Gender, Artificial Intelligence, and Digital Skills: Sub-Saharan Africa

Angeline Wairegi, Gladys Kerubo Ombati and Kevin Otieno

February 2024

Gender, Artificial Intelligence, and Digital Skills: Sub-Saharan Africa

Angeline Wairegi, Gladys Kerubo Ombati and Kevin Otieno

February 2024

Contents

Cover photo

By [Alexander Suhorucov](#) from Pexels

1. Introduction

The digital economy is credited with having created sustainable economic growth in several nations across the globe.[1] Many African countries, in fact, have identified investment in the emerging digital economy sector as integral to achieving the Sustainable Development Goals (SDGs), with several supporting the African Union's Digital Transformation Strategy for Africa (2020-2030).[2] The digital economy is estimated to represent almost 5 percent of Africa's Gross Domestic Product (GDP) by 2025, and will account for 9 percent of the continent's GDP by 2050.[3] However, the penetration of the digital economy is lower in Africa compared to other regions in the world: in 2019, only 30 percent of the African population engaged in online shopping, compared to 45 percent and 50 percent in South America and Asia respectively; only US$22 billion was generated in turnover in regional business to consumer (B2C) e-commerce transactions compared to $1,100 billion in Asia; and $30 billion-worth of services were digitally delivered, substantially lower than the $790 billion in Asia.[4] This can be attributed to several factors, including low digital and physical connectivity; small numbers of people using the internet (30 percent of the total population); the low number of people using bank accounts or mobile money (40 percent), and the lack of secure internet servers and unreliable postal services.[5] The emerging digital economy in Africa brings with it new challenges and opportunities. Importantly, it also effects significant changes in the labour market. A 2017 study, for instance, found that jobs in developing countries were more predisposed to being substituted by automation.[6] In Africa, this risk varies by country, from 65 percent in Nigeria to 85 percent in Ethiopia.[7] Also, countries with lower levels of GDP per capita are found to be more vulnerable to the digitisation of their labour market.[8] Labour force participation rate (LFPR) is also a key indicator of economic health. Between 2000 and 2019, Africa enjoyed a high labour force participation rate, which remained largely unchanged. In 2019, the LFPR stood at 63.1 percent, higher than the global average of 60.1 percent, largely driven by eastern Africa and Central Africa.[9] Africa's employment-to-population ratios (EPRs) are also high compared to those globally, with EPRs highest in eastern Africa and lowest in northern Africa, and higher in men than women (by 17.3 percent).[10] Finally, informal sectors account for higher rates of employment on the continent.Navigating this new digital economy requires new digital skills. The ability to gain new (or improve) digital skills, however, mirrors broader digital divide trends. which, in turn, are a reflection of global inequalities. The gap between those with internet access and those without it varies from country to country. For instance, low-income communities with limited capabilities have fewer opportunities to gain the skills necessary to successfully navigate the rapidly transforming digital economy;[11] a 2015 survey of South African households found that 35 percent of households saw no relevance in accessing the internet, owing to their socio-economic circumstances.[12]

Given the rising importance of the digital economy, there is a greater need globally for digitally high-skilled individuals to take up new and changing jobs in various sectors of the economy. In many developing

countries, having to meet the requirements of the digital economy labour market has led to an increased demand for vocational training institutions to scale up the informal sectors and offer higher quality jobs.[13] There is, thus, a close and direct relationship between education and employment.[14] Education and training ensure that a nation's people are not just able to access employment opportunities, but can engage in jobs that that increase their quality of life. Backing this statement is the fact that countries with high educational standards have higher employment opportunities and working conditions.[15]What happens of jobs, ways of work, and gender equality in this complex ecosystem of digitisation, employment, and skilling? This report outlines the findings from two components of a larger project that investigates the resources available to women to acquire digital skills for the digital economy in 12 countries (representing the East, West, South, and Northern regions) in Africa. The first component is an economic trend analysis study. It endeavours to understand the economic trends in the continent in the broadest terms—assess which industries are expanding, which are on the downswing, and how 'ways of work' and associated 'jobs', 'tasks' and 'skills' are evolving. This analysis also attempts to understand the gap between the quantity, quality, and type of jobs available in relation to the technological changes affecting specific sectorial labour market. Finally, it highlights the gendered nature of specific labour markets. The objectives of the trend analysis study were as follows:

I. Understand which economic sectors in the region are most being affected or impacted by technological changes.

II. Assess how these technological changes are affecting the 'jobs' and 'tasks' in these sectors.

III. Determine how the technological changes are affecting 'employment'.

IV. Establish whether there are 'skilled' candidates in the region who are ready for these changes (jobs and tasks created by technological changes).

The second component of the project is a mapping of the skill development ecosystem available in the 12 countries investigated in Component 1 through which workers, especially women, acquire skills relevant to the technologies of a 21st century global economy, and which enable them to access well-remunerated, quality work. The primary objectives of this component were as follows:

I. Understand the educational and skill development structure for each country and region under study.

II. Examine the role of public and private sector collaboration in skills development.

III. Assess the delivery and relevance of skills in light of digitalisation, automation, and artificial intelligence and gender.

IV. Establish the readiness and responsiveness of the TVET ecosystem in the face of technological transformation and to ensure gender equity.

V. Determine how technology is impacting skill development in institutions.

Key findings from the economic trend analysis study (Component 1) showed that

I. West Africa had the highest labour force participation of the four analysed regions;

II. Northern Africa has the lowest female LFPR (FLFPR) at 24.24 percent, while Eastern Africa has the highest FLFPR at 49.92 percent of the total labour force;

III. The Southern Africa region has the highest GDP per employed persons;

IV. Proportionally, the agricultural sector employed the largest number of people; however, all four analysed regions reflected a downward trend in the percentage of people working in the agricultural sector; and

V. As of 2019, Northern Africa has the highest number of people with digital skills among its active population, followed by Eastern Africa.

The key findings from the skills analysis study (Component 2) were as follows:

I. The countries of study are prioritising TVET institutions as the formal means to skill, reskill, and upskill their population to successfully compete in the global digital economy.

II. There is gender disparity in both the number of female instructors and female students in TVET institutions.

III. Female students dominate enrolment in vocational courses in TVET institutions while male students make up the largest percentage of

students in technical courses.

IV. All four regions of study suffer from insufficient infrastructure, the absence of a qualified pool of instructors, and few resources for TVET institutions.

V. TVET institutions lack funding in all four regions of study.

Though African TVET systems currently face several challenges in terms of their readiness for the Industry 4.0 revolution, efforts are being made to combat them. Some examples include:

I. **Investment in technology:** African countries are investing in technologies like automation and artificial intelligence to upgrade their TVET systems.

II. **Collaboration with industry:** African countries are working to establish partnerships between TVET institutions and industry to ensure that training programs align with industry needs.

III. **Teacher training:** African countries are working to provide training for teachers to ensure that they have the skills and qualifications to teach Industry 4.0-related subjects.

IV. **Curriculum development:** New curricula are being developed to align with the needs of Industry 4.0. It is important to note that the readiness of African TVETs for Industry 4.0 hinges upon concerted efforts on the part of the government, private sector, and other stakeholders.

2. Labour Market Analysis: Sub Saharan Africa

2.1 Overview

Despite political and financial upheaval, food crises, and major natural disasters, Africa's economy has grown in the past decade. This economic activity is believed to have been significantly accelerated by new technologies, which have accomplished the following: increased access to communications previously impeded by poor infrastructure; accommodated segments of the population previously financially excluded via the adoption of mobile banking; and resulted in the increased participation of small and medium enterprises (SMEs) in e-commerce.[16] Notably, the impact of technology depends on both access to it as well as the region's socio-economic positioning within the country, continent, and broader economic landscape. For example, an empirical analysis of the impact of mobile phones and the internet in Sub-Saharan Africa (SSA) for the period of 2006-2015 demonstrated that while a 10 percent increase in mobile phone penetration results in a 1.2 percent change in real GDP per capita, the internet did not significantly impact GDP during this period.[17]

An assessment of the broad, gender-sensitive macroeconomic labour market and technological trends was carried out in three case countries per region (South, North, East and West) in Africa. This component of the study mapped and analysed economic trends, asking which industries expanded and contracted, and how the 'way of work' and the associated 'jobs' 'tasks' and 'skills' are changing on the African continent. Also under study was the gap between the quantity, quality, and type of available skilled manpower with respect to technological changes that impact specific sectors and labour markets, and the gendered impact of these changes. The study also identified the type of 'technological change' either currently affecting the regions of study or which could arise in the future—this is likely to determine the jobs, tasks and skills landscape.

2.1.1 Objectives

The labour market trend analysis had the following objectives:

I. To understand which economic sectors in the region are most affected or impacted by technological changes.

II. To assess how these technological changes are affecting the jobs and tasks in the sectors most impacted by technology.

III. To determine how technological changes are affecting employment indicators like wages, quality of jobs, workforce demographics, etc.

IV. To establish whether the current workforce in the region has adapted—or is able to adapt—to the evolving labour market.

2.2 Methodology

2.2.1 Data Collection and Analysis

This study utilitised global and regional datasets for the macroeconomic trend analysis. Global data sets were accessed through the World Bank, ILO, WEF, ITU data banks. If these datasets did not contain the required data, region-specific data sets like national household surveys and labour force surveys were made use of. Data from the period between 1990 and 2021 was analysed for all 12 countries of study. The countries of study are:

I. In East Africa: Kenya, Uganda, and Rwanda;

II. In West Africa: Ivory Coast (also referred to as Côte d'Ivoire), Ghana, and Nigeria;

III. In South Africa: Botswana, Zimbabwe, and South Africa;

IV. In North Africa: Egypt, Tunisia, and Morocco.

Data thus collected from multiple sources was normalised to a standard unit of measurement, enabling the identification of any inconsistencies due to breaks in data series, changes in sources or data entry errors. The multiple imputation technique was made use of to compute the percentage of missing data. This method first proposed by Rubin[18] is consistent, asymptotically normal, and efficient, as shown in different reviews.[19]

The following outcome variables were utilised in the trend analysis:

I. activity rate;

II. digital skills use and implications;

III. employed population;

IV. employed population by occupation, sector and gender;

V. employed population participating in education and training (with gender disaggregated data);

VI. employment by field of study;

VII. employment rate;

VIII. GDP by sector;

IX. involuntary part-time and temporary employment;

X. job turnover;

XI. long-term unemployment rate (disaggregated by sector and by gender);

XII. monthly gross income;

XIII. over-qualification rate (of tertiary graduates);

XIV. population in education and training;

XV. self-employment and unemployment by occupation;

XVI. unemployment rate;

XVII. working-age population;

XVIII. young people neither in employment nor education or training (NEET);

XIX. digital skills match/mismatch between employers' needs and job seekers' talents, and

XX. the size of the science, technology, engineering and math's (STEM) gender gap.

Data analysis by age groups, gender and regions was also conducted to gain further insight into skills requirements for specific sectors. Descriptive analysis, which includes measures of central tendencies, measures of dispersion and measures of distribution, was computed for all the indicators.

2.3 Findings from the Labour Market Analysis

2.3.1. Labour market analysis and trends at the regional level

Labour force participation rate (LFPR), defined by the ILO as the measure of a country's working-age population (persons above 15 years old) that is actively involved in the labour market either by working or looking for work, is an important element of a region's employment sector. In 2019, Africa had a total LFPR of 63.1 percent (489.7 million), a figure higher than the global average of 60.7 percent.[20] This statistic indicates that Africa, in general, has an abundant supply of labour, possibly owing to its large working age population.[21] Table 1 provides a breakdown of the working age population in the 12 countries of study across the four African regions, with data obtained from national sources on labour force participation and compiled by the ILO.

As the table demonstrates, South Africa has the highest average working-age population of 18,258,046, with a variation of 2,899,392 people, among the countries of Southern Africa. In Eastern Africa, Kenya has the highest average working-age population of 15,852,301 people with a variation of 4,867,474 people. In Western Africa, Nigeria has the largest average working-age population of 47,412,448 people, while Egypt has the highest average working-age population in Northern Africa of 23,270,107 people.

Regional variations in LFPR abound. As of 2015, Northern Africa had the lowest LFPR of 45.7 percent while Eastern Africa reported the highest rate at 77.3 percent. Central Africa had a participation rate of 68.8 percent, Southern Africa 56.9 percent, and Western Africa 58.5 percent.[22] It is also significant to note that only a small percentage of the working-age population in Africa participates in the formal employment sector; most people on the continent derive their livelihoods from work in the informal sector.[23] Globally, the informal sector has played an important role in economic recovery from the COVID-19 crisis, resulting in a slight increase in the incidence of informality.[24]

In 2020, Western Africa had an average labour force participation of 28,057,760 people. Nigeria had the highest number of labour force participation at 62,259,271 people while Côte d'Ivoire had the least number, at 8,549,394 people. In East Africa, the past decade has seen an increase in labour force participation (like the trends observed in the countries of study in West Africa), with Kenya having the largest labour force of 24,973,363 people as of 2021. The average number of people in the force in the region as of 2021 was 16,322,914 people.

In 2021, South Africa in the Southern Africa region recorded the highest number in the workforce

Table 1

The number of people participating in the labour force in the four African regions obtained from national sources on labour force participation and compiled by the ILO

	Country	Mean	Median	Standard Deviation	Kurtosis	Skewness	Range	Minimum	Maximum
Southern Africa	South Africa	18,258,045.69	18,689,053.50	2,899,391.92	- 0.89	- 0.13	10,035,842.00	12,953,669.00	22,989,511.00
	Botswana	681,318.91	679,314.00	163,692.83	- 1.18	0.03	552,458.00	418,801.00	971,259.00
	Zimbabwe	5,996,686.63	5,877,139.50	708,500.33	- 0.60	0.27	2,693,702.00	4,721,816.00	7,415,518.00
Eastern Africa	Kenya	15,852,301.00	15,233,014.00	4,867,474.43	- 1.07	0.33	16,141,069.00	8,832,294.00	24,973,363.00
	Uganda	10,611,455.72	9,900,245.50	3,355,575.99	- 0.90	0.54	11,103,104.00	6,248,326.00	17,351,430.00
	Rwanda	4,477,024.19	4,378,682.50	1,179,886.23	- 1.14	0.25	3,764,912.00	2,879,037.00	6,643,949.00
Western Africa	Cote d'Ivoire	6,471,252.31	6,393,117.50	1,228,382.72	- 0.74	0.08	4,516,259.00	4,289,363.00	8,805,622.00
	Ghana	9,726,665.63	9,528,800.00	2,209,410.14	- 1.17	0.22	7,307,670.00	6,394,047.00	13,701,717.00
	Nigeria	47,412,448.16	47,728,346.50	9,709,509.47	- 1.17	0.01	32,691,715.00	31,787,602.00	64,479,317.00
Northern Africa	Egypt	23,270,106.88	23,519,770.00	4,768,973.00	- 1.61	- 0.14	13,737,629.00	15,516,692.00	29,254,321.00
	Morocco	10,423,431.72	10,775,053.00	1,413,344.61	- 1.04	- 0.58	4,446,858.00	7,656,050.00	12,102,908.00
	Tunisia	3,486,360.41	3,461,942.00	513,818.97	- 1.09	- 0.31	1,649,170.00	2,505,832.00	4,155,002.00

Figure 1

Labour Force Participation in East, West, North, and South Africa regions from 1990 – 2021
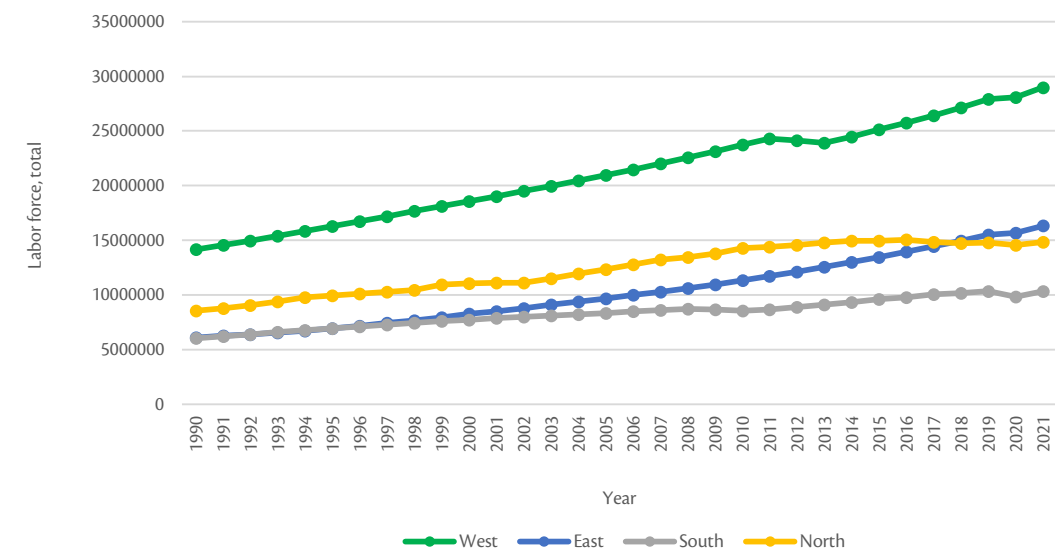
at 22,668,184 people, followed by Zimbabwe at 7,415,518 people, while Botswana had the least number at 971,259 people. The average number of people in the labour force in the region as of 2021 was 10,351,653 people. Like the other three regions of study, North Africa saw an increase in labour force participation between 1990 and 2021. In 2021, Egypt enjoyed the highest labour force participation at 28,462,356, followed by Morocco with 11,959,366 people, and Tunisia had the least with 4,151,766 people. As of 2021, the average number for the region was 14,857,829 people.

An area that Africa still faces challenges with is that of decent work. Defined by the ILO as productive work for women and men in conditions of freedom, equity, security and human dignity. The continent also struggles with deficits and poverty.[25] Globally, Africa has the lowest GDP per capita. It is estimated that 53.9 percent of workers in Africa are poor, 58 percent are employed in low-skill jobs, and only 12.5 percent of the workforce are employed in jobs that are deemed high-skill.[26] Among the working-age population in Africa, agriculture remains the most important sector, consisting of activities in farming, hunting, forestry, and fishing. In 2019, slightly more than half the workers (50.7 percent) were employed under this sector—a decline from 53.1 percent in 2011.[27] Importantly, employees of this sector primarily work under informal conditions. Table 2 details the percentage of population in each country of study working in the agricultural sector in 2020.

All four regions have seen a steady decline in the proportion of the population employed in the agricultural sector. The Southern Africa region witnessed the smallest decline and the Western Africa region the most significant decline (from 53.48 percent in 1991 to 34.96 percent in 2019).

2.3.2. Women's participation in the labour market and an analysis of the sectors that engage women

Many African nations have taken measures to bridge the gender gap in labour force participation rates. However, the continent still has a high gender gap of 17.7 percent in labour participation between men and women, although this figure is considerably lower than the global average rate of 27 percent.[28] Regionally, Northern Africa accounted for the highest gender disparity in LFPR at 47.3 percent in 2019.[29]

Over the past decade (1990-2021), the proportion of female labour participation has varied in countries across the four regions of study. In Western Africa, the FLFPR between 1990 and 2021 increased slightly from 43.11 percent to 43.96 percent. Of the three countries of study in this region, only the Ivory Coast witnessed an increase in FLFPR from 33.34 percent to 40.97 percent in the same period. Both Nigeria and Ghana saw a decrease from 46.62 percent to 43.97 percent and 49.39 percent to 46.71 percent respectively. Compared to Western Africa, the average FLFPR in Eastern Africa has increased significantly since 1990, from 47.5 percent to 49.9 percent. Rwanda's FLFPR increased from 48.99 percent in 1990 to 51.58 percent in 2021, the highest in the region. Uganda recorded a rate of 33.34 percent in 1990 and 40.97 percent in 2021, while Kenya's increased from 47 percent to 49 percent in the same period.

The southern region of the continent also saw an increase in FLFPR in this period. In the three countries of study in the region, the FLFPR increased in Botswana from 42.31 per cent in 1990 to 48.88 percent in 2021; from 38.19 percent to 44.83 percent in South Africa, and from 46.62 percent to 51.13 percent in Zimbabwe over the same time period. In Northern Africa, the FLFPR has shown a slight increase on average. However, this increase has not occurred in all countries in the regions. For example, Egypt has seen a significant decline in FLFPR from 1990 to 2021, from 24.12 percent to 18.63 percent. Morocco only saw a slight increase in the same time frame, from 22.88 percent to 25.75 percent, while Tunisia also saw a marginal rise from 22.88 percent to 28.34 percent.

The agricultural sector is one of the largest employers of women in Africa. Among the four regions under study, Rwanda has the highest proportion of women employed in the agriculture sector at 88.12 percent (approximately 81.09 percent of the total population of Rwanda is employed in agriculture), while South Africa had the lowest percentage of women employed in the agriculture sector, 6.16 percent (the total population in South Africa employed in agriculture is estimated to be 7.72 percent).

In the period between 1990 and 2019, there has been a decrease in the number of women employed in the agricultural sector in all four regions of study. In West Africa, Côte d'Ivoire had 52.89 percent of women employed in agriculture in 1991 and 31.04 percent in 2019 (the highest in the region), while the percentage of women employed in agriculture in Nigeria decreased from 45.88 percent in 1991 to 22.1 percent

Table 2
The percentage of the population in the countries of study working in the agricultural sector in 2020

	Country	Mean	Median	Standard Deviation	Kurtosis	Skewness	Minimum	Maximum
Northern Africa	Egypt, Arab Rep.	29.87345	29.8	4.207978	0.556081	0.08181	20.62	39.02
	Tunisia	18.59103	18.75	2.708856	-1.18212	-0.38	13.8	22.13
	Morocco	42.34241	43.9	4.367647	-0.80512	-0.72737	33.25	46.93
Western Africa	Cote d'Ivoire	48.56862	49.9	3.872557	-0.499	-0.83476	40.15	52.76
	Nigeria	44.18034	44.95	5.425128	-1.37146	-0.35395	34.97	50.57
	Ghana	49.73345	54.95	8.911234	0.202851	-1.29685	29.75	57.12
Eastern Africa	Kenya	53.54	55.86	6.668673	-1.58798	-0.38974	44.4	61.14
	Rwanda	81.09207	85.16	9.312818	-0.60372	-0.94564	62.29	89.17
	Uganda	70.08483	70.6	2.170989	-1.32212	-0.42102	66.14	72.68
Southern Africa	Botswana	20.59862	20.88	3.097876	-0.75974	-0.58627	15.07	25.09
	South Africa	7.721379	7.02	2.647969	-1.70623	0.264521	4.6	11.51
	Zimbabwe	63.75034	64.51	2.627011	-1.76416	-0.13214	60.03	67.24

Figure 2

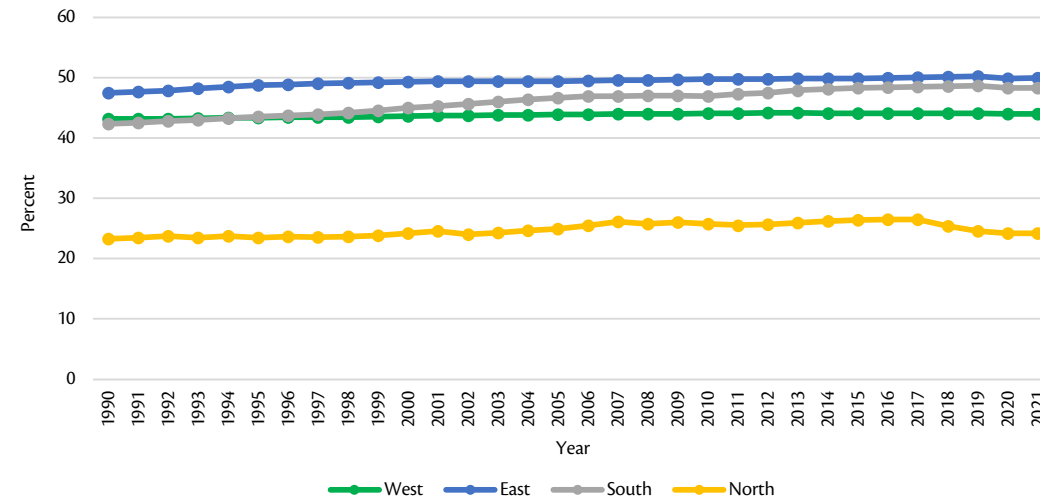**Average female participation rate from 1990 to 2021 in West, East, South, and North Africa regions.**

Table 3

The percentage of the population in the countries of study working in the agricultural sector in 2020

	Country	Mean	Median	Std Dev.	Kurtosis	Skewness	Minimum	Maximum
Northern Africa	Egypt, Arab Rep.	40.43	42.48	7.79	0.96	-0.93	21.21	53.63
	Tunisia	18.78	20.9	5.46	-0.98	-0.81	8.96	24.15
	Morocco	58.61	58.91	2.43	0.82	-0.91	52.12	61.62
Western Africa	Cote d'Ivoire	44.99	46.64	6.79	-0.61	-0.72	31.04	52.89
	Nigeria	36.82	38.78	7.68	-1.29	-0.44	23.57	45.88
	Ghana	44.53	49.93	9.90	0.45	-1.41	22.1	52.15
Eastern Africa	Kenya	61.17	62.05	5.32	-1.55	-0.14	54.05	68.33
	Rwanda	88.11	91.52	7.73	-0.05	-1.17	70.98	94.54
	Uganda	76.46	77.17	2.37	-0.24	-0.79	71.17	79.68
Southern Africa	Botswana	15.13	15.6	3.15	-1.21	-0.24	10.27	20.09
	South Africa	6.16	5.39	2.50	-1.70	0.30	3.2	9.78
	Zimbabwe	71.172	71.58	1.00	-1.11	-0.32	69.48	72.71

of women working in agriculture in 2019. The Eastern Africa region has the largest number of women working in the agricultural sector. However, a similar trend is observed here. In 1990, 79.68 percent of women in Uganda were employed in the agricultural sector. This declined to approximately 71.17 percent in 2013 and rose to 76.77 percent in 2019 (the highest in the region). It is estimated that the proportion of women working in the agriculture sector in Rwanda was 94.54 percent in 1991, which declined to 70.98 percent in 2019.

In comparison with the other countries of study, a significantly low number of women were employed in agriculture in the Southern Africa region. In Zimbabwe, 69.48 percent of women worked in agriculture in 2018. In the same period, 15.28 percent and 3.79 percent of women worked in agriculture in

Botswana and South Africa respectively. Northern Africa also witnessed a decline in the proportion of women employed in agriculture from 1990 to 2019. Overall, in the period under study, Morocco had the highest average proportion of women employed in agricultural sector at 58.61 percent, while Tunisia had the lowest at 28.79 percent.

In general, the years between 1990 and 2019 saw an increase in the number of waged and salaried women in all four regions of study across Africa. In 2019, Tunisia had the highest proportion of wage and salaried women workers in Northern Africa at 75.42 percent, while Ghana had the highest in Western Africa at 10.96 percent. In Eastern Africa, Kenya had the highest proportion of at 26.34 percent, while South Africa led at 81.71 percent in Southern Africa, boasting the highest overall percentage in the four

Figure 3

Wage and salaried female workers in North, West, East, and South Africa regions from 1990 – 2019
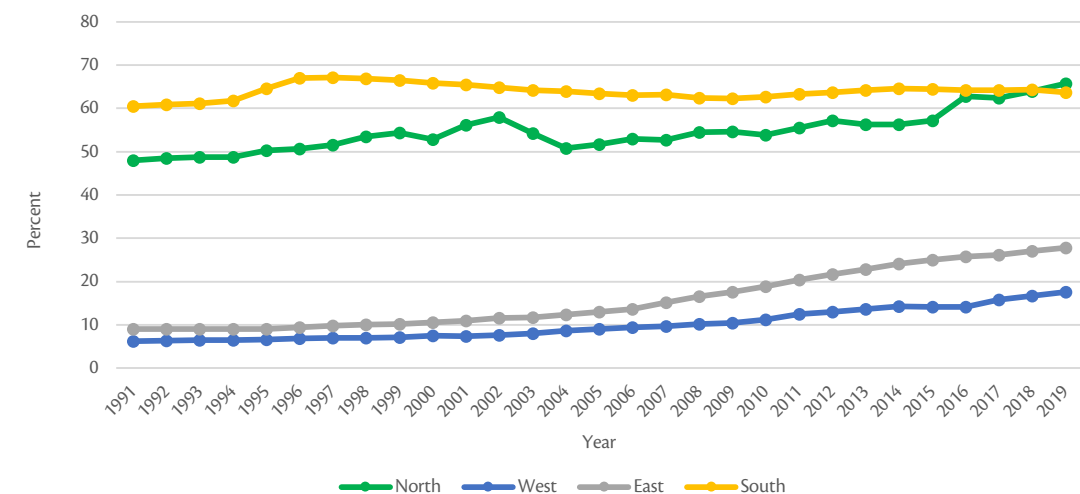
regions. Of the 12 countries of study, Côte d'Ivoire had the lowest percentage of waged and salaried women at 8.88 percent.

2.3.3. Technological trends across economic sectors

Technological innovations are transforming the nature of work in Africa. The primary driving factors for technological development and adaption are advancements in mobile technology and internet access on the continent. The study defines internet users as individuals who have used the Internet (from any location) in the past three months and finds a dramatic increase in adoption and use across Africa. The number of people with access to and using the internet in Western Africa has risen steadily between 2005 and 2019. In Nigeria, the percentage of the population using the internet rose from 1.72 percent

in 2005 to 31.9 percent in 2019. Similarly, Ghana and Côte d'Ivoire respectively saw a 41.3 percent increase and 35.8 percent increase in internet users over the same period. Similarly, the number of internet users in Eastern Africa has also increased in the 14 years between 2005 and 2019. In 2019, Rwanda had the highest population of internet users in East Africa, 25 percent. The number of people using the internet in Northern and Southern Africa is higher than that in Eastern and Western Africa. With the two regions, Tunisia and Morocco are home to the highest proportion of the population using the internet at 64.8 percent. South Africa comes a close second, with 62.4 percent of its population being internet users.

The number of mobile subscriptions has increased exponentially in Africa between 1990 and 2013, a rise that can be attributed to low entry barriers—

Regional mobile subscribers in West, East, South, and North Africa regions from 1985 to 2029. The number of subscribers from 2021 to 2029 has been calculated using mathematical simulation.

mobile usage is affordable and demands no literacy requirements.[30] Significantly, mobile technologies have impacted the type of work and activities associated with work in Africa. Research shows that the reduction in communication costs associated with mobile phones has tangible economic benefits, improving agricultural and labour market efficiency, and affecting consumer welfare, effects particularly dramatic in a country's rural regions.[31] Mobile technology also harbours the potential to improve working life in several avenues ranging from job seeking, improvement in working conditions, and training.[32]

The combined average of mobile cellular subscriptions of Western Africa in 2013 was approximately 44,559,131, in Eastern Africa 18,862,603, in Southern Africa 37,660,185, and finally, the average mobile subscriptions in Northern Africa in 2013 was 51,613,711. By the end of 2020, 495 million people subscribed to mobile services in Africa, representing 46 per cent of the region's population, an increase of almost 20 million in 2019.[33] Mathematical projections show that the number of subscriptions will only continue to increase. By 2030, simulations forecast that the Western Africa region will have an average of 164,699,921 mobile subscribers, Eastern Africa 54,199,995, Southern Africa 43,356,922, and Northern Africa 72,326,391 mobile cellular subscriptions.

2.3.4. Technological impact on the labour market and economic sectors in Africa

As technology reshapes the skills needed for work, the demand for lower-level skills replaceable with technology is declining. At the same time, there is greater demand for advanced cognitive skills, socio-behavioural skills, and skill combinations associated

with greater adaptability. While already evident in developed countries, this pattern is now seen in certain developing countries as well. In Bolivia, for instance, the share of employment in high-skill occupations increased by 8 percentage points from 2000 to 2014.[34] In Ethiopia, this increase was 13 percent.[35] The changes brought about by technology are thus reflected not only in the creation of new jobs, but also in the changing skills profiles of existing jobs.

In Africa, many workers remain in low-productivity jobs, often in firms in the informal sector, where access to technology is poor. Despite improvements in the regulatory environment of businesses, informality has remained high over the last two decades. For those in this sector, access to the internet continues to be a challenge despite the relatively high penetration of mobile technology in the continent. Mechanisation in agriculture is similarly ridden with challenges: the low cost of labour in comparison to the costs of machinery hinders the uptake of technology. One of the economic sectors greatly affected by technological development and advancement in Africa is the services sector, which consists of wholesale and retail trade and restaurants and hotels; transport, storage, and communications; financing, insurance, real estate, and business services; and community, social, and personal services.[36] The service sector across Africa has grown consistently in the past decade. In West Africa, Nigeria has had the highest growth of employment in the service sector, increasing from 36 percent of the population employed in services in 1991 to 53 percent in 2019. Ghana's service sector has grown from 29 percent in 1991 to 49 percent in 2019 while Côte d'Ivoire saw an increase from 34 percent to 46 percent. The average rate of people employed in this sector in the
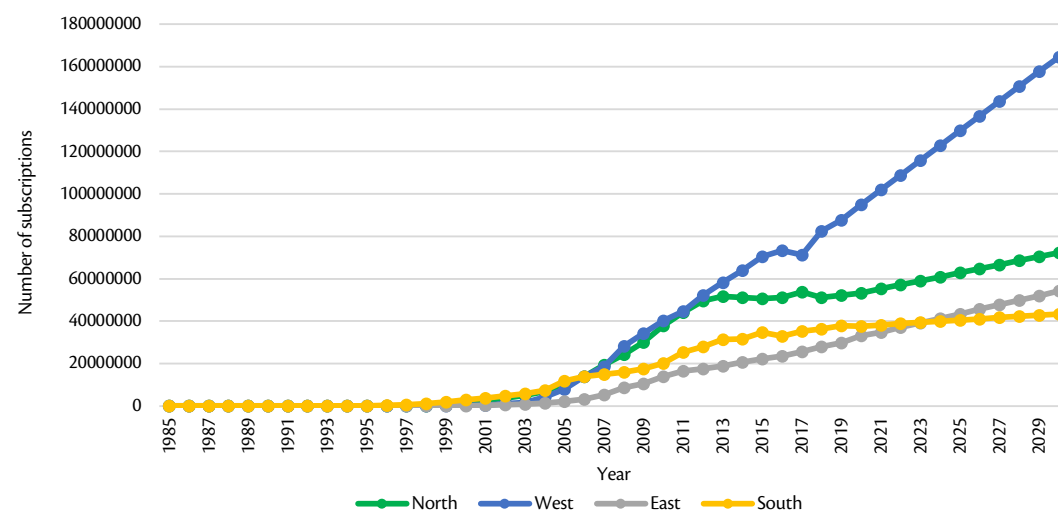
Western African region stood at 49 percent in 2019, a significant increase from the 33 percent recorded in 1991. The average rate of the Eastern Africa's working population in the sector stood at 30 percent in 2019, up from 22 percent in 1991. As of 2019, Kenya has the highest percentage of its population working in the service sector, 41 percent. Southern and Northern Africa have seen their service sectors grow from 60 percent to 72 percent and 33 percent to 44 percent respectively in the years between 1991 and 2019.

Technology has also had a significant impact on the industrial sector in Africa—on economic activities carried out in mining and quarrying, manufacturing, construction, and public utilities (electricity, gas, and water).[37] Of the four regions of Africa under study, Northern Africa had the highest proportion of people working in this sector in 2019 and has seen an increase in this proportion from 1999 to 2019. The Eastern and Southern Africa regions, however, have witnessed a decline in the number of people employed in the industrial sector over the same period. The Western African regions, meanwhile, saw a slight increase (less than 2 percent) in this proportion.

### 2.3.5. Technology's impact on women's participation in the labour market

Women's involvement in the labour market is influenced by a variety of economic, socio-demographic, and cultural factors.[38] Technological factors also play a role—studies have shown that the use of Information and Communication Technologies (ICTs) exerts a positive influence on female labour force participation in developing countries.[39] The female participation rate is in general positively correlated with the use of ICTs measured as the percentage of individuals using the internet and mobile cellular telephone subscriptions per 100 inhabitants.[40] ICTs have been found to empower women by aiding in their financial inclusion, increasing the transparency of labour market information, and leading to a rise in female participation in the labour market by making it easier for women to balance work and family duties.[41]

A 2021 study found that ICT's positive effect on financial inclusion and increased female education meant that the use of ICT, both through the internet and mobile phone, resulted in increased female labour force participation in Africa.[42] The study also demonstrated that that the impact of ICT on female employment was strongest in the industrial sector.[43] Unfortunately, in the digital economy—one of the fastest growing and most promising sectors in many countries in Africa—women continue to be underrepresented and marginalised as tech entrepreneurs.[44] Women's participation in the tech industry in Africa is very low: only 9 percent of African tech start-ups were led by women, according to a 2016 report by Venture Capital for Africa. Additionally, McKinsey estimated in 2016 that women occupied a mere one-third of leadership positions in telecoms, media, and technology.[45]

Figure 5

Regional employment in the Western, Eastern, Northern, and Southern Africa regions in the industrial sector
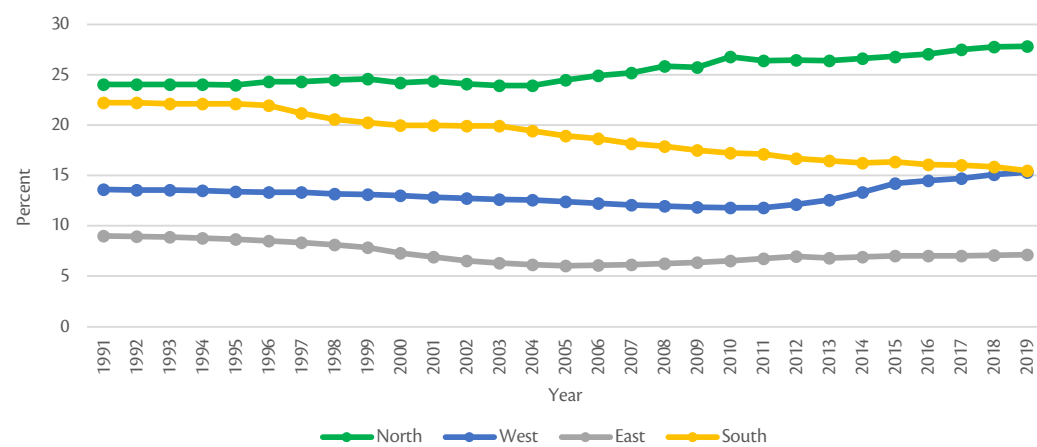
3. Technological Changes and Responsiveness of Skills Architecture

3.1. Overview

Across the world, those in the workforce have been forced to adapt to technology-induced changes in the labour market by constantly reskilling or upskilling in order to meet market needs.[46] To compete in the global market, nations must ensure that their citizens can acquire the skills needed to adapt to and thrive in the new economic landscape. Education, thus, is pivotal to a healthy employment ecosystem; studies show there is a direct relationship between the two in any given country[47] and countries with higher employment opportunities and working conditions are found to have better educational standards.[48] The adoption of technology in—and the digitalisation of—the labour market has increased the global demand for individuals with high digital skills, now suitably equipped to take on new or changing jobs in various sectors of the economy. However, there are gaps between skills demand and job availability in the market; for instance, developed countries tend to have overeducated individuals in technologically unskilled jobs.[49] This, coupled with the informality of most labour markets in developing markets, means that a large working population is "overeducated". In developed countries, tends to be curated to answer to the needs of the market. This flexibility allows developed markets to be competitive for high skilled jobs in the world.[50] To meet the demand for high skilled workers, Technical and Vocational Education and Training (TVET) has gained popularity in developing countries. These institutions prioritise educational curriculums that scale up informal sectors to offer quality jobs.[51] Identifying TVET as a priority area, the African Union has launched several initiatives to promote its development in the continent. While TVET institutions have historically been seen as an alternative to post-secondary education for youth who cannot afford higher education, they are now seen as critical to skilling. However, the TVET landscape in Africa is beset with multiple challenges: insufficient funding, small pool of qualified instructors, and outdated equipment and facilities. There is also a significant gender gap in participation in TVET programs, with a disproportionately low number of women enrolled. Recognising these issues, a number of governmental agencies, non-governmental organisations, and international organisations are working to improve the TVET system in Africa.

The goal of this component of the study is to map the skill development ecosystem available in the 12 countries of studies, with a specific focus on the TVET landscape.

3.2. Objectives

The primary objectives of this component were as follows:

I.   To gain an understanding of the education and skill development structures in each country and region under study.

II. To examine the role of public and private sector collaboration in skills development.

III. To assess the delivery and relevance of skills in light of digitalisation, automation, and artificial intelligence and gender.

IV. To evaluate the readiness and responsiveness of the TVET ecosystem to technological transformation and gender inequity.

V.   To determine how technology impacts skill development in institutions.

3.3. Methodology

A literature review using the Social Ecosystem Model (SEM) which links 'working, living and learning' as the new and expanded parameters of skills formation in a digital age was conducted for the 12 countries detailed in Section 2.[52] The variables utilised for this analysis are indicated below.

Table 4
Variables utilised for skills architecture analysis

INDICATOR	VARIABLES
Training Landscape	• Availability of technologies and infrastructure e.g., laptops, internet • Knowledge/capacity to train, on the use of these technologies • Skills trainings using these technologies (capacity of trainers and trainees)
Industry 4.0 Readiness of TVETs	• Competencies/knowledge/skills • Innovativeness (Research & Development) • Sectors of specialisation • Resources (Financial, legal, managerial) • Ease of adaptation
Assessing readiness	Curricula, Skill set: Teachers, Trainers, and Instructors; Infrastructure (tied to number 2)
Industry and private sector Engagement	Skills demand vs. supply, extent of Collaboration (Internship programs, apprenticeships)
Number of trainees in TVET ecosystem	Gender, skills
Skills Supply	• Education levels in the workforce or the population e.g., according to the International Standard Classification of Education (ISCED) • Percentage of population with post-secondary qualification • Graduation rates • Uptake of post-secondary and TVET education • Percentage of people not completing school education • Percentage people receiving training within a particular period
Skills Demand	• Occupations within the workforce • Wage levels • Productivity • Skills shortages and vacancies (unmet vacancies) • Employee jobs in knowledge-based industries/high technology firms • Under-employment/over-qualification of workers

Data collection and analysis will follow the same steps outlined in Section 2.2 of this report.

3.4. Skills Architecture

One of the modes of skilling, reskilling, and upskilling in all four regions under study is the use of Technical and Vocational Education and Training (TVET) to train the workforce and impart necessary skills. The three Eastern African countries under study (Kenya, Rwanda, and Uganda) offer formal training in TVET institutions. The existence of National Qualification Frameworks (NFQs) in each country ensures that the curricula of TVETs are designed in accordance with pre-determined frameworks, rules, and regulations. This ensures uniformity in the development of occupational standards, assessment, and certification of trainee skills in all the TVETs in the country, which can be adhered to by all trainers and instructors.

In the Eastern Africa region, Kenya has the highest number of TVETs at 984, Uganda has 801 TVET institutions, and Rwanda 383. In all three countries, most formal TVET institutions are found in urban areas. This results in unequal access to training for those in rural and peri urban areas.[53] Non-formal training, which includes on-the-job training by various ministries and firms, workshops, and apprenticeship, is also recognised. However, despite this recognition, there is no particular method by which the acquisition of skills by trainees is certified. In Northern Africa, the TVET structure is more developed than in the Eastern region of the continent. All the Northern African countries under study recognise both formal and non-formal TVET training. These countries have also implemented NQFs, with

the exception of Egypt, which is in the final stages of adopting its NFQ. In Egypt, formal centres offer training and re-training programs for both employed and unemployed workers in the labour force, while most of the informal ones provide vocational training to various disadvantaged groups, particularly women and disabled and unemployed youths, assisting them to improve their ability to generate income, usually in the informal sector. These centres are run by non-governmental organisations and local organisations and are heavily subsidised by government funds. As of 2018, the World Bank reported a total of approximately two million students as having enrolled in vocational institutions in Egypt. Morocco, an approximate enrolment of 246,200 students, and 95,000 students.

In Southern Africa, TVETs offer both formal systems of training and informal training conducted by non-governmental organisations, church organisations, and other private entities. Botswana has a National Credit and Qualifications Framework (NCQF), which allows for the classification of qualifications according to a set of criteria for specific learning levels achieved. The framework also facilitates the coordination of education and training, the assessment of learning, and the granting of credits and certificates. Among the possibilities for informal training, traditional apprenticeship is the most popular in Botswana. South Africa is home to the South African National Qualifications Framework (SANQF), which guides the implementation of the formal training given by TVET institutions in the country. The NQF is designed to contribute to the overall personal development of each learner as well as the social and economic development of the nation as a whole. In this country,

non-formal education is perceived as complementing and supplementing formal education, meant largely for those who drop out of the formal system. In Zimbabwe, the Government implemented the Zimbabwe National Qualifications Framework (ZNQF) in 2018 to foresee implementation of the formal training of TVETs. The ZNQF aims to integrate the different parts of the education and training system into a unified structure of recognised qualifications with clear pathways. It provides a mechanism to link basic education, TVET and higher education to each other in a way that recognises the achievements of learners and graduates. The majority of TVET is provided by both public and private institutions. In 2017, Zimbabwe had an enrolment of 22,911 students in its TVET institutions. South Africa had the highest enrolment rate in the region with 355,400 students, and Botswana saw the lowest with only 10,100 students.

The Western African countries under study offer both formal and informal training in their TVET institutions. Nigeria does not have a comprehensive or integrated NQF, and curricula for TVETs are structured within the existing subsystems of education in three domains of knowledge, skills, and attitudes/values. The Nigerian Skills Qualification Framework (NSQF) was developed for the TVET subsystem. The National Board for Technical Education (NBTE), National Commission for Mass Literacy, Adult and Non-Formal Education (NMEC), and National Directorate of Employment (NDE) offer non-formal TVET programmes. Cote d'Ivoire embraces a formal, structured TVET environment under its NFQ, which has set guidelines and standards for curriculum, assessment, and certification. 13 public training delivery units operate

in rural areas, with 10 mobile training units offering non-formal training and three application and production workshops offered to develop the skills of craftspeople and provide logistical support to young graduates.

Finally, Ghana sees a large proportion of its young population trained in the informal education sector. It is estimated that more than 400,000 apprentices are currently enrolled in informal training. Apprenticeships in the informal economy are not controlled by the government, but trade associations play an informal regulatory role in this training system. There are no written curricula, no formal assessments or certification procedures, and master crafts persons (MCPs) are not appointed by any legal entities. This absence of formality has led to several attempts being made to upgrade informal apprenticeships in Ghana.

The key stakeholders in TVET are teachers and trainers. Most TVETs in the four regions of study suffer a shortage of these central actors in most of their programmes. In Egypt, the student teacher ratio in technical colleges in 2014-2015 was 56.8 while that of apprenticeship was 12.7. In Ghana, the student to teacher ratio in public TVETs was 17 while the average at private TVETs stood at 18. South Africa had the largest student to trainer ratio—the figure in public TVETs was 66.6 compared to that of private TVETs at 16.9, and the average ratio in the country was 46.2. In Morocco, the average ratio is 38 trainees to each permanent trainer; an average ratio of 41:1 is seen in TVET institutions in ministerial departments; 52:1 is the figure in public TVET institutions, and 19:1 is the ratio in private TVET institutions.

3.5. Women's Access to Skills and Technology

3.5.1. Women's access to TVET education

Although women play a critical role in the agricultural sector in Africa, they are underrepresented in agricultural education and training.[54] In many countries in Africa, only the male heads of household are entitled to further education, training or TVET.[55] Women's decision making abilities, however, have been proven to be linked to overall betterment; when women are able to make decisions at a higher level within the household, they are also able to implement better farming practices. These, in turn, result in higher yields, and help increase the earnings of the entire household. All this is only possible, however, if women have the same access to agricultural training and TVET education as their male counterparts. A 2006 study was inconclusive on whether men could transfer their knowledge and skills to women farmers,[56] pointing to the crucial need for women to be involved in the training of female farmers on the continent. The curriculum itself is also central to women's success—a 2013 study recommended that the agricultural TVET curriculum on the continent be structured in a more participatory manner, and that gender aspects be considered when deciding themes and training periods; for example, user-friendly platforms for training and capacity building lessons could be tailored to meet the needs for different categories of people.[57]

The gender disparity observed in the agricultural TVET sector mirrors the African TVET system as a whole. TVET institutions and their services are deeply gendered in Africa, reflecting the broader socio-cultural dynamics of the (often patriarchal) societies in which they exist.[58] Further still, as studies suggest, TVET systems do not simply reflect the gender dynamics of broader society, but even work to perpetuate them.[59] Apart from enjoying lower access to TVET and other training institutions, women also find it more difficult to complete the TVET programme once it has begun, often because of gender-based violence, especially among those from poor households, a factor also responsible for the low numbers of women students in TVET institutions.[60]

Some countries acknowledge these gender gaps in TVET institutions, and have conceived of policies to ensure the inclusion of vulnerable groups like women. Kenya, for example, in its Technical and Vocational Education and Training Act determines that the Authority (TVETA) "shall have regard to the objectives and needs of development of technical and vocational education and training and shall ensure that there are balanced competencies, gender equity, inclusion of persons with disabilities, the marginalised and other minority groups".[61] Ensuring women's equal and full participation in the labour force, and particularly in non-traditional sectors like STEM, is critical to for women's economic empowerment. While some strides have been taken in building more inclusive TVET frameworks, much remains to be done. When planning skills learning courses for TVET institutions, gender gaps must be contextualised and considered so that the specific needs of women and marginalised groups are addressed.

3.5.2. Women as TVET instructors

Most countries of the Organization for Economic Cooperation and Development (OECD) have a higher proportion of female teachers at the primary and secondary levels, while more than half of the teaching staff is male at the tertiary level.[62] A similar trend is observed in TVET institutions in the countries of study. Even though there has been a steady increase in the number of women accessing technical education, the number of female instructors in TVET institutions is still significantly lower compared to that of men. For instance, gender disparities persist in Ghana among trainers and students; technical education is dominated by male instructors and students, and vocational education has more women in both the instructor role and as students.[63] Such disparities in the African TVET system are borne of cultural and societal norms on gender roles and persisting gender stereotypes, which are also responsible for the gender gaps experienced among TVET trainers/instructors.

3.5.3. Women's employability in the labour market

Local labour market demographics mirror those of women in African TVETs. Women, even those equipped with the necessary skills, find it difficult to find quality employment, especially in fields that demand high technical skills.[64] A survey of construction companies in Zambia operating between 2000 and 2003 found that larger-sized companies did not employ qualified female craftspeople, and only 22 percent of women who participated in a 2002 survey in Tanzania were engaged in an occupation that matched their skills,[65] indicating that a large percentage of working women were in mismatched occupations or simply not employed. Furthermore, formal training-related employment for women was lowest in occupations with highest levels of formal sector employment; jobs with low formal sector employment, on the other hand, had high female employment rates.[66] Ineffective marketing strategies, lack of capital, inadequate equipment and machinery, lack of improved technology, and inadequate training and low skill development hindered women's employment in high formal sector employment.[67] While patriarchal structures in African cultures also prevent women from accessing and acquiring the skills necessary for more high valued jobs,[68] studies show that women in general are also more accustomed to working in lower quality jobs in society.[69]

3.6. Skills Development and Industry 4.0 Readiness

As the world moves into the Fourth Industrial Revolution, employability has become a pressing issue across nations. Lower- and Middle-Income Countries (LMICs) are home to a large number of youths who are not employed, educated, or trained. Most African countries fall into this category. It is important that African countries leverage this demographic and reduce the gap between educational attainment and high skilled employment to increase national productivity and meet the SDGs. At present, educational outcomes on the continent are unsatisfactory in comparison with developed nations—African graduates find themselves with skills that are not in demand in the market. This leads to most youth being absorbed into highly vulnerable jobs that require lower skills, which are not aligned with their education levels.[70] The changing labour market has given rise to increased demand for high quality skills training. Increasingly, TVETs are being used to gain these skills, especially by members of vulnerable communities, including women. In March 2021, UNESCO and the African Union launched the Pan-African Initiative for the Digital Transformation

of TVET and Skills Development Systems in Africa. Through several complementary actions, including the creation of national networks and a pan-African training programme, this initiative seeks to equip stakeholders in the sector with what is necessary to make a successful digital shift.

Africa suffers from insufficient infrastructure and resources for TVET institutions. First, TVET institutions lack funding in all four regions under study. In all 12 countries of interest, the state government is still the greatest contributor to TVET expenditure. The low level of public resources allocated (only 2 percent to 6 percent of public expenditure on education according to the OECD-AfDB/2008 report) forces most countries on the continent to adopt a strategy of diversification of sources of financing in order to reach a wider public while optimising training costs.[71] The second challenge affecting most TVETs is the lack of trainers. Most trainers tend to focus on theoretical aspects and leave out the more practical lessons. The lack of digital skills among trainers has also made it difficult for TVETs across Africa to adapt to the digital transformation.

3.7. Reforms Required in Skills Architecture

Historically, TVET courses have not had direct linkages with the digital world. Now, however, it is critical that TVETs in the African continent incorporate curricula with a focus on digital skills and hire instructors with digital skills, and contribute to the acquisition of digital literacy among the continent's population. However, TVETS face a number of challenges, both generally and in relation to in digital training, some of which are outlined in section 3.5.

It is evident that national policies and strategies are needed to strengthen, manage, and better plan the TVET sector. An analysis of the 12 countries of study in this study shows that much improvement is needed in current national strategies and policies. For example, Ghana, used in this section as a case study, is yet to have a well-performing skills anticipation system. Sector skills councils are expected to contribute to improving the analysis and forecasting of skills needs at sectoral level, but there are not enough organisational structures and human resources to centralise the information and provide evidence for making TVETs more responsive to current and future skill needs.

Currently operational TVET institutions in the countries of study also suffer from poor quality of skills provision. Skills delivery does not always meet basic quality requirements thanks to insufficient financial resources and a shortage of adequately skilled teaching and training personnel. This adversely affects the image of TVETs, both among employers and among young people and their families. In this regard, the Ghanian TVET Commission, working through the WorldSkills Ghana experts and the Sector Skills Bodies, and in collaboration with training institutions, keeps exploring ways to improve and localise skills offered in institutions. The Commission is partnering with the Petroleum Commission to establish the Institute of Welders in the Country through the Sector Skills Bodies, and is working towards curriculum development, and standard generation among other related issues.

The Commission is also taking steps to introduce greening philosophies and technologies across all TVET institutions and embed them into their curriculum. This is especially important since the world is heading towards a green revolution which will prioritise cleaner and more efficient use of natural resources. Considering the continuous exploration for oil and gas in Ghana, the country must turn its attention towards the training of manpower to meet the requirements of this sector.

According to the World Economic Forum (2020), different jobs are in a state of emergence and decline. Those utilising digital skills or based in the digital economy are in high demand, while jobs in the retail, administrative, and industrial sector are in decline.

TVET institutions in Ghana, for instance, need to be responsive to these changing trends and demands. The aforementioned Commission is addressing these changing trends in the labour market via the establishment of the Sector Skills Bodies, Skills Gap Analysis and Audit of sectors, needs assessment of TVET Institutions, and several other strategies. General and international trends must be considered, evaluated and adapted to the context of the Ghanaian economy and industry for skilling to be successful.

4. Analysis and Recommendations

The economic and labour market in Africa has seen significant shifts in the last 20 years. Sectors that have historically contributed to the continent's GDP have seen a decline in the number of people participating in it. The agricultural sector, for example, has contracted in the years between 1990 and 2019 in all 12 counties of study. Meanwhile, mobile and internet use, and economic activities related to them, is on the rise. Unfortunately, the gender gap in women's participation in the labour market has persisted. To prepare their nations to meet national SDG goals by leveraging the emerging digital economy, many governments have prioritised training and retraining programs in TVET institutions.

TVET institutions are crucial to equipping individuals with the skills and training relevant to the new demands in the industry, thereby contributing to the nation's productivity. TVETs have also been

key in reducing unemployment rates among youth unable to afford higher education, ensuring them decent work for decent pay. The TVET sector in Sub-Saharan and Northern Africa largely takes on a formal training structure, although the importance of informal training is acknowledged in both regions. While some progress has been made in reformatting TVET infrastructures to meet the demands of a digital economy, much still needs to be done to ensure students are imparted with the skills necessary to navigate this economy.

Various existing gaps within the educational sector may hinder the adoption of technologies by the continent's population. To manage the risks and reap the benefits of the Fourth Industrial Revolution, Africa should focus on designing an African-focused strategy geared towards the common goal of transforming its entire education system. The first step in this

direction is the training or retraining of educators, many of whom are not tech-savvy. An inadequate pool of skilled trainers will only lead to rising numbers of people with obsolete skills; this poses a huge risk to the African economy, as productivity will be stifled and unemployment rates will likely rise.

Some countries have not only embraced ICT courses in their TVET curriculum, but also begun using ICT in the delivery of this curriculum. This, however, may be constrained by inadequate infrastructure and resources—a lack of computers, limited access to internet, and an unqualified pool of trainers. Given that most TVET institutions are public, a lack of funding has hindered the acquisition of these resources and the development of this infrastructure. Despite this challenge, some private-public partnerships are helping bridging this gap, with the private sector keen on setting up initiatives that provide the infrastructure and training required. Further, it is worthwhile to note that most African countries are in the process of formulating strategies and policies that will advance the use of technology and help them gain from the Fourth Industrial Revolution.

Meanwhile, the gap in women's access to technology, skills training and in participation in the labour market in Africa is large. This divide poses an immense threat to national productivity. All stakeholders in the Fourth Industrial Revolution should bear this in mind, and make sure the participation of women does not lag behind that of men. Currently, female students enrolling in TVETs account for less than 50 percent of total students, despite the existence of policies and frameworks in many African countries to address this gender disparity. A pattern of gendered participation in TVET courses is also seen, with women dominating

vocational courses and men the technical education courses. This trend is mirrored in the instructional roles in TVET institutions. This gender disparity is a result of poor programming of curricula which does not address gender needs. Furthermore, communication about and advocacy for these programs also seems to be ineffective in reaching the desired audience.

Though African TVET systems are currently faced with several challenges in terms of readiness for the Industry 4.0 revolution, some efforts are being made to address them. Some examples include:

I.   Investment in technology: African countries are investing in technology like automation and artificial intelligence to upgrade their TVET systems.

II. Collaboration with industry: African countries are working to establish partnerships between TVET institutions and industry to ensure that training programs align with industry needs.

III. Teacher training: African countries are working to provide training for teachers to ensure that they have the necessary skills and qualifications to teach Industry 4.0 related subjects.

IV. Curriculum development: African countries are developing new curricula to align with the needs of Industry 4.0. It is important to note that the readiness of African TVETs for Industry 4.0 hinges upon concerted efforts from the government, private sector, and other stakeholders.

5. Gaps and Opportunities: The Way Forward

Various gaps were identified in data availability in the study on skilling, reskilling, and upskilling venues for the digital economy and labour market in Africa. Some of the gaps that need to be studied further include:

I.   Factors that have continually led to the gender disparities being witnessed in TVETs across Africa. This includes the programming of curricula in light of gender needs in TVETs, the effectiveness of communication and advocacy strategy in reaching potential TVET students, and socio-cultural perceptions of gender roles and how they influence the choice of training among TVET students.

II. The extent to which technological training is accessible to women and whether this influences their access to skills (reskilling, upskilling).

III. The number of TVET institutions focused on technology training and the number of women attending those institutions, as well as graduation and employability rates.

IV. A fuller picture on the adaptability of TVETs in the light of the Fourth Industrial Revolution. It is important to explore the impact of infrastructure, trainers, and the financial situation of the

African TVETs on their adaptability in a time of industrialisation.

V. Understanding the importance of cross-border data flows and harmonising Africa's data governance landscape. There is a need to research the gains the African countries have made economically and socially in the broader context of the global data economy, and see how this has impacted women in low-end and high-end IT skills and affected their participation in the labour market.

In the next phase of the project, we will begin primary data collection in the four regions to fill in some of the knowledge gaps identified above, specifically:

I.   the extent to which technology affects women's employment;

II. the extent to which it affects the types of jobs and tasks available to women;

III. the venues that women utilise to acquire skills needed to successfully navigate the digital economy, and

IV. the impact of digital skills training on women's employment.

Bibliography

Abendin, S. a. (2021). Abendin, Simon, and Pingfang Duan. "International trade and economic growth in Africa: The role of the digital economy." Cogent Economics & Finance 9, no. 1 (2021): 1911767. *Abendin, Simon, and Pingfang Duan. "International trade and economic growth in Africa: The role of the digital economy." Cogent Economics & Finance 9, no. 1 (2021): 1911767.*, 1911767.

Achandi, E. L., Mujawamariya, G., Agboh-Noameshie, A. R., Gebremariam, S., Rahalivavololona, N., & Rodenburg, J. (2018). Women's access to agricultural technologies in rice production and processing hubs: A comparative analysis of Ethiopia, Madagascar and Tanzania. *Journal of Rural Studies, 60*, 188 - 198.

African Development Bank. (2008). *African Development Report 2008 - 2009*. Oxford: Oxford University Press.

African Union. (2020). *The Digital Transformation Strategy for Africa (2020-2030)*. Addis Ababa, Ethiopia: African Union. Retrieved February 6, 2023, from https://au.int/sites/default/files/documents/38507-doc-dts-english.pdf

Aggarwal, A. (2013). Lessons learnt from informal apprenticeship initiatives in Southern and Eastern Africa. *Minister of Higher Education and Training Declaration of: The year of the Artisan*.

Aker, J. C., & Mbiti, I. M. (2010). Mobile phones and economic development in Africa. *Journal of economic Perspectives, 24*(3), 207 - 232.

Al-Samarrai, S., & Bennell, P. (2007). Where has all the education gone in sub-Saharan Africa? Employment and other outcomes among secondary school and university leavers. *The Journal of Development Studies, 43*(7), 1270 - 1300.

Amoamah, M., Owusu, M., Brew, E. M., Ampiaw, R. E., & Dadzie, J. (2016). Gender Inequality in TVET Institutions – Bridging the Gap: The Case of Accra Polytechnic. *Mathematical Theory and Modeling, 6*(1), 27 - 35.

Arntz, M., Gregory, T., & Zierahn, U. (2016). The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis. OECD Social, *Employment and Migration Working Papers No. 189*. Paris, France: OECD.

Asare, R., Akuffobe, M., Quaye, W., & Atta-Antwi, K. (2015). Characteristics of micro, small and medium enterprises in Ghana: Gender and implications for economic growth. *African Journal of Science, Technology, Innovation and Development, 7*(1), 26 - 35.

Bonnet, F., Vanek, J., & Chen, M. (2019). *Women and Men in the Informal Economy: A Statistical Brief*. Geneva, Switzerland: International Labour Office.

Bray-Collins, E., Andrade, N., & Wanjiru, C. (2022). Gender and TVET in Africa: A review of the literature on gender issues in Africa's TVET sector. *Futures of Education, Culture and Nature-Learning to Become, 1*, 151 - 171.

Chetty, K., Aneja, U., Mishra, V., Gcora, N., & Jaya Josie, J. (2018). Bridging the digital divide in the G20: skills for the new age. *Economics, 24*.

Chun, N., & Tang, H. (2018). Do information and communication technologies empower female workers? Firm-level evidence from Viet Nam.

Duncan, G. J., & Hoffman, S. D. (1981). The incidence and wage effects of overeducation. *Economics of education review, 1*, 75 - 86.

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? *Technological Forecasting and Social Change, 114*, 254 - 280.

Furia, D., Castagna, A., Mattoscio, N., & Scamuffa, D. (2010). Education and labour market in the age of globalisation: Some evidence for EU-27. *Procedia - Social and Behavioral Sciences, 9*, 1140–1144., 9, 1140 - 1144. doi:https://doi.org/10.1016/j.sbspro.2010.12.297

Gomis, R., Kapsos, S., & Kuhn, S. (2020). *World employment and social outlook: trends*. Geneva, Switzerland: International Labour Organization.

Google; International Finance Corporation (IFC). (2020). *e-Conomy Africa 2020: Africa's $180 billion Internet economy future*. Google; IFC.

Green, F., & McIntosh, S. (2007). Is there a genuine under-utilization of skills amongst the over-qualified? *Applied economics , 39*(4), 427 - 439.

Greene, L., & Mamic, I. (2015). *The future of work: Increasing reach through mobile technology*. Geneva, Switzerland: International Labour Organization (ILO).

Haftu, G. G. (2019). Information communications technology and economic growth in Sub-Saharan Africa: A panel data approach. *Telecommunications Policy, 43*(1), 88 - 89.

International Labour Organization (ILO). (2015). *Education and labour markets: Analysing global patterns with the KILM*. Geneva, Swizterland: International Labour Organization (ILO).

International Labour Organization (ILO). (2018). *World Employment and Social Outlook Trends 2018*. Geneva, Switzerland: International Labour Organization (ILO).

International Labour Organization (ILO). (2023). *World Employment and Social Outlook Trends 2023*. Geneva, Switzerland: International Labour Organization (ILO).

International Labour Organization (ILO) Regional Office of Africa. (2020). *Report on Employment in Africa (Re-Africa): Tackling the Youth Employment Challenge*. Geneva, Switzerland: International Labour Organization (ILO) .

International Labour Organization. (2017). *The gender gap in employment: What's holding women back?*. Retrieved from ILO: https://www.ilo.org/infostories/en-GB/Stories/Employment/barriers-women

International Labour Organization. (2019). *World Employment and Social Outlook Trends 2019*. Geneva, Switzerland: International Labour Organization.

International Labour Organization Regional Office of Africa. (2020). *Report on employment in Africa (Re-Africa): Tackling the youth employment challenge*. Geneva, Switzerland: International Labour Organization (ILO).

Karasiotou, P. (2012). Education and the labor market. Reflets et perspectives de la vie économique, 3, 51 - 72. doi:https://doi.org/10.3917/rpve.513.0051

Kuepie, M., Nordman, C. J., & Roubaud, F. (2006). Education and labour market outcomes in Sub-Saharan West Africa. Paris: *DIAL* .

Lemma, A., Mendez-Parra, M., & Naliaka, L. (2022). *The AfCFTA: Unlocking the Potential of the Digital Economy in Africa*. London, UK: ODI.

Leuven, E., & Oosterbeek, H. (2011). Overeducation and mismatch in the labor market. *Handbook of the Economics of Education* , 4, 283 - 326.

Mehta, A., Felipe, J., Quising, P., & Camingue, S. (2011). *Overeducation in developing economies: How can we test for it, and what does it mean? Economics of Education Review* , 30(6), 1334 - 1347.

Millington, A. K. (2017). *How changes in technology and automation will affect the labour market in Africa*. London, UK: Knowledge, Evidence and Learning for Development (K4D).

Muya, M., Price, A. D., & Edum-Fotwe, F. T. (2006). Construction craft skills requirements in sub-Saharan Africa: a focus on Zambia. *Engineering, Construction and Architectural Management* , 13(3), 223 - 241.

Myovella, G., Karacuka, M., & Haucap, J. (2020). Digitalization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies. *Telecommunications Policy, 44*(2), 101856.

Nangara, A. (2022, September 20). *Africa: Harnessing Mobile Technologies Growth to Drive Smart Agriculture in Africa*. Retrieved from All Africa: https://allafrica.com/stories/202209200087.html

Narcyz, R., Soja, P., & Weistroffer, R. (2019). The role of information and communication technologies in socioeconomic development: towards a multi-dimensional framework. *Information Technology for Development* , 25(2), 171 - 183.

National Council for Law Reporting. (2013). *TECHNICAL AND VOCATIONALEDUCATION AND TRAINING ACT, NO. 29 OF 2013*. Nairobi, Kenya: National Council for Law Reporting.

NEPAD. (2013). *Review of Agricultural Technical Vocational Education and Training (ATVET) Best Practices in Africa*. NEPAD.

Ngoa, G. B., & Song, J. S. (2021). Female participation in African labor markets: The role of information and communication technologies. *Telecommunications Policy, 45*(9), 102174.

Nikulin, D. (2017). *The impact of ICTs on women's economic empowerment. Catalyzing Development through ICT Adoption: The Developing World Experience*, 15 - 24.

Oketch, M. O. (2017). Cross-country comparison of TVET systems, practices and policies, and employability of youth in Sub-Saharan Africa. *W. Bertelsmann Verlag*.

Porfido, D., & Marks, Z. (2021). *Womena and the Digital Economy in Africa*. Cambridge, MA: Harvard University.

Royston, P., Carlin, J. B., & White, I. R. (2009). Multiple imputation of missing values: new features for mim. *The Stata Journal* , 9(2), 252 - 264.

Rubin, D. B. (1987). The calculation of posterior distributions by data augmentation: Comment: A noniterative sampling/importance resampling alternative to the data augmentation algorithm for creating a few imputations when fractions of missing information are modest: The SIR. *Journal of the American Statistical Association, 82*(398), 543 - 546.

Rubin, D. B. (2004). *Multiple imputation for nonresponse in surveys.* (Vol. 81). Hoboken, New Jersey: John Wiley & Sons.

Sicherman, N. (1991). Overeducation in the labor market. *Journal of labor Economics* , 9(2), 101 - 122.

Spiteri, J., Deguara, J., Muscat, T., Bonello, C., Farrugia, R., Milton, J., . . . Said, L. (2023). The impact of COVID-19 on children's learning: A rapid review. *Educational and Developmental Psychologist*, 40(1).

Spours, K., & Grainger, P. (2018, July 5). *A Social Ecosystem Model: A New Paradigm for Skills Development?* Retrieved from G20 Insights: https://www.g20-insights.org/policy_briefs/a-social-ecosystem-model-a-new-paradigm-for-skills-development/

Statistics South Africa. (2015). General Household Survey. Retrieved February 6, 2023, from www.statssa.gov.za

Suhaida, M. A., Nurulhuda, M. S., & Yap, S. F. (2013). Access to ICT as moderating factor to women's participation in the labor force: A conceptual framework. *International Journal of Trade, Economics and Finance, 4*(4), 197.

Toesland, F. (2018). *Women-led tech startups on the rise in Africa: Daunting obstacles remain in the tech industry*. Africa Renewal.

UNESCO. (2018). *Global education monitoring report gender review 2018: Meeting our commitments to gender equality in education*. Retrieved from UNESCO: https://unesdoc.unesco.org/ark:/48223/pf0000261593

Vandenbosch, T. (2006). Post-primary agricultural education and training in sub-Saharan Africa: Adapting supply to changing demand. *Unpublished manuscript, World Agroforestry Centre*, 10 - 112.

World Bank. (2018). *World development report 2019: The changing nature of work*. . Washington, DC: The World Bank.

World Bank. (2020). *Employment in agriculture (% of total employment) (modeled ILO estimate) - Sub-Saharan Africa*. Retrieved from World Bank: https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=ZG

World Bank Source. (2023). *Databank: Metadata Glossary*. Retrieved from Data Bank: https://databank.worldbank.org/metadataglossary/jobs/series/SL.SRV.EMPL.ZS#:~:text=The%20services%20sector%20consists%20of,ISIC%203)%20or%20categories%20G%2DU%20(

Yuan, Y. C. (2000). Multiple imputation for missing data: Concepts and new development. *In Proceedings of the Twenty-Fifth Annual SAS Users Group International Conference., 267*(11)

Endnotes

1 Abendin, Simon, and Pingfang Duan, "International trade and economic growth in Africa: The role of the digital economy," Cogent Economics & Finance 9, no. 1 (2021): 1911767.

2 African Union, *The Digital Transformation Strategy for Africa (2020-2030)* Addis Ababa, Ethiopia: African Union, 2020. Retrieved February 6, 2023, from https://au.int/sites/default/files/documents/38507-doc-dts-english.pdf

3 Google; International Finance Corporation (IFC), *e-Conomy Africa 2020: Africa's $180 billion Internet economy future*. Google; IFC, 2020.

4 Lemma, A., Mendez-Parra, M., & Naliaka, L, *The AfCFTA: Unlocking the Potential of the Digital Economy in Africa*. London, UK: ODI, 2022.

5 Ibid.

6 Frey, C. B., & Osborne, M. A., The future of employment: *How susceptible are jobs to computerisation? Technological Forecasting and Social Change, 114 (2017)*, 254 - 280.

7 Millington, A. K., How changes in technology and automation will affect the labour market in Africa, 2017, London, UK: Knowledge, Evidence and Learning for Development (K4D).

8 Arntz, M., Gregory, T., & Zierahn, U., The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis. *OECD Social, Employment and Migration Working Papers No. 189*, 2016, Paris, France: OECD.

9 International Labour Organization (ILO) Regional Office of Africa, *Report on Employment in Africa (Re-Africa): Tackling the Youth Employment Challenge, 2020*, Geneva, Switzerland: International Labour Organization (ILO) .

10 Ibid.

11 Chetty, K., Aneja, U., Mishra, V., Gcora, N., & Jaya Josie, J., Bridging the digital divide in the G20: skills for the new age, 2018, *Economics, 24*.

12 Statistics South Africa, General Household Survey, 2015. Retrieved February 6, 2023, from www.statssa.gov.za

13 Oketch, M. O., Cross-country comparison of TVET systems, practices and policies, and employability of youth in Sub-Saharan Africa, 2017, *W. Bertelsmann Verlag*.

14 Kuepie, M., Nordman, C. J., & Roubaud, F., Education and labour market outcomes in Sub-Saharan West Africa, 2006, Paris: *DIAL*.

15 Furia, D., Castagna, A., Mattoscio, N., & Scamuffa, D., Education and labour market in the age of globalisation: Some evidence for EU-27, 2010, *Procedia - Social and Behavioral Sciences, 9, 1140–1144*; and Karasiotou, P., Education and the labor market. *Reflets et perspectives de la vie économique*, 2012, 3, 51 - 72. doi:https://doi.org/10.3917/rpve.513.0051

16 Myovella, G., Karacuka, M., & Haucap, J., Digitalization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies, 2020, *Telecommunications Policy, 44*(2), 101856

17 Haftu, G. G., Information communications technology and economic growth in Sub-Saharan Africa: A panel data approach, 2019. *Telecommunications Policy, 43*(1), 88 - 89.

18 Rubin, D. B., The calculation of posterior distributions by data augmentation: Comment: A noniterative sampling/importance resampling alternative to the data augmentation algorithm for creating a few imputations when fractions of missing information are modest: The SIR. *Journal of the American Statistical Association*, 1987, 82(398), 543 - 546.

19 Ibid.; Yuan, Y. C., Multiple imputation for missing data: Concepts and new development. *In Proceedings of the Twenty-Fifth Annual SAS Users Group International Conference., 267*(11), 2000; Royston, P., Carlin, J. B., & White, I. R., Multiple imputation of missing values: new features for mim. The Stata Journal , 2009, 9(2), 252 - 264.

20 (International Labour Organization (ILO) Regional Office of Africa, 2020

21 Ibid.

22 International Labour Organization (ILO)., *Education and labour markets: Analysing global patterns with the KILM*, 2015, Geneva, Switzerland: International Labour Organization (ILO).

23 Bonnet, F., Vanek, J., & Chen, M., *Women and Men in the Informal Economy: A Statistical Brief, 2019*, Geneva, Switzerland: International Labour Office.

24 International Labour Organization (ILO)., *World Employment and Social Outlook Trends 2023*, 2023, Geneva, Switzerland: International Labour Organization (ILO).

25 Gomis, R., Kapsos, S., & Kuhn, S,, *World employment and social outlook: trends, 2020*. Geneva, Switzerland: International Labour Organization.

26 Ibid.

27 World Bank, *Employment in agriculture (% of total employment) (modeled ILO estimate) - Sub-Saharan Africa*, 2020, Retrieved from World Bank: https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=ZG

28 International Labour Organization (ILO), 2018

29 International Labour Organization, *World Employment and Social Outlook Trends 2019*, 2019, Geneva, Switzerland: International Labour Organization.

30 Greene, L., & Mamic, I., *The future of work: Increasing reach through mobile technology*, 2015, Geneva, Switzerland: International Labour Organization (ILO).

31 Aker, J. C., & Mbiti, I. M., Mobile phones and economic development in Africa, 2010, *Journal of economic Perspectives*, 24(3), 207 - 232.

32 Greene, L., & Mamic, I., 2015.

33 Nangara, A., *Africa: Harnessing Mobile Technologies Growth to Drive Smart Agriculture in Africa, 2022*. Retrieved from All Africa: https://allafrica.com/stories/202209200087.html

34 World Bank, World development report 2019: *The changing nature of work*, 2019, Washington, DC: The World Bank.

35 Ibid.

36 World Bank Source, *Databank: Metadata Glossary*, 2023. Retrieved from Data Bank: https://databank.worldbank.org/metadataglossary/jobs/series/SL.SRV.EMPL.ZS#:~:text=The%20services%20sector%20consists%20of,ISIC%203)%20or%20categories%20G%2DU%20(

37 Ibid.

38 Suhaida, M. A., Nurulhuda, M. S., & Yap, S. F., Access to ICT as moderating factor to women's participation in the labor force: A conceptual framework, 2013, *International Journal of Trade, Economics and Finance*, 4(4), 197.

39 Nikulin, D., The impact of ICTs on women's economic empowerment. *Catalyzing Development through ICT Adoption: The Developing World Experience*, 2017, 15 - 24.

40 Ibid.

41 Narcyz, R., Soja, P., & Weistroffer, R., The role of information and communication technologies in socioeconomic development: towards a multi-dimensional framework. *Information Technology for Development*, 25(2), 171 – 183; Chun, N., & Tang, H., Do information and communication technologies empower female workers? Firm-level evidence from Viet Nam, 2018.

42 Ngoa, G. B., & Song, J. S., Female participation in African labor markets: The role of information and communication technologies, 2021, *Telecommunications Policy , 45*(9), 102174.

43 Ibid.

44 Porfido, D., & Marks, Z., *Womena and the Digital Economy in Africa*, 2021, Cambridge, MA: Harvard University.

45 Toesland, F. (2018). *Women-led tech startups on the rise in Africa: Daunting obstacles remain in the tech industry. Africa Renewal.*

46 Furia, D., Castagna, A., Mattoscio, N., & Scamuffa, D., Education and labour market in the age of globalisation: Some evidence for EU-27, 2010, *Procedia - Social and Behavioral Sciences, 9, 1140–1144.*

47 Kuepie, M., Nordman, C. J., & Roubaud, F., Education and labour market outcomes in Sub-Saharan West Africa, 2006, *Paris: DIAL .*

48 D. Furia et al, 2010; and Karasiotou, P., Education and the labor market. *Reflets et perspectives de la vie économique,* 2012, 3, 51 - 72. doi:https://doi.org/10.3917/rpve.513.0051

49 Mehta, A., Felipe, J., Quising, P., & Camingue, S., Overeducation in developing economies: How can we test for it, and what does it mean? *Economics of Education Review, 2011, 30*(6), 1334 - 1347.

50 Leuven, E., & Oosterbeek, H., Overeducation and mismatch in the labor market, *Handbook of the Economics of Education, 2011, 4,* 283 - 326.

51 Oketch, M. O., Cross-country comparison of TVET systems, practices and policies, and employability of youth in Sub-Saharan Africa, 2017, *W. Bertelsmann Verlag.*

52 Spours, K., & Grainger, P., *A Social Ecosystem Model: A New Paradigm for Skills Development?* 2018

53 Aggarwal, A., Lessons learnt from informal apprenticeship initiatives in Southern and Eastern Africa. *Minister of Higher Education and Training Declaration of: The year of the Artisan,* 2013.

54 Vandenbosch, T., Post-primary agricultural education and training in sub-Saharan Africa: Adapting supply to changing demand. U*npublished manuscript, World Agroforestry Centre,* 2006, 10 - 112.

55 Achandi, E. L., Mujawamariya, G., Agboh-Noameshie, A. R., Gebremariam, S., Rahalivavololona, N., & Rodenburg, J., Women's access to agricultural technologies in rice production and processing hubs: A comparative analysis of Ethiopia, Madagascar and Tanzania. *Journal of Rural Studies, 2018,* 188 - 198.

56 Vandenbosch, T., 2006.

57 NEPAD, *Review of Agricultural Technical Vocational Education and Training (ATVET) Best Practices in Africa,* 2013, NEPAD.

58 Bray-Collins, E., Andrade, N., & Wanjiru, C., Gender and TVET in Africa: A review of the literature on gender issues in Africa's TVET sector. *Futures of Education, Culture and Nature-Learning to Become,* 2022, 151 - 171.

59 Ibid.

60 UNESCO. *Global education monitoring report gender review 2018: Meeting our commitments to gender equality in education,* 2018.

61 National Council for Law Reporting, *TECHNICAL AND VOCATIONALEDUCATION AND TRAINING ACT, NO. 29 OF 2013, Nairobi,* Kenya: National Council for Law Reporting, 2013.

62 Spiteri, J., Deguara, J., Muscat, T., Bonello, C., Farrugia, R., Milton, J., Said, L., The impact of COVID-19 on children's learning: A rapid review. *Educational and Developmental Psychologist,* 2023, 40(1).

63 Amoamah, M., Owusu, M., Brew, E. M., Ampiaw, R. E., & Dadzie, J., Gender Inequality in TVET Institutions – Bridging the Gap: The Case of Accra Polytechnic, *Mathematical Theory and Modeling,* 2016, 6(1), 27 - 35.

64 Muya, M., Price, A. D., & Edum–Fotwe, F. T., Construction craft skills requirements in sub–Saharan Africa: a focus on Zambia. *Engineering, Construction and Architectural Management, 2006, 13*(3), 223 - 241., and Al-Samarrai, S., & Bennell, P., Where has all the education gone in sub-Saharan Africa? Employment and other outcomes among secondary school and university leavers. *The Journal of Development Studies,* 2007, 43(7), 1270 - 1300.

65 Ibid.

66 Al-Samarrai, S., & Bennell, P, 2007, Where has all the education gone in sub-Saharan Africa?.

67 Asare, R., Akuffobe, M., Quaye, W., & Atta-Antwi, K., Characteristics of micro, small and medium enterprises in Ghana: Gender and implications for economic growth. *African Journal of Science, Technology, Innovation and Development,* 2015, 7(1), 26 - 35.

68 Achandi, et al., 2018, Women's access to agricultural technologies in rice production and processing hubs.

69 International Labour Organization., *The gender gap in employment: What's holding women back?* 2017, Retrieved from ILO: https://www.ilo.org/infostories/en-GB/Stories/Employment/barriers-women

70 Duncan, G. J., & Hoffman, S. D., The incidence and wage effects of overeducation. *Economics of education review,* 1981, 1, 75 – 86; Sicherman, N., Overeducation in the labor market, *Journal of labor Economics,* 1991, 9(2), 101 – 122; and Green, F., & McIntosh, S., Is there a genuine under-utilization of skills amongst the over-qualified? *Applied economics,* 2007, 39(4), 427 - 439.

71 African Development Bank, African Development Report 2008 – 2009, 2008. Oxford: Oxford University Press.

JustJobs
NETWORK

JustJobs Network is an applied research institute finding evidence-based solutions to pressing labour market challenges. We produce research on good job creation and workforce development, focusing our work on the critical knowledge gaps in the employment landscape.

JustJobs convenes a global network of diverse stakeholders — including policy shapers, academics, and grassroots leaders — to deepen the practical implications of our research endeavours and amplify their impact. Through the combination of cutting-edge research and global knowledge sharing, we aim to forge a fresh, dynamic channel for policy dialogue on employment at national, regional and international levels.