications

For it to remain competitive in the future, Moldova will have to invest in developing its human capital, along with improving physical infrastructure and general business climate. The current workforce possesses the skills which could be redundant in the coming years.

The Government may want to consider a comprehensive strategy to digitize the economy by encouraging the use of ICT across all economic sectors and to improve digital literacy among the population, thus creating opportunities for firms to become more productive by adopting those technologies, and for workers to adapt to and gain from those changes.

The analysis of workforce employed in urban areas suggests that most of the workers which are at high risk of

[45] Though, other less developed countries like Vietnam, Sri Lanka and Laos have similar distribution of risks among their workforce

Table: Ranking skills/tasks used by each major occupation. [*The skill/task which is used by most number of workers within the occupation is ranked first.*]

| ***Main Occupation*** / ***Skill/Task Type*** | Aggregate Usage | Managers | Professionals | Techn. and Assoc. Profs. | Clerical Support workers | Service and Sales workers | Craft and Related Trade workers | Plant and Mach. Operators | Elementary occupations |
|---|---|---|---|---|---|---|---|---|---|
| Communication Device Usage | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Coordinating with Workers | 2 | 3 | 2 | 2 | 2 | 5 | 2 | 5 | 2 |
| Repetitve in Nature | 3 | 9 | 6 | 4 | 5 | 3 | 4 | 2 | 3 |
| Client Interaction | 4 | 4 | 4 | 3 | 6 | 2 | 6 | 6 | 6 |
| Basic Quant Skills | 5 | 2 | 7 | 6 | 9 | 4 | 5 | 3 | 5 |
| Advanced Writing | 6 | 7 | 5 | 5 | 12 | 7 | 10 | 8 | 8 |
| Advanced Reading | 7 | 5 | 3 | 8 | 3 | 10 | 11 | 12 | 9 |
| Cognitive | 8 | 14 | 8 | 9 | 13 | 9 | 7 | 7 | 7 |
| Physical | 9 | 15 | 16 | 15 | 15 | 6 | 3 | 4 | 4 |
| Basic Writing | 10 | 11 | 13 | 11 | 11 | 8 | 12 | 9 | 13 |
| Basic Reading Skills | 11 | 8 | 10 | 7 | 10 | 12 | 14 | 11 | 10 |
| Basic Computing | 12 | 10 | 9 | 10 | 4 | 11 | 15 | 16 | 15 |
| Internet Usage | 13 | 12 | 11 | 14 | 8 | 14 | 16 | 17 | 16 |
| Data Processing Skills | 14 | 13 | 12 | 13 | 7 | 15 | 17 | 18 | 17 |
| Supervising Skills | 15 | 6 | 14 | 12 | 14 | 13 | 9 | 13 | 12 |
| Presentation Skills | 16 | 16 | 15 | 16 | 17 | 16 | 18 | 14 | 14 |
| Advanced Quant Skills | 17 | 17 | 18 | 17 | 18 | 17 | 13 | 15 | 18 |
| Advanced Computing Skills | 18 | 18 | 17 | 19 | 16 | 19 | 19 | 19 | 19 |
| Operating Heavy Machines | 19 | 19 | 19 | 18 | 19 | 18 | 8 | 10 | 11 |

*Source: Authors' analysis*

automation are less educated, are employed in low-skill occupations and work in the manufacturing and commerce sector. The share of young workers (under the age of 30) is the highest. These workers may require assistance in getting retrained and equipped with soft and digital skills required to keep their skillset relevant. Both firms and the Government may consider deciding for on-the-job training or short-term training courses for these workers respectively.

Furthermore, nearly 60 percent of the jobs will see significant transformation in the tasks performed over the next couple of decades. These are jobs at medium risk of automation. The results of the analysis suggest that jobs that are currently considered high skilled and employ highly educated workers will also use the soft skills like supervising skills or teamwork, and the hard skills like advanced computational techniques to a large extent than today.

To keep those jobs relevant, the Moldovan government will have to change the existing curriculum for students starting as early as first grade. There is need to adapt modern practices in education to provide soft and hard skills needed to compete against workers in the developing and advanced countries.

## 4.4 Comparing Moldova with other countries, and the costs of not adapting

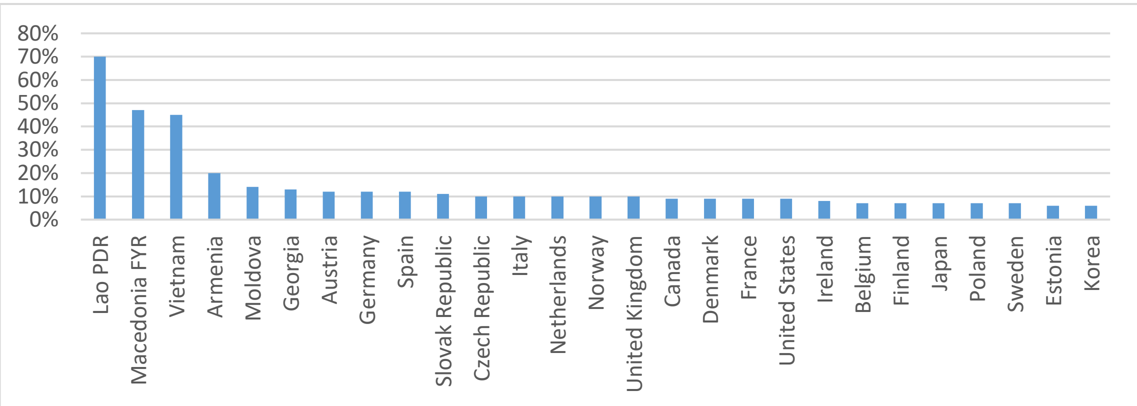
The next section will discuss how to better position young people for the opportunities or to face the risks that could arise due to digitization. Before that, we briefly compare these results for Moldova with other countries.

Figure X provides a summary of the results of similar analyses for a range of countries, in different regions of the world, at different states of economic development, and with varying technological potential. Due to the similarity in the methods used, it is possible to compare these results for Moldova with other countries. At the same time, as the dataset used here—the STEP Survey—is different from datasets used in other countries, and noting that these calculations are speculative, it is necessary to take these comparisons as indications of possible outcomes, rather than specific predications.

It is possible to summarize from these results that Moldova is not alone in facing a threat to jobs due to automation; many countries will see some jobs automated away and many more jobs change significantly. At the same time, it is critical to note that some of these countries have been investing significantly more—for longer periods—in education and social protection programs, increasing the likelihood that their workers will be better able to adapt to technological change. If digital technologies will shift patterns of trade, or make some economies much more productive than others, then it is likely that falling behind in these kinds of "future-proofing" investments might exacerbate inequalities within and across countries.

Laggards will not be able to compete in local, national, or global markets. They will find themselves shut out of value chains or new market opportunities. Businesses that fall behind risk failure, taking jobs with them and potentially bifurcating markets as 'connected' firms do better. Such businesses and workers will in any case find it increasingly difficult to compete or contribute in the future, as technology advances could deepen divides. The outcome of lagging in adoption of technology thus means degraded competitiveness, poor job outcomes, and exposure to the future's risks. The risks

Figure: Comparing countries by share of jobs with high risk of automatability




Note: Analysis for Lao PDR, Georgia, Moldova, Macedonia FYR, and Vietnam used STEP Survey data, while analysis for the other countries shown used data from the Survey of Adult Skills (PIAAC).

Source: World Bank analysis; Nedelkoska, L. and G. Quintini (2018), "Automation, skills use and training", OECD Social, Employment and Migration Working Papers, No. 202, OECD Publishing, Paris, https://doi.org/10.1787/2e2f4eea-en from not advancing for rural workers, for example, is significant (see Box).

What might be the public policy responses for Moldova in this case?

# 5 Ideas for today and tomorrow

Moldova could position itself to take better advantage of digitization and technological change in terms of job creation. The foregoing analysis finds that the major risk for Moldova from digitization (and specifically, automation) over the coming decades is one where workers might not be prepared for the future of work due to the shifting task content of their jobs. Some jobs — about 14 percent — could be replaced, whereas about 60 percent of the jobs would experience major changes in the task structure. Hence, public policies should place a high priority on preparing the workforce — of both today and tomorrow — for the future of work, in workplaces, occupations, and sectors that may be increasingly digitized.

We also find that, correspondingly, there is a major gap in the digital readiness of businesses across the economy, especially those outside of the digital industries. Moldova is not alone in this; surveys of businesses globally find that few have embraced the digital opportunity in substantial ways.[46] Public policies can create an enabling environment for all businesses to digitize more effectively, and specific programs and interventions could accelerate digitization by closing specific market gaps in knowledge, access to finance, and skills. And finally, it might be possible to expand the benefits of digital work to more people. Building on pilots in other countries, and on the popularity of online freelancing in Moldova, we focus on this opportunity here. The following outlines what these efforts would entail.

These directions are also in line with the Government's Medium-Term Sector Policy Priorities (2019-2021), notably to improve the access to and quality of education to promote a knowledge-based society, to develop the information and communication technology infrastructure, and to facilitate the development of the small and medium enterprise sector.[47]

While this analysis has not focused in detail on rural Moldovans, it is important to recognize that digitization can pose a risk but also hold opportunities for them. There is insufficient data to offer a quantitative analysis of these opportunities or challenges, but some of the possible dimensions are explored in Box.

## 5.1 Preparing the workforce for the future of work

The future is determined by the development of digital economy and society. In light of rapid advances in the fields of Artificial Intelligence and robotics, there is a potential of new technologies to substitute for human labor. These are fundamental, structural changes shaping tomorrow's economy and the organization of tomorrow's society. Today's children may go on to be employed in jobs we haven't yet imagined, jobs that will require a different skill set than today's labor market is demanding. Moldova's education system is not yet adequately preparing young people for the future, and a screening of the current situation is already showing the effects of this strain.

To develop the fundamental skills of the young generation, in 2010 the Moldovan education system transitioned from objective-based curricula to key-competences based curricula. According to the European Commission, 'key competences' are the knowledge, skills, and attitudes needed by all for personal fulfillment and development, employability, social inclusion and active citizenship.[48] Key

[46] https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/five-fifty-digital-lipstick; https://forrester.nitro-digital.com/pdf/Forrester-s%20Digital%20Maturity%20Model%204.0.pdf

[47] See Official Gazette of the Republic of Moldova No. 126-132 Art. 392 of April 20, 2018

[48] https://ec.europa.eu/education/policy/school/competences_en

**Box: Digital opportunities and challenges for rural Moldova**

With few exceptions, rural communities lag in coverage or access to digital technologies. Even as the mobile phone has become commonplace globally, other technologies have remained out of reach or unaffordable for rural workers and businesses. The opportunity no doubt exists: examples of small or rural towns in China that have become 'Taobao villages' suggest the potential of the internet to overcome distance and allow rural businesses to tap into national or even global markets. Similar hopes abound for the use of ICTs in schools or health centers in rural areas, to connect those communities to a wider range of knowledge providers. And freelance workers can be located anywhere, working virtually for an employer located anywhere else in the world. But this potential is often unrealized due to low levels of skill, poor infrastructure (e.g. spotty electricity or bad roads that increase costs of doing business), or limited rollout of appropriate technologies due to various market failures, starting with basic commercial viability.

Moldova is no exception to these trends. With a vibrant local ICT industry and widespread access to affordable internet services—even if through mobile networks—it might be possible for rural inhabitants to take advantage of digital tools. However, rural areas are hollowing out, with most of the skilled workers moving to cities or even emigrating. It certainly is possible that in the long term, rural Moldova could see a technology-enabled revitalization like what happened in China, or even in some European countries. But this will need investments in more than digital services, to improve basic infrastructure and skills, and to create an ecosystem for businesses and individuals that makes the costs of moving to or doing business in rural areas affordable. Digitization will likely have a more positive outcome for rural areas in countries such as Moldova, but the path to realizing that has many steps.

*References: UNFPA & Center for Demographic Research, POPULATION SITUATION ANALYSIS IN THE REPUBLIC OF MOLDOVA, 2016: https://moldova.unfpa.org/sites/default/files/pub-pdf/PSA_engleza.pdf; World Bank, World Development Report 2016: Digital Dividends; https://qz.com/899922/once-poverty-stricken-chinas-taobao-villages-have-found-a-lifeline-making-trinkets-for-the-internet/; https://sampi.co/taobao-villages-china-rural-ecommerce/; https://enrd.ec.europa.eu/sites/enrd/files/tg_smart-villages_case-study_de.pdf*

competences include: literacy and languages; math, science and engineering; digital competence; personal, social and learning competence; civic competence; entrepreneurship; cultural awareness and expression.

Key competences developed by the education system at the level of primary, low secondary and high secondary education are providing a solid foundation for the development of any professional competences that the Technical and Vocational Education and Training (TVET) system and Higher education – but also Life Long Learning – should further build upon in development of the new workforce. Critical baseline competences required by labor market in any occupations (ISCO-08) are: communication skills, organizational skills, writing and use of IT tools. The link between key competences and professional competences is compelling enough for some countries to already start preparing children for smooth transition from education activity to professional life during school years.

The countries that are most advanced at preparing children and youth for the digital economy and society are Denmark, Finland, Ireland, and Estonia – among the 9 first digital economies and societies in the world.[49] These countries' experiences are relevant for Moldova mainly because of the similarities in population size, along with Estonia's similar historical path after gaining independence in 1991. Due to

[49] https://ec.europa.eu/digital-single-market/en/news/digital-economy-and-society-index-desi-2017

efforts in their education systems, these countries' economies today are registering high ICT sector performance, large ICT use in non-ICT industries, public administration efficiency due to e-Governance and, most importantly, development of an efficient and innovative workforce. Each of these countries also developed an ICT country Strategy. Those ICT strategies were implemented rigorously, despite changes in government.

The overall philosophy adopted in education was that *children are the innovators of the future* and creators of added value. While being ensured a happy childhood, they were to be also prepared for the future digital economy and society. Thus, while playing, children were to be taught through problem/project/ phenomenon-based learning, where everything would be well understood and applicable, with opportunities to learn by doing. The education strategies were research-based, were often funded through significant public programs, and included a strong awareness-raising component.

These strategies were based on several very important blocks, described below:

- Teaching approaches: strong focus of STEM education based on real life issues; use of ICT devices by all teachers and all students in all subjects, starting in primary school; coding, gaming, robotics, programming are introduced in primary school either as separate subjects or as a part of STEM curricula;
- Teachers' role: change from delivery of information to guidance through on line information; support to and training of teaching staff of all disciplines; in-school ICT specialists support teachers in using apps and ICT devices;
- ICT helpers: development of digital learning materials at national level for teachers of all subjects, e-repositories for teachers and students; e-textbooks; online assessments; online exams; e-enrollment in the Higher education system;
- Infrastructure enablers: schools without walls; Digital and Innovation Hubs; FabLabs and Living Labs;[50] Startups Centers;
- Population digital literacy development: transition of public services to e-services without other alternatives; schemes for development of digital skills with adult population.

The report provides specifics on the referenced countries and their initiatives in Annex 1. Taking the experiences of these countries into account and adapting them to Moldova's context may allow the latter to catch up with the new global developments on digital and automated economy, and thus to prepare the workforce of tomorrow to better integrate with the global value chain. Specific approaches to do this are out of the scope of this report, but may be investigated in future studies.

## 5.2 Preparing firms for the future

As it has been discussed earlier, there are a few sectors where firms — especially smaller business—are using digital tools and services. These range from engagement in online marketing, to automation of production, to using accounting or HR management tools.

Discussions with public and private sector stakeholders suggest that information gaps may be a key reason for lower rate of adoption of digital services. Businesses may have limited awareness about digital technologies relevant to their sectors, lack of knowledge of where to (reliably) source those tools or technologies, limited (digital) skills among workers or low levels of knowledge about where to acquire such skills, and in some cases, poor information about the costs-and-benefits of such investments.

[50] Fabrication laboratory, a workshop offering (personal) digital fabrication. A living lab is an experimental, innovation-testing space, typically located in an existing physical-social space such as a city or community.

Lagging adoption of these efficiency enhancing or innovation-supporting digital technologies implies that Moldova's businesses might not remain competitive as the country integrates with European markets. It also suggests a missed opportunity for higher value job creation, as firms replace repetitive tasks or outdated processes. And it also suggests missing on a new or expanded market for Moldova's own ICT companies to serve local businesses; even if this market is relatively small, it can lead to innovation through the intensive collaborations that could arise from such partnerships.

There are examples of various government supported programs to overcome such information gaps. In Georgia, the World Bank has financed the 'Broadband for Development' program, which aims to skill-up owners of micro, small and medium sized enterprises (MSMEs) to take advantage of the opportunities from ecommerce. This is complemented by programs being rolled out by Georgia Post to make shipping and logistics simpler for these businesses, and a national program to roll out fiber optic internet connectivity across rural areas.[51]

In Malaysia, the public agencies such as the Malaysia Digital Economy Corporation (MDEC) with the SME Development Corporation (SMECorp) (and other agencies and partners) have been supporting e-commerce adoption by small businesses. Their support includes training, connection with trusted partners, and some financial support to list products and services online.[52]

The problem of trusted vendors' and overcoming knowledge gaps among business owners may be addressed through a program such as one in rural Quebec, led by the federal network of 57 Community Futures Development Corporations (SADCs) and 10 Community Business Development Corporations (CAEs). The SADC-CAE also offer web and e-commerce assistance, through individual IT consultants in their target settlements who reach out to local businesses and survey their IT needs, and refer them to local IT enterprises capable of attending to a specific request. The consultants also help businesses evaluate the offers and ensure quality of delivery.[53]

Apart from such measures to increase access to technology and information, it is also important for markets to function well. Critically, evidence suggests that firms exposed to competition (locally or internationally) have incentives to upgrade technology. And public policies need to address non-technological barriers as well; for example, even if firms wish to use e-commerce, they will see no benefit if logistics systems are weak or regulations stymie trade.[54]

Building on these examples, and noting the potential to link Moldova's ICT companies and workers with its businesses in other sectors, it is possible to define the broad outlines of a "digitizing business" program.

First, to inform program design, it is critical to improve the data about digital technology adoption by Moldova's businesses. Hence, this activity should start with a nationally representative survey of SMEs to understand the extent of their digitization, and the reasons for why or why not they have adopted these technologies.

Noting that information gaps are a key problem, this activity could mobilize a network of 'digital facilitators' that will assist businesses (especially SMEs) in selected sectors to evaluate and define potential investments in digital

[51] http://documents.worldbank.org/curated/en/320681467987898858/pdf/PAD1543-PAD-P152441-R2016-0029-1-OUO-9.pdf pages 35-39

[52] See https://www.mdec.my/digital-innovation-ecosystem/ecommerce; https://www.mdec.my/news/empowering-malaysias-micro-entrepreneurs-to-boost-ecommerce

[53] https://www.sadc-cae.ca/en/entrepreneurs-assistance/web-and-e-commerce

[54] The World Bank's World Development Report for 2016, on digital dividends, discusses these and other 'analog complements' in detail. See World Bank Group. 2016. World Development Report 2016: Digital Dividends. https://openknowledge.worldbank.org/handle/10986/23347

technologies. Hence, in a pilot phase, this activity could train a team of digital facilitators to engage with SMEs, understand their business processes and needs, and propose appropriate digital investments (along with a cost-benefit analysis).

These engagements could be done in coordination with local business associations (e.g. the CCI) and the SME development agency (ODIMM) to identify target SMEs, and with the IT industry association (ATIC) to identify appropriate providers of digital solutions.

The pilot could be evaluated rigorously (even potentially through a randomized controlled trial) and, based on those results, scaled up with the target of digitizing SMEs across the country through appropriate technical assistance and linkages with solutions providers.

## 5.3 Promoting digital employment among individuals

World Bank analysis has found that in Moldova, "jobs became less inclusive between 2006 and 2012. Women, the poor, youth, and rural residents fared less well in the labor market as employment opportunities dried up." Specifically, even having "rising educational attainments, young people face significant challenges finding non-farm jobs."[55]

In this situation, improving digital skills among young people, for example, might lead to improvements in labor market outcomes. There is consistent evidence globally that shows a wage premium for workers who have even basic digital skills,[56] while evidence also suggests that digital skills are increasingly in demand for middle-skill jobs.[57]

But beyond this, it might be possible to consider using digitally enabled work (DEW) to close some of the gaps in the labor market. DEW includes the range of technology interventions: from the process of finding and applying for jobs (using online jobs boards), to matching skills to specific tasks in local markets (e.g. through gig economy-type platforms such as TaskRabbit or Lyft), to matching workers with employers globally (e.g. through online freelancing services). An estimate by the McKinsey Global Institute suggests that such online talent platforms could boost global GDP by US$2.7 trillion by 2025.[58]

At present, gig economy platforms for local services (e.g. ridesharing, non-tradable services) do not exist in Moldova. This implies an opportunity, but also means that some part of the labor force might not have efficient digitally enabled means to find work.

However, digitally enabled online freelancing may be an option for piloting and evaluation in Moldova. Online freelancing connects workers and employers through on-line work platforms. It allows the process of finding, doing, and being paid for a job to all happen on-line. This presents a "win-win" for both parties: employers save on transaction costs by outsourcing on-line, while workers get paid, often at a more competitive rate than they would on their local markets. Online freelancing may be a pathway to work for many Moldovans that might be un- or underemployed due to spatial mismatches in the demand for and supply of labor.

Examples for publicly supported programs that support people gaining skills to use such online freelancing platforms (awareness, knowledge, and access to technology) and generate incomes or find employment come from Malaysia and Kosovo (see Box).

[55] World Bank, Moldova Poverty Assessment 2016 : A Jobs Diagnostic for Moldova - 10 Key Facts. World Bank. https://openknowledge.worldbank.org/handle/10986/26041
[56] https://www.oecd.org/els/emp/Skills-for-a-Digital-World.pdf
[57] https://www.burning-glass.com/research-project/digital-skills-gap/
[58] https://www.mckinsey.com/featured-insights/employment-and-growth/connecting-talent-with-opportunity-in-the-digital-age

**Box: Public programs to support income generation via online freelancing**

In Malaysia, an integrated and growing program on digital work assists individuals in the Bottom 40 of income distribution – from low-income households, or individuals earning less than RM4,000 (about US$1,000) per month. The program: (1) connects B40 populations to online work – through training programs and providing access to Internet connectivity, and through efforts to attract demand for local and international microtasking and online freelancing platforms; (2) Supports job creation through the digital-enabled 'sharing economy' – this includes connecting individuals from the B40 to platforms (including ride-sharing, tourism, advertising, back-office support, delivery services), creating a regulatory framework for sharing economy services, and fostering collaboration between sharing platforms and other private firms in other sectors to increase demand. The program has been running in its current form since 2012. Preliminary results are that over 75,000 'B40' workers have been trained since 2015, of which half have been successful at earning an income through the program. Many beneficiaries have earned incomes through digital work, in some cases over RM 500 (about $110) a month; on an annualized basis, this represents the median income of a "middle 40" family in the income distribution.

The World Bank has also piloted such initiatives in Pakistan, Nigeria, Bangladesh, and notably, in Kosovo. In Kosovo, the program, known as Women in Online Work (WoW), is giving participants a chance to compete in the global market for jobs in IT and related services, such as graphic design, data entry, and virtual assistance. This program focused on women pursuing online employment by providing them with online work employability training.

After two pilot phases in 2016-2017, 85 women—most of whom were under- or unemployed previously, from a total of five municipalities, have graduated the program, with a collective earning reaching ~$30,000 for a total of 335 competitively gained online contracts, while additional 5 participants found jobs in the local IT market, and generated an additional ~US$9,000 over a six month period. Some WoW graduates began making higher than the country's average salary, while enjoying flexible and fewer work hours. In addition, some of the beneficiaries transitioned to entrepreneurship, with three startups being formed. The program is now moving towards scale-up as part of a new investment project (the Kosovo Digital Economy Project, scheduled for implementation between late 2018 and 2023), to cover up to 2,000 men and women over the coming few years.

*Source: Authors' analysis.*

It might be possible that such initiatives could yield similar results in Moldova, but with appropriate parameters.[59] Initial discussions with the Government suggest a weak appetite for such an intervention, especially if targeted at those who might not already possess the skills or readiness to engage in digital work. Moreover, many stakeholders note that such an initiative might not yield significant results in rural Moldova as most young people have moved out to urban areas or out of the country. Hence, the focus could be on secondary cities where young people may be unable to find work despite having relevant technical and/or soft skills (especially language and communication skills).

Such a program should (1) train these individuals (potentially focusing on young people that are under- or unemployed) with IT industry-oriented skills and then (2) assist them to engage in online freelancing. The program could be organized — as it has been in Malaysia and Kosovo — in partnership with the relevant public

[59] For example, in Kosovo, the pilot focused on addressing the high level of inactivity of women in the labor market – often due to social and cultural factors apart from skills mismatches in the local economy. In Moldova, with much of the young population either moving to the cities or leaving the country, the beneficiaries and sought outcomes of a similar effort would need to be altered.

agencies or organizations for digital development (such as the MEI), and working with local civil society and/or education institutions.

# 6 Conclusion

Moldova has an opportunity to position itself to take advantage of technological change and the ongoing digital transformation. To some extent, it already has some of the necessary elements: over the past decade it has accelerated the process of digitizing its Government, and its local digital industry has been creating jobs and growing its exports. Both the private sector and the Government are aligned in their vision to realize the digital economy's opportunity. Public policies and programs that are well-defined and implemented can help here, by helping to create more, better, and more inclusive digital jobs.

Three overall messages arise from our analysis:

- **Continue support to digital industries**, including making them more inclusive and promoting innovation and entrepreneurship;
- **Do more on digital literacy** and skills beyond the IT industry, for today's workers and for tomorrow's workforce;
- **Accelerate the digitization of businesses** across the economy to capture the benefits of increasing productivity, access to markets, and innovation.

These three messages translate into broader policies and actions that the Government may consider going forward. See Table (next page) for a discussion of a short- and medium-to-long term program.

***Table: Policies and actions to grow digital jobs in Moldova***

| Strategic direction | Intended effects | | | Actions to consider |
|---|---|---|---|---|
| | *Prepare the workforce of the future* | *Prepare firms for the digital futures* | *Promoting digital employment* | |
| **Continue the support for digital industries** | Ensure that the IT workforce has skills to address new trends in the global market; create a pipeline of students with skills for the future | Provide an enabling environment for companies to startup and grow | Ensure a supply of IT workers ready to transition to their jobs, with practical knowledge | *Short-to-medium term*: Continue and scale-up ongoing programs and efforts as a collaboration of the public and private sectors, supporting the IT industry to improve quality and shift to higher value-added products and services; increase awareness of younger students and their families about digital skills and jobs<br><br>*Long-term*: Boost investments in education (see below) |
| **Do more on digital literacy** | Incorporate digital skills in all levels of education; increase coverage of programs to train Moldovans outside of the IT industry in digital skills | - | Increase awareness of jobseekers about online work, including through better technical and soft skills | *Short term*: Implement specific short-term programs to quickly train un- or underemployed people to find and do work online<br><br>*Long-term*: Invest in a steady and strategic upgrading of the education system to incorporate new methods of teaching, update the curriculum and teachers' skills, and improve digital infrastructure in the education system |
| **Accelerate the digitization of businesses** | Improve the digital skills of today's workers across sectors, going beyond the ICT industry | Increase awareness of businesses outside of ICT about digital opportunities | - | *Short term*: Identify a few pilot sectors to test out training approaches for businesses and individuals (workers) to improve their digital competencies and skills; set up a program to link local IT expertise with businesses to identify and implement digital upgrades, potentially with a focus on SMEs<br><br>*Long-term*: Scale up the program to cover more sectors, in partnership with the IT industry |

Source: Authors’ analysis.

# Figures: Analysis of the risk of automatability

Figure A:Distribution across industries

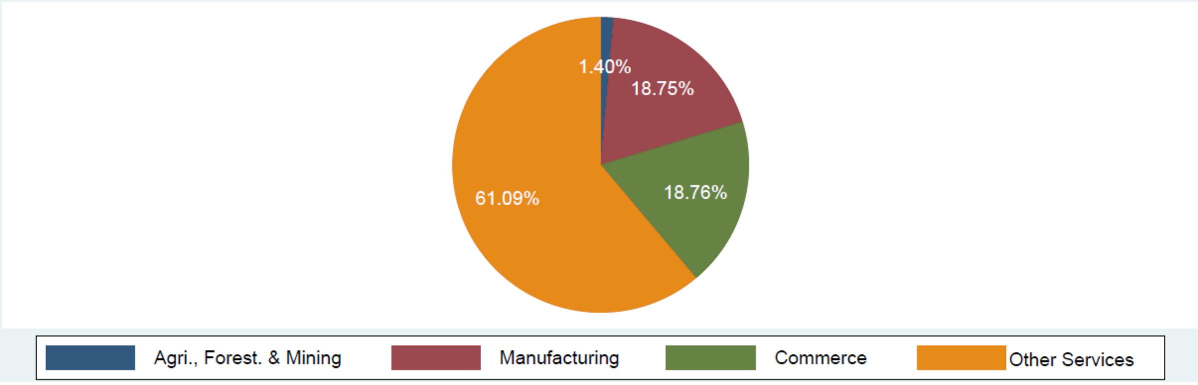



Figure B:Distribution across occupations

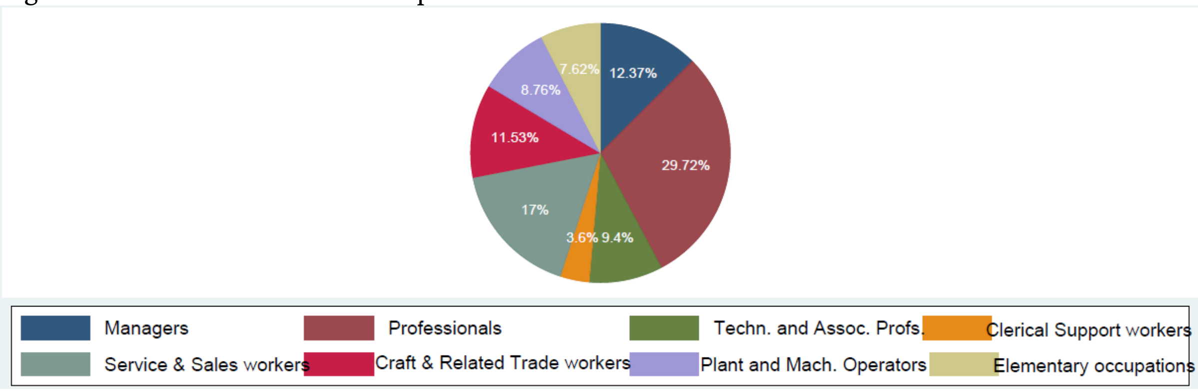



Figure C: Educational distribution

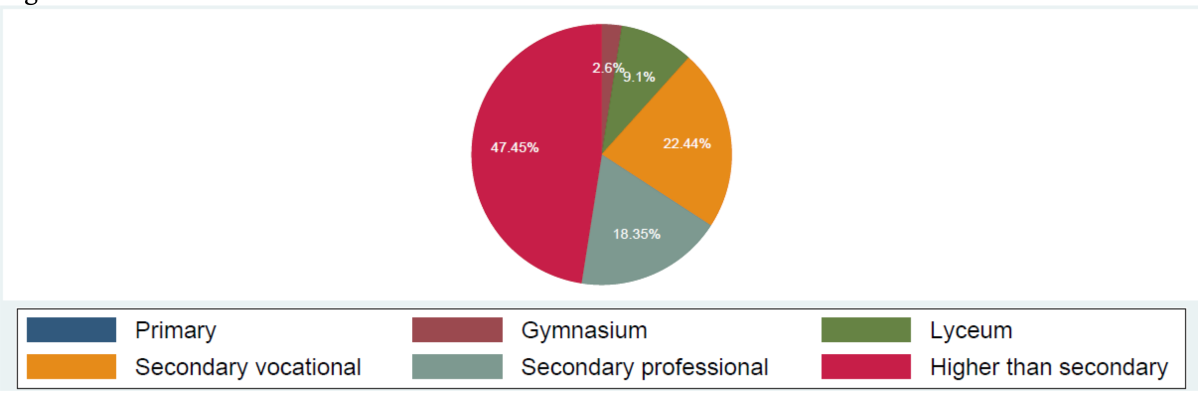



Figure D: Proportion of Jobs at High, Medium and Low risk of Automation (2014)

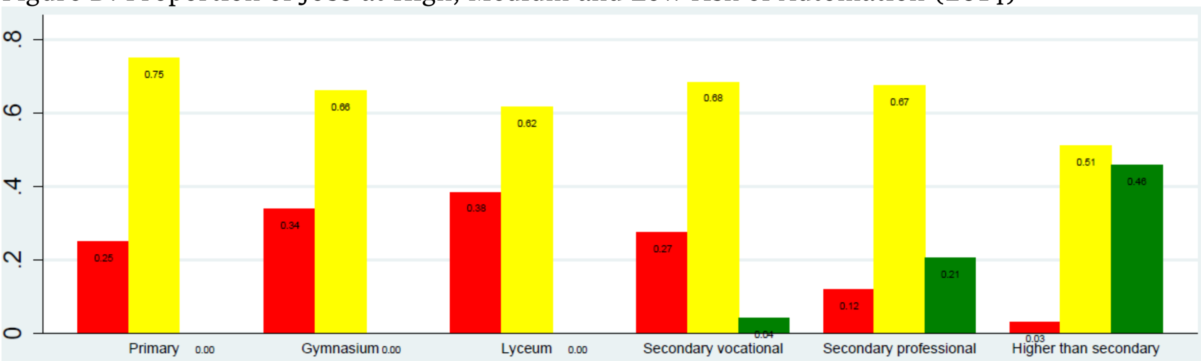


Figure E: Proportion of Job at High, Medium and Low risk of Automation (2014)

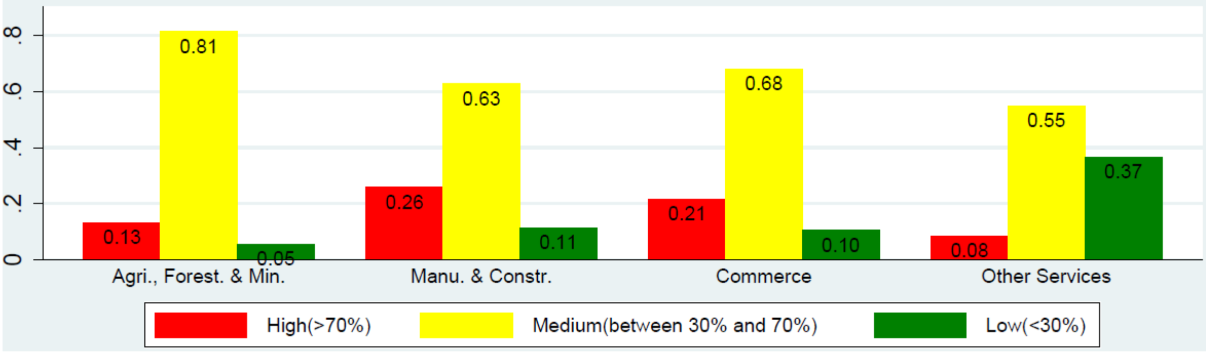
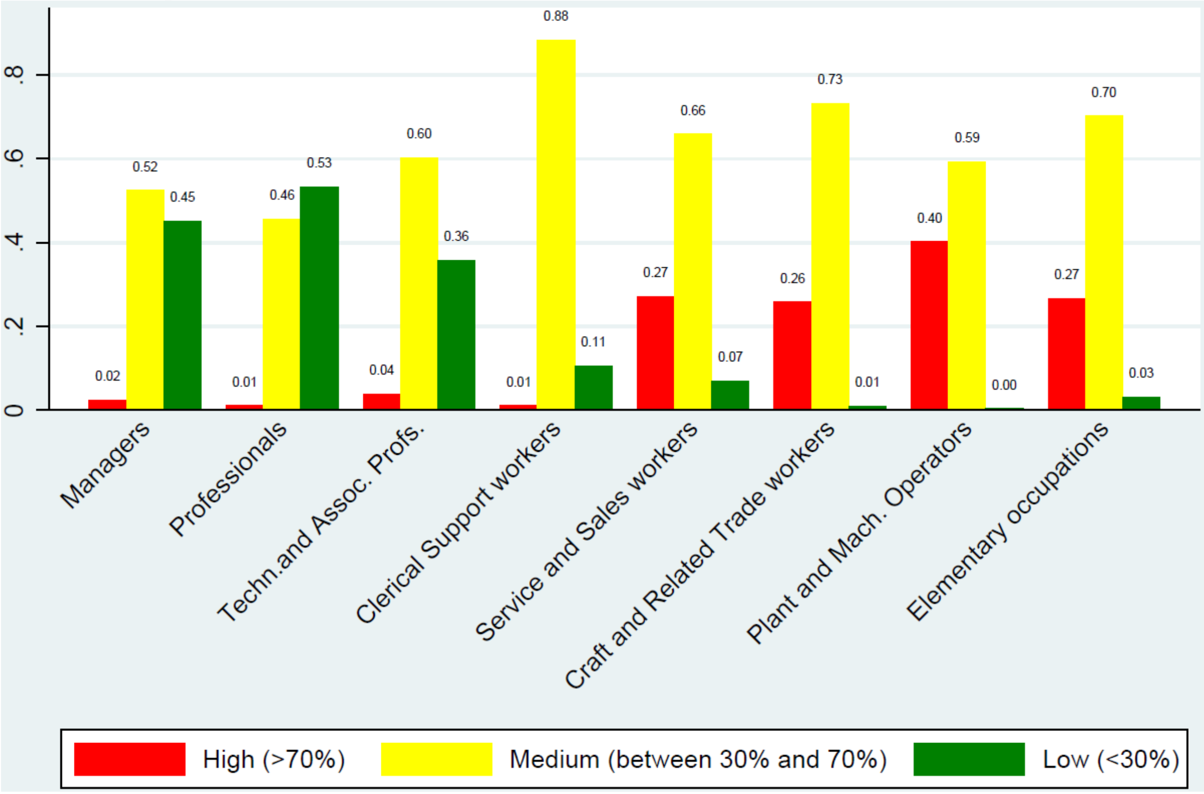



Figure F: Proportion of Jobs at High, Medium and Low risk of Automation (2014)



# Annex 1: Methodology to estimate the effect of automation of employment

We are primarily using two data-sets for this analysis i.e. Labor Force Survey for Moldova (LFS) and STEP surveys for Armenia and Georgia. We will use the data from 2014, 2015 and 2016 LFS. It collects detailed information related to employment and socioeconomic variables about the randomly selected individuals across Moldova. The sample size is nearly twice in 2014 as compared to 2015 and 2016. Since we want to focus on the workers employed in the urban areas, we will drop all other observations which are not employed by some enterprise or belong to the rural areas.

This study is focused on assessing the threat of automation to workers in Moldova using Occupation-based approach (Frey-Osborne) and Job-based Approach (Arntz, Gregory and Zierahn). Job-based approach is focused using the variation in tasks across different occupations to assess the threat of automation. Though, the LFS data does not collect information about the tasks being used by workers in their jobs. In order to use a proxy for tasks being performed by workers, we will match the LFS data with the STEP data from Georgia and Armenia[60]. Since STEP data collects information about individuals between 15 and 64, we also dropped all workers above 64 in LFS data. We use gender, education level (ISCED level), major industry (single digit) and the occupation code (3 digit level) to match the tasks to the workers. It will generate duplication for each observation in the LFS data. We randomly drop duplicates for each LFS observation which we were able to match with the STEP data. We also drop the unmatched observations from the STEP data. It should be noted that we do the similar exercise for each year of LFS data since we have three years data.

Once we have defined the proxy tasks for each worker in LFS data, now we can employ two different approaches as mentioned above. The first one follows Frey-Osborne (FO) in which they have defined the probability of automation for 6 digit SOC occupations, hence called the "Occupation-Based Approach". Second, we will estimate the probability of automation at the individual level using the tasks employed by the individual to perform the job. This method has been introduced by Arntz, Gregory and Zierahn (AGZ) to estimate the probability of automation for jobs at an individual level for OECD countries and hence, has been called the "Job-Based Approach". FO estimate the probability of automation based on the type of occupation, while AGZ argued that with-in the same occupation category, the workers might be performing varying tasks with different intensity.

FO estimated the probability of automation at 6 digit Standard Occupational Classification (SOC) whereas the LFS survey uses 4 digit International Standard Classification of Occupations (ISCO). To calculate the occupation-based probability of automation, we matched the 6 digit SOC codes to 4 digit ISCO codes and if there was more than one 6 digit occupation codes matched to a 4 digit ISCO code, we weigh each 6 digit SOC code by the inverse of number of duplication (or matching). Since SOC code is at 6 digit and ISCO code is at 4 digit level, there will be many instances where more than one 6 digit SOC code is matched with a 4 digit ISCO code. We weigh equally all the 6 digit SOC codes matched to a 4 digit ISCO code. For example, one ISCO code is matched to 3 different 6 digit SOC code, so we weigh each of the SOC code by one-third. However, if it is one-to-one match, then we simply assign the FO probability of automation to the 4 digit ISCO code. Using this method, we will have the probability of automation for each 4 digit ISCO code. It will give the same probability of automation for every individual which belongs to the same ISCO code, irrespective of the industry she is working on or the task-structure of her job.

[60] We have also used Sri Lanka, Laos, Viet Nam, Yunnan and Bolivia as well to perform the same analysis since these countries have similar per capita income. The results are similar. We are using Armenia and Georgia since they have similar historical structure of the economy as Moldova, though, they have higher per capita income than Moldova.

To incorporate the task-structure of the job, we follow the approach introduced by AGZ. First, we match the FO probability of automation for occupations to the job-based data collected in LFS survey using the multiple imputation approach. Our dependent variable is the probability of automation imputed by FO for 6 digit SOC occupation codes. As a result, we first have to match the 6 digit SOC occupation codes to 4 digit ISCO codes used in the LFS survey to record occupation data. In doing so, there are some instances, in which more than one 6 digit SOC codes are matched to a 4 digit ISCO code. Using the same methodology as used by AGZ, we duplicate these observations where the data for independent variables is the same, though, the dependent variable is different depending on the probability of automation for each 6 digit SOC code. For example, if there is a 4 digit ISCO code which is matched to 10 different SOC codes, we will duplicate 10 observations using probability of automation for each SOC code as dependent variable. Following AGZ, we also use Expectation Maximization Algorithm introduced by Ibrahim (1990) as follows:

$$y_{ij} = \sum_{n=1}^{N} \beta_n x_{in} + \varepsilon_{ij}$$

Here, $y_{ij}$ is the transformed probability of automation for each individual, $i$ is the observation and $j$ is used for the number of duplicates and $x_{in}$ are $N$ characteristics of job that we are employing to calculate the job-based probability of automation. $\beta_n$ will give us the estimates showing the impact of each of these job-related tasks on the probability of automation.

Since we want to restrict the predicted probability of automation between 0 and 1, we have used the Generalized Linear Model in Papke and Wooldridge (1996) where the dependent variable is transformed to a non-restricted interval[61]. In addition, as we use the survey data, we need to weigh each observation in the regression analysis. To account for survey weights and the duplication weights and 3 different years, we also use three types of weights, following the methodology in AGZ, which will be multiplied to find the final weights for the regression analysis. In case, there is no duplication, the survey weight will be the annual weight, multiplied by one-third, used in the regression. For the observations which has duplication in the data, we will introduce the first weight such that the sum of all duplication for each observation adds to one. Second weight is the survey weight for LFS data, multiplied by one-third. We multiply these two together to find the final weight for each duplication of the observation. The next issue is what weight we need to assign to each duplication as a first weight. We start by inverse of the number of duplication for the observation and update as follows:

Using the predicted values for each observation and given the job characteristics $x_{ij}$ and the estimates, we can find the likelihood of $y_{ij}$ to be the true automatibility. We will have one predicted value $\hat{y_i}$ for each duplicated observation $j$. Using this predicted value $\hat{y_i}$, we update the first weight as $w_{ij} = \frac{\widehat{f(y_i - y_{ij} | x_{in}, \beta_n)}}{\sum_{j=1}^{J} \widehat{f(y_i - y_{ij} | x_{in}, \beta_n)}}$ where *f(.)* is the standard normal density. After calculating the new weights for duplicated observations, we run the regression again and update the weights. We will keep running this algorithm unless the weights converge.

Once the weights converge, then we use the estimated model to predict the transformed probability of automation using the socioeconomic and task data for each individual. In contrast to the Occupation-based approach, if two individuals have the same 3 digit ISCO code for occupation but differ in the task-structure of their job, Job-based approach will have two different probability of automation.

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[61] Wooldridge and Papke used the fractional logit model in their paper. Though, the same method can be modified and used as fractional probit model as we have applied in our analysis.

Table 6 gives the results for the regression analysis. In order to compare the results of two approaches, we plot the estimated kernel density for both as shown in Figure 5. Unsurprisingly, we do not see big difference across the years since there will not be any drastic change within three years. Since the results are similar across the years, we will use only 2014 for Figure 1-9 since it has nearly 60 percent more observations as compared to other years.

**References**

**Ibrahim J.G.** (1990), "Incomplete data in generalized linear models", *Journal of the American Statistical Association,* No. 85, pp. 765-769.

**Papke, L. E. and J.D. Wooldridge** (1996), "Econometric Methods for Fractional Response Variables with an Application to 401(K) Plan Participation Rates", *Journal of Applied Econometrics*, Vol. 11, pp. 619-632.

# Annex 2: Examples of education and teaching approaches

| EU Key Competences | OECD copmetences | Initiatives countries are using for developing these competencies |
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| Communicating in a mother tongue: ability to express and interpret concepts, thoughts, feelings, facts and opinions both orally and in writing. | Communication skills<br>Writing skills<br>Building effective relationships<br>Presentation Skills<br>Listener<br>Positive dispositions | Finland<br>Finland historically developed national love of childhood, a profound respect for teachers as trusted professionals, and a deep understanding of how children learn best based on the research.<br>Curricula from 2016 is even more advanced that before:<br>New methods of teaching<br>Freedom to teach anywhere<br>Teaches are guiding<br>Teachers have master’s degree in education, with specialization in research and classroom practice<br>Curriculum sets learning outcomes that must be achieved |

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| | Makes presentations at work<br>Reading Forms<br>Advanced reading<br>Filling Forms<br>Writing articles<br>Client Inter. Intensity | Class without walls<br>Coding from the primary school integrated into all the subjects taught by main teacher and IT teacher<br>Group work, learning café - The famous form of seminars in Finland – Learning cafe – is a new and interesting way of learning.. Firstly, the seminar takes place in an informal, if I may say so, atmosphere. Each of the students can feel themselves confident, drinking a cup of coffee, ask questions and discuss issues together with a part of a team of about five people. Secondly, everyone can move freely around the room, come the other groups of students and ask them questions and discussing incomprehensible elements in informal atmosphere. After drawing up a poster on the special themes, each student could look at the posters of other groups, drinking coffee or tea, and asking questions on the topic. It significantly reduced the time of understanding the learning material. At the end of the class, each of the groups present successfully performed in front of class, answering in detail to questions.<br><br>Denmark<br>Class of the future – school without walls – this an approach build on the concept of inclusive education promoting the principles of collaborative efforts, support networks and flexible approach, attention to curricula needs, appreciation of diversity and respect for all, teaching strategies, individualized instructions, peer tutoring, cooperative learning.<br>Problem based learning at Aalborg University. http://www.en.aau.dk/about-aau/aalborg-model-problem-based-learning The method is based on the following principles<br>acquiring knowledge and skills independently and at a high academic level<br>working analytically, interdisciplinary, result oriented methods<br>cooperating with the business community for defining solution for real professional problems<br>developing abilities for teamwork<br>becoming well prepared for the labour market<br><br><br>Ireland<br>'Threads' is another national digital initiative. This is an online space where students can store and share their multimedia oral history projects, promoting peer-learning. The site is moderated by the student's teachers as they must upload their project to their teacher's account before it is published on the main page.<br>Bidge21 model of teaching http://bridge21.ie/wp-content/uploads/2011/04/Technology-Teamwork-and-21st-Century-Skills-in-the-Irish-Classroom.pdf The Bridge21 learning model is designed to release the potential of technology-mediated learning, through a structured move away from individualized, teacher-led learning. The essential elements of the model are as follows |

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| | | A structured team-based pedagogy influenced by the Patrol System learning method of the World Organization of the Scout Movement (WOSM).<br>A physical learning space designed and configured to support team-based learning.<br>Adult support that seeks to guide and mentor, with teachers orchestrating team activities.<br>Engagement with content through student-led projects.<br>Technology used as an integral tool in the process.<br>Incorporation of team and individual reflection as a regular part of the learning.<br>Cross-curricular thematic learning.<br>Problem-based Learning Network https://www.dkit.ie/centre-learning-teaching/links-useful-websites/problem-based-learning-pbl-ireland This is funded by the Higher Education Authority through the Strategic Initiative Funding. The role of the network is to facilitate the sharing of experience and expertise across disciplines and institutions in Ireland. The network was launched at the PBL Symposium that was held at the National University of Ireland, Maynooth on Friday, November 4th, 2005.<br>Collaborative project based learning and problem based learning in Dublin Technical University http://www.aishe.org/readings/2005-1/donnelly-fitzmaurice-Collaborative-Project-based-Learning.html project-based learning and problem-based learning share several characteristics. Both are instructional strategies that are intended to engage students in authentic, “real world” tasks to enhance learning. Students are given open-ended projects or problems with more than one approach or answer, intended to simulate professional situations. Both learning approaches are defined as student-centered, and include the teacher in the role of facilitator or coach. Students engaged in project- or problem-based learning generally work in cooperative groups for extended periods of time, and are encouraged to seek out multiple sources of information. Often these approaches include an emphasis on authentic, performance-based assessment.<br>Dublin’s Digital Hub, https://www.thedigitalhub.com/ The Digital Hub is a collaborative space for digital companies to scale and grow. Structured support in the form of workshops and seminars complement the natural networking environment. H2 Learning – direction within Digital Hub activity, works in partnership with an array of education stakeholders in Ireland and across the world. They collaborate with businesses, organizations, agencies, and individuals involved in education, and engage in a host of ICT-in-education-based projects. Digital Hub offers consultancy on using ICT for teaching, learning & assessment, engages in education projects focused on new dynamic approaches, supply e-learning expertise to education and training.<br><br>Estonia<br>Class rooms of the future developed in schools that are part of the projects with the idea of extending over different disciplines and over other schools |

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| | | Mektory – I HUB at Technical University in Estonia https://www.ttu.ee/mektory-eng. It works to bring together scientists, students and entrepreneurs, to solve practical product development problems and generate new intelligent ideas (technology transfer), to maximize theoretical studies at the university through practice, to prepare better-trained engineers with experience in cooperating with companies (labs, practical side of the studies), to encourage students start-up companies to move forward, to address upcoming generations and show that engineering is exciting, feasible and down to earth (School of Technology) ,to guarantee success in internationalization by bringing together different cultures, working habits, ideas and interesting solutions. |
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| Communicating in a foreign language: as above, but includes mediation skills (i.e. summarizing, paraphrasing, interpreting or translating) and intercultural understanding. | Communication skills<br>Writing skills<br>Presentation skills<br>Bilingual<br>Listener<br>Positive dispositions<br><br>Makes presentations at work<br>Reading Forms<br>Advanced reading | Finland<br>Group work, learning café,<br>International Innovation Hub - Vantaa Innovation Institute was established in 2009 to accelerate the transformation of Vantaa, and the Aviapolis area around Helsinki Airport in particular, into an even more dynamic and innovative business hub, this is an international organisations in cooperation with companies, research institutes, and universities. This is one of Finland's most dynamic business hubs and the fastest-growing concentration of small and large businesses in the region, with more than 35,000 people working locally. Vantaa Innovation Institute offers a variety of networking and training services, plans and carries out development projects, coordinates various cluster programmers, and promotes testing and development environments where new technologies, service solutions, and concepts can be piloted. Vantaa Innovation Institute also provides an excellent base for homegrown companies that are |

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| | Filling Forms<br>Writing articles<br>Client Inter. Intensity | just starting out on the road to expand their business internationally. It focuses on innovation and R&D. The emphasis is on making it easier for companies to find new partners and customers and develop their own services and products. Vantaa Innovation Institute's current core clusters are focused around logistics, ICT, health care, and environmental products and services.http://www.hightechfinland.com/direct.aspx?area=htf&prm1=1147&prm2=article<br>Denmark<br>The Digital Hub<br>https://di.dk/english/news/pages/digitalhubtomakedenmarkthedigitaltestcentreoftheworld.aspx is designed to provide a unique framework where up to 1,000 IT specialists and students from Denmark and abroad can work, develop, make models and prototypes in partnership with Danish businesses. The Confederation of Danish Industry's Digitization Panel proposes that private and public sector stakeholders should come together to create a joint initiative that brings entrepreneurs, students and the established business community together to generate the digital solutions of the future. The idea is the Digital Hub to make Denmark the digital test centre of the world.<br><br>Ireland<br>Dublin's Digital Hub since it was established in 2003, https://www.thedigitalhub.com/<br><br>Estonia<br>Mektory – I HUB at Technical University in Estonia https://www.ttu.ee/mektory-eng |
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| Mathematical, scientific and technological competence: sound mastery of numeracy, an understanding of the natural world and an ability to apply knowledge and technology to perceived human needs (such as | Problem solving<br>Research<br>Mathematics<br>Analytical skills<br>Critical thinking<br><br>Basic Maths Skills<br>Advanced Maths Skills<br>Operate heavy machinery | Finland<br>STEM starts with kindergarten in Finland http://www.stemcoalition.eu/programmes/start-finland<br>STEM fits into all areas of a school's curriculum<br>http://nsuworks.nova.edu/cgi/viewcontent.cgi?article=1016&context=transformations<br>FabLab in Yli-li and other parts of Finland https://www.fablabs.io/labs/fablabyliii The tools in our learning environment are CNC engraver, vinyl cutter, 3d printer, surface planning machine, circular saw, various drills, various hand tools, metal cutters and benders, sewing machine, overlock sewing machine and computers with 3d planning tools. Work done in our environment comes from the curriculum and real life problem solving following a certain pedagogical process.<br><br>Denmark<br>FabLab offered by University can be used for digital productions e.g. for projects, assignments or exams. It offers the following services: |

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| medicine, transport or communication). | | Digital video recording studio with editing equipment -booking at http://sdu-dk.libcal.com/booking/fablab - the studio is called FABLAB studio<br>3D printers - book by selecting one of the 3D-printers at http://sdu-dk.libcal.com/booking/fablab. Note: The 3D printers are located at the Southern entrance to the library<br>Extra powerful PCs with dual screens with graphics programs such as InDesign and Photoshop and a variety of statistical and simulation programs -booking at fablab@sdu.dk<br>Possibility of printing and graphic productions at SDU's Print & Sign<br>Center for Applied Games Research This is a game based education in Denmark. Located at Aalborg University, the center does research, conferences and trainings in game based learning in close collaboration with the Danish teacher training colleges.<br><br>Ireland<br>In 2014 the Government launched a three year strategy to deliver an increase in STEM subjects. At the launch of the National Skills Strategy 2025 the Taoiseach said: “The ability to attract new jobs, and having our people fill those jobs, is dependent on having a well-educated, well-skilled and adaptable work force. This National Skills Strategy aims to provide an education and training system that is flexible enough to respond to a rapidly changing environment...” The Action Plan for Education sets out a number of actions to further improve Irish students’ performance in mathematics, including:<br>introducing coding and computer science throughout the school curriculum;<br>a comprehensive National Policy Statement on STEM Education in schools;<br>new measures to upskill mathematics teachers.<br>The Math curriculum at primary level (age 5 – 12 years) is currently being revised by the National Council for Curriculum and Assessment, with a key change being to focus on computational thinking, and this may include coding.<br>Limerick Fablab http://fablab.saul.ie/us/ 2012 has evolved into a fully functional digital fabrication laboratory that offers cultural, educational and research programmes on digital fabrication, bridging the gap between these technologies and all disciplines.<br><br>Estonia<br>STEM education is not yet part of integrated subjects in the national curricula, however there is a number of projects/organizations that are piloting within different schools. Estonia lacks a strategy and common national platform for school–industry collaboration http://ingenious-science.eu version 3 15/05/2012 could serve as a basis for future STEM education-related decisions and activities.<br>FabLab in Vestmannaeyjar, Estonia - https://sites.google.com/a/tkvg.ee/estonia-island-project-eip/interim-report-may-2016 |

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| Digital competence: confident and critical usage of information and communications technology for work, leisure and communication. | Word Office<br>Comp skills –Typing<br>Analytical skills<br>Critical thinking<br><br>Using Computer<br>Internet<br>Data Processing<br>Advanced computation skills<br>Communication devices<br>Using programming languages | Finland<br>ICT is not a subject of its own in the Finnish national curricula but it is one of seven transversal competences which should be included in all subjects<br>Starting fall 2016, coding is a mandatory, cross curricular activity that starts from first year of school.<br>Coding from the primary school integrated into all the subjects taught by main teacher and IT teacher<br>Implementation of computing, coding, computational thinking initiatives - Innokas, a national network to promote robotics, coding and the use of ICT in education http://www.innokas.fi/en. Funded by the Finnish National Agency for Education. The Innokas Network guides and encourages students, teachers, school administrators and other stakeholders.<br>Self- or peer assessment tools/frameworks for teachers and students digital competence including certification - National tools for digital competence self-assessment TRIM - Tampere Research Center for Information and Media<br>Headmasters: http://ropeka.fi/en<br>Teachers: http://opeka.fi/en<br>Students: http://oppika.fi/ (not available in English) Research Unit for the Sociology of Education (RUSE)<br>Teachers and students: https://rosa.utu.fi/taitotesti/ (not available in English)<br>Game based education - national level digital education initiatives concerning game based education<br>Learning analytics group (run by the Ministry of Education and Culture). The task of the group is to promote co-operation between various actors in the field of learning analytics; to promote interoperability in learning analytics; to track and anticipate legislation on learning analytics. MPassID - authentication solution, Single sign-on (SSO): http://www.mpass.fi/en/ (national level implementation in process)<br>New learning spaces - Oppimaisema – a portal of modern learning spaces and school architecture: https://oppimaisema.fi/<br>https://ec.europa.eu/epale/en/blog/adults-acquiring-digital-skills-insights-finnish-approach-and-results-erasmus-project Finnish National Agency for Education is delivering the Content and digital competence integrated learning (CDCIL) under the Digi4Adults project for<br>VET students<br>Emigrants<br>Adults<br>ICT is imbedded in other training programs |

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| | | Denmark<br>ICT in the curriculum of primary and lower secondary education ICT is incorporated across the Common Objectives, integrated in all subjects.<br>ICT in upper secondary education (age 16-19) is a separate subject. Digital tools are now in all students' pockets: tests are sent via internet, assessment is done via internet.<br>Extracurricular activity – Robotics and coding<br>Coding Class An industry driven initiative focusing on computational thinking and collaboration between (IT) companies and schools. Students from 10 municipalities and approx. 60 it companies collaborate using coding tools to solve real world problems produced by the companies.<br>10 "knowledge centers" in VET. The agreement on vocational education reform (2015) has decided to establish up to 10 "knowledge centers" in vocational education and training. Among other things, the centers will help students in vocational education to handle rapid technological development and match the competencies demanded by companies in the digital labor market.<br>"Make A Good School Better" Strategy: The strategy, adopted in December 2012, includes the decision of the national government to reserve DKR 500 million (roughly € 67 million) until 2015 to strengthen the use of IT in primary and lower secondary schools, with the objective to "customize teaching in primary schools to future needs and integrate digital learning resources more consistent in the daily lessons " The strategy comprises four key initiatives:<br>Support for the purchase of digital learning resources and efficient distribution of digital learning resources;<br>Wireless networking in schools towards 2014 and access to computers for all students;<br>Clear targets for the use of digital learning materials and digital learning;<br>Research and development<br>Uni-Login: Single Sign On solution that connects pupils, teachers, parents the school and digital learning resources. More than 1 million registered users.<br>The EMU is the national knowledge and learning portal offering free inspirational resources for teachers in schools and pedagogues in pre -schools. Most of these (reference) resources are created by teaching professionals and a corps of subject experts/editors, and validated with respect to e.g. evidence and quality. The bulk of these OER are not typically for direct use together with pupils in the classroom. They serve as inspiration and guidelines, but some are easily localized for use in the classroom. Parts of the OER can be used in the classroom, e.g. videos. The EMU is about to undergo changes, and a new EMU is expected to be launched in mid 2018.<br>The Materialeplatformen is the national educational web repository. In one section it is a catalogue of all learning resources for Danish schools (mostly commercial and from e.g. museums). In another peer-2-peer section it is a national repository of OER, produced by teachers for teachers. |

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| | | DiDaK initiative: The purpose of this project is to map out how the digital competencies (information, production, participation, operational competences) highlighted in the reform of upper secondary education implemented in the teachers' practice. The idea is that the participating schools will cooperate with scientists, develop and implement a range of different courses that focus on digital competencies.<br>National championships in digital skills Students work with innovative projects combining real world problem solving and IT. Then they present the projects at a regional level and the winners participate at the national finals at the Danish Learning Festival. Here they present for both a jury and the conference audience in general. Compared with traditional student competitions the Digital skills championship emphasis teachers and leaders learning from innovative student experiences and sharing pedagogical practices at the local and national events. The event include approx. 2000 students and 200-300 teachers, leaders, researchers and industry representatives.<br><br>Ireland<br><br>Computer Science will be introduced as a Leaving Certificate subject (post-primary level – 12 – 18 yo) in the school year 2018 to be examined for the first time in 2020.<br>Computational Thinking has become a key focus in Irish education of late. In responding to this educational trend, the primary national support service for teachers, the PDST, devised a summer course based on this topic which was extremely popular with teachers in July and August 2017.<br>Scratch is also a very popular national coding initiative and is run by the Lifelong Kindergarten group at the MIT Media Lab.<br>The Programme for a Partnership Government (2016) commits to introducing a coding course for the Junior Cycle and introducing ICT/computer science as a Leaving Certificate subject.<br>Traditional paper-based standardized assessments are now being moved online assessment and it is hoped that students will be able to complete their assessments using this platform, if they wish, in the near future. The Educational Research Centre (ERC) has been working on piloting these assessments<br>Teachers also find 'Duchas' a fantastic national resource when pupils are engaged in online learning. This site allows teachers and pupils access to an online project which aims to digitise the National Folklore Collection of Ireland,<br>Open access resource for teachers which has been generated by the PDST Technology in Education team is a collection of good practice videos. This repository allows teachers to see how ICT has been effectively embedded in Teaching, Learning and Assessment across a wide variety of subjects and activities.<br>The Flipped Classroom The flipped classroom is a model of teaching in which teachers post videos online in lieu of lessons in the classroom. Content is delivered at home instead of traditional homework and |

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| | | students spend class time actively working on tasks to assimilate learning. The concept of delivering content at home to free up time in class has been promoted to teachers in Ireland through the successful teacher blog RangBianca.<br>Web site where prime school children learn all the disciplines via playing Ireland Learning Path, https://www.scoilnet.ie/<br><br><br>Estonia<br>School owners (local municipalities, government, private entities, not for profit entities) are responsible for providing schools with a sufficient level of digital infrastructure. Such sufficient infrastructure includes hardware and software; including laptops and tablets for students and teachers, necessary network solutions and IT systems, local and broadband connectivity and virtual learning environments.<br>The government is responsible for the strategic planning, design of national curricula and setting up a framework for school curricula. The government supports schools to integrate digital culture into learning via several programme-based initiatives (learning materials, teachers' education etc.).<br>Programming is not a mandatory subject in the Estonian national curriculum, but formal and informal education offers the possibility to acquire diverse IT knowledge, including in-depth IT training and career counseling to make plans for specializing in the field in the future. The effect of ICT hobby education on acquiring higher IT education is remarkable – about 36% of the students who have entered IT studies have considered earlier experience from hobby activities as the most decisive factor in their choice. This suggests that the 319 general education schools in Estonia (68% of all schools) that provide IT hobby activities are ensuring sufficient numbers of student candidates for technology programmes in the future.<br>The national curriculum refers to digital competence as a key competence. At national level, the concept of digital competence and guidance materials for all subjects are designed. At national level, IT as a subject is described as an optional subject. Schools are responsible for designing their school/regions/focus specific curricula. It is up to schools to decide how students' ICT skills are being developed – via different subjects or through a separate subject. Often schools design their own curriculum for ICT.<br>ICT for inclusion (early school leavers, migrants, etc.) and special needs (physical, mental, emotional) providing distances learning for children that are not attending the school.<br>Universities have started to develop various additional ICT curricula for people already working, including managers, to develop their awareness and improve their skills in using technology for more efficient business management.<br>Mobile learning initiatives (including the use of notebooks, laptops, tablets, mobile phones or other mobile devices) BYOD is one focus of the Lifelong learning strategy. The first objective is to increase teachers' digital competence and their awareness of the students' need for digital skills. The second objective is to |

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| | | ensure the access and availability of digital learning materials. For this purposes was established Estonia Information Technology Foundation (HITSA).Used to be Tiger Leap Foundation<br>Learning Analytics - portal of digital materials is being developed. Secondly, national e-assessments are developed and implemented. Information System for Learning materials – Ministry of Education and Research (HTM)/ E-assessment -Foundation Innove (Innove)<br>Two repositories:<br> http://www.koolielu.ee: educational resources for pre-school and general education.<br> www.e-ope.ee: Resources for vocational and higher education<br>Repositories of electronic learning materials and learning objects<br> koolielu.ee/waramu – learning materials for pre-school, basic and secondary education<br>Learning platforms  moodle.hitsa.ee – used by ~200 basic and secondary education schools, applied higher education schools, universities and vocational schools,  viko.edu.ee – used by basic and secondary education schools<br>Government and manufacturing industry has, for example, launched a digital skills training project called DigiABC for unskilled workers, targeting the workers through their workplaces via Unemployment office. in Estonia – ministries, libraries, communities, and so on, are contributing to basic skills training in the framework of lifelong learning. The state wants to boost the role of communities and has launched the e-Community project to shape libraries into larger or smaller information society support points, empowering the librarians with the skills necessary for helping people to use e-services and advise on other technological issues.<br>[http://www.vaatamaailma.ee/projects/estonian-digital-skills-and-jobs-coalition](http://www.vaatamaailma.ee/projects/estonian-digital-skills-and-jobs-coalition) Representatives from all the mentioned sectors aim to continue developing the digital skills of Estonians through their activities and have come together in 2017 to establish the National Digital Skills and Jobs Coalition coordinated by the All Digital partner organisation Vaata Maailma foundation. All of the coalition partners have made significant contributions to developing the digital skills in Estonia in the past. The partners of the coalition have extensive experience in digital skills trainings. |
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| Learning to learn: ability to effectively manage one’s own learning, either individually or in groups. | Creativity<br>Analytical skills<br>Listener<br>Critical thinking<br>Learning new things<br>Freedom to think<br>Cognitively Challenging | Finland, Denmark, Ireland, Estonia have identical approaches<br><br>Digital skills are cross cutting all the new teaching methods<br><br>New teaching methods: Problem based learning, learning café, collaborative learning, peer-learning, and bridge21 method of teaching.<br>Infrastructure enablers: schools without walls, FabLabs, I Hubs, Living labs. |

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<tr><td rowspan="2">Social and civic competences: ability to participate effectively and constructively in one's social and working life and engage in active and democratic participation, especially in increasingly diverse societies.</td><td>Detailed-Oriented<br>Building effective relationships<br>Leadership<br>Team work<br>Self-starter<br>Listener<br>Critical thinking<br>Positive disposition</td><td rowspan="2">Concepts that are put in place by countries to develop the Social and civic competences, as well as Cultural awareness and expression and contribute to the Sense of initiative and entrepreneurship<br><br>The future classroom or classroom of the future or classroom of tomorrow is a physical setting that integrates a variety of high performance pedagogies with educational technologies in an appropriate physical layout. It involves the use of fashionable technology (Film, TV, PC's, iPads or whatever) and/or pedagogies (e.g. discovery learning). This way of organizing the classroom develops the team work spirit, critical thinking, increase of responsibilities, learning to learn skills as well as development of digital skills.<br><br>A fab lab (fabrication laboratory) is a small-scale workshop offering (personal) digital fabrication. A fab lab is typically equipped with an array of flexible computer-controlled tools that cover several different length scales and various materials, with the aim to make "almost anything". It offers the opportunity to</td></tr>
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| Sense of initiative and entrepreneurship: ability to turn ideas into action through creativity, innovation and risk taking as well as ability to plan and manage projects. | Organizational skills<br>Customer services<br>Problem solving<br>Planning<br>Building effective relationships<br>Project management<br>Supervisory skills<br>Multi-tasking<br>Time management<br>Leadership<br>Team work<br>Meeting deadlines<br>Self-starter<br>Listener<br>Critical thinking<br>Positive disposition<br><br>Requires Supervision of others work<br>Coordinating with Other Workers<br>Coordinating with non-coworkers | test the theoretical knowledge and to make some propotypes based on specific applications – CAD. With Fablab students are developing the team work spirit, collaboration skills / decision making skills, critical thinking, design thinking, learning and development of software.<br><br>Innovation hubs are social communities or work space or research centers that provide subject-matter expertise on technology trends, knowledge and strategic innovation management, and industry-specific insights. These hubs enable active knowledge transfer between researchers and business experts, on the one hand, and industry, government and representatives of academia, on the other hand. Here, decision makers can meet and brainstorm with scientists and business experts and discuss their complex business challenges. Innovation Hub offers demonstrations of emerging technologies – ranging from computer systems, to cloud computing applications, to advanced security solutions, to data analytics and demos designed for specific industries, such as healthcare, energy, finance and much more.<br><br>A living lab is a research concept. A living lab is a user-centered, open-innovation ecosystem, often operating in a territorial context (e.g. city, agglomeration, region), integrating concurrent research and innovation processes within a public-private-people partnership, living labs place the citizen at the centre of innovation. The living lab process,[32] which integrates both user-centred research and open innovation, is based on a maturity spiral concurrently involving a multidisciplinary team in the following four main activities:<br>Co-creation: bring together technology push and application pull (i.e. crowdsourcing, crowdcasting) into a diversity of views, constraints and knowledge sharing that sustains the ideation of new scenarios, concepts and related artifacts.<br>Exploration: engage all stakeholders, especially user communities, at the earlier stage of the co-creation process ]<br>Experimentation: implement the proper level of technological artifacts to experience live scenarios with a large number of users.<br>Evaluation: assess new ideas and innovative concepts as well as related technological artifacts in real life situations.<br><br>Start up hub is an entrepreneurial venture which is typically a newly emerged, fast-growing business that aims to meet a marketplace need by developing a viable business model around an innovative product, |
| Cultural awareness and expression: ability to appreciate the creative importance of ideas, experiences | Creativity<br>Building effective relationships<br>Listener<br>Critical thinking<br>Positive disposition | |

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| and emotions in a range of media such as music, literature and visual and performing arts. | Freedom to think | service, process or a platform. A startup is usually a company designed to effectively develop and validate a scalable business model. The start ups are offering needed training, possibility to validate the ideas, provide mentorship support, possibility to test the propotype. The cross-pollination of ideas can make your business stronger.<br>Finland<br>All living labs in Finland http://www.openlivinglabs.eu/ourlabs/Finland<br>International Innovation Hub - Vantaa Innovation Institute<br>http://www.hightechfinland.com/direct.aspx?area=htf&prm1=1147&prm2=article – see above.<br>Finland Startup – AngelList https://angel.co/finland<br><br>Denmark<br>All living labs in Denmark http://www.openlivinglabs.eu/ourlabs/Denmark<br>Living Lab Copenhagen Living Labs (LLs) are defined as user-centered, open innovation ecosystems based on systematic user co-creation approach, integrating research and innovation processes in real life communities and settings. LLs are both practice-driven organisations that facilitate and foster open, collaborative innovation, as well as real-life environments or arenas where both open innovation and user innovation processes can be studied and subject to experiments and where new solutions are developed.<br>Innovation Center Denmark http://icdk.um.dk/<br>Startup Denmark http://www.startupdenmark.info/<br><br>Ireland<br>All living labs in Ireland http://www.openlivinglabs.eu/ourlabs/Ireland<br>Dublin's Digital Hub https://www.thedigitalhub.com/ - see above<br>Limerick Fablab http://fablab.saul.ie/us/ 2012 - see above<br>Start up Ireland startupireland.ie/<br><br>Estonia<br>All living labs in Estonia http://www.openlivinglabs.eu/ourlabs/Estonia<br>Mektory – I HUB at Technical University in Estonia https://www.ttu.ee/mektory-eng<br>A separate initiative is implemented to better support entrepreneurship: developing the curricula and learning materials and supporting cooperation between employers and schools.<br>Start-ups in ICT in Estonia – supported by the Government and by the donors as well as angel investors.<br>http://www.startupestonia.ee/ Startup Estonia is a governmental initiative aimed to supercharge the local startup ecosystem in order to see many more startup success stories to come from Estonia. For that, we |

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| | | are working on making Estonia one of the world's best places for startups by focusing on these 4 building blocks: strong ecosystem, smart money, smart people, and friendly regulations. |