MSM | MAASTRICHT SCHOOL OF MANAGEMENT

Working Paper No. 2019/02

Future of Work Africa: A Desk Study for VSO Netherlands

Julius Gatune[1], Diederik de Boer[2]

April 2019

[1] Project Consultant, Maastricht School of Management
[2] Director International Projects and Consultancies, Assistant Professor Sustainable Business Development, Maastricht School of Management

MSM

The Maastricht School of Management is a leading provider of management education with worldwide presence. Our mission is to enhance the management capacity of professionals and organizations in and for emerging economies and developing countries with the objective to substantially contribute to the development of these societies.

www.msm.nl

MSM | MAASTRICHT SCHOOL OF MANAGEMENT

Future of Work Africa:

A Desk Study for VSO Netherlands

Julius Gatune

Diederik De Boer

April 2019

Executive Summary

Modern economies have followed a growth trajectory that transformed economic structure from agriculture to manufacturing and eventually to diversified industries providing services to various manufacturing sectors. This transformation process has seen people to move from low paying agricultural jobs to highly productive manufacturing jobs. This transformation took place in the Western world and more recently has been replicated in Asia, the so-called "Asian Miracle. However, this transformation has yet to happen in Africa and this largely explains the high levels of poverty.

Trends shaping future of Work

Technological progress has been a crucial driver of transformation and thus for the nature of work. While technological progress is continuous, occasionally a breakthrough occurs launching humanity on a new trajectory of productivity. These breakthroughs have been referred to as Industrial Revolutions. The world is now at the cusp of a new revolution. Recent breakthroughs in Information and Communication Technologies (ICTs) are unleashing new capabilities and fundamentally changing the nature of work through automation. Increasingly, machines are available to replace or complement workers at all levels. Economic models are being disrupted creating new industries and business models based on emerging platform economies. This technological revolution is being referred to as the 4th Industrial Revolution (4IR) (WEF 2017).

Beyond technological developments there are other key trends shaping the future of work. These are:

- Socio-Economic drivers in particular demographics (rapid urbanization and rise of middle class) and changing societal values;
- The shift towards a green economy;
- Governance drives, in particular the dissipation of power from central governments upwards to supra-national levels (hyper-globalization) and downwards to people though emerging social networks enabled by new technologies;

The rising urban populations and a growing middle class are going to fuel aggregate demand and thus jobs. Society values are changing and demanding for sustainability in production and consumption. This is fueling the rise of a green economy which is creating many new jobs. The governance landscape is changing as global governance structures become more important in shaping trade and investment flows and the quality of jobs by setting a race to the bottom as countries compete to be part of the emerging global production networks and value chains.

These trends are all being impacted by the 4IR. Automation is making low cost production advantage less important and re-ordering the global value chains. The 4IR technologies are providing platforms for new kinds of economies like sharing economies in line with changing values of society for reduced consumption. Indeed, the 4IR technologies are going to largely shape the future of work in both the developed and developing countries but with differing impacts.

Impact on Jobs

The new platforms being enabled by the 4IR technologies are allowing vast collection of data creating a new base for competing through improved abilities to mine the data. As a results new business are being born disrupting traditional models. The technologies are blurring traditional business boundaries. The result provides for a radically different business landscape that is emerging with significant impact on where work is done, who does it and how the value created is shared. The 4th Industrial Revolution is seen as presenting unprecedented opportunities:

- At a macroeconomic level, they point that automation could raise productivity growth on a global basis by as much as 0.8 to 1.4 percent annually;
- At a microeconomic level, businesses everywhere will have an opportunity to capture benefits and achieve competitive advantage from automation technologies, not just from labor cost reductions, but also from performance benefits such as increased throughput, higher quality, and decreased downtime;
- The 4IR technologies have enhanced consumer welfare by providing access to goods and services more cheaply, faster and with more convenience e.g. e-books, Uber cabs, social media, etc. Their impact has been to transfer enormous amounts of value-add to consumers, freeing up their buying power for other goods and services. This creates opportunities for entrepreneurs to create new products and experiences as new-found buyer power can support these new industries.

The major challenges associated with the 4IR is obliteration of jobs through automation and rise of inequality as those of high skills and the owners of capital capture much of the benefits. The 4IR is a challenge to both developed and developing world. However, different countries have very different initial conditions and thus likely to be impacted differently:

- Differences in the skill base across regions alter the incentives to automate and the potential to create new jobs and occupations. This implies that limitations in the skill base of the population may constrain technology adoption or the creation of new jobs;
- Cost pressures to automate also differ substantially across regions. Countries with faster wage growth and/or shrinking working-age populations in relation to the overall population will experience greater incentives to automate;
- To the extent that automation can increase the competitive advantage of producing in developed countries, the offshoring trend is being reversed as a higher share of production takes place in developed countries;
- The welfare costs of automation may be higher in developing and emerging economies because their safety nets are less developed than in higher-income economies;
- Estimates of the share of jobs at risk of being eliminated in rich and poor economies have different consequences. In industrialized economies the spread of automation implies the risk of redundancy for many workers. In developing economies, many workers are engaged in economic activities that could feasibly be done with greater technology and efficiency—and are paid accordingly. Automation need not imply the loss of that work, but rather the possibility of a further diminishing of income.

Though the 4IR is seen as a technology which is likely to benefit the developed countries that are dominated by formal economic sectors and significant manufacturing sectors, the 4IR technologies have the potential to help drive transformation of economies of developing countries especially African countries. For instance, he 4IR technologies can help improve productivity of agriculture through better crop surveillance by drones, and the 4IR technologies can help formalize the informal sector by using the platform business model to link service providers to buyers and also to provide a way to rate services, pay for services etc. The 4IR can impact on transformation pathways proposed for African economies. In this regard the 4IR technologies provide many opportunities to young people in Africa.

Skills for Future

Africa's private sector is not prepared for the competitive landscape that will come with the 4IR. The biggest threats are seen as coming from new nimble entrants to existing industries and lack of employees with needed skills.

WEF (2017) argues that beyond Science Technology Engineering and Maths (STEM), which is the foundation of the 4IR skills, other key skills are: business and entrepreneurship skills, complex problem-solving skills, social skills, process skills (critical thinking, active listening), system skills (judgement) and cognitive skills (logical reasoning and creativity). However, all levels of education in Africa are ill prepared to deliver these skills.

Efforts to overcome some of the challenges at the primary and secondary school levels include providing laptops to students, introducing e-learning platforms and blended learning (combining traditional and online learning), using computer games for learning, and increasing access to online learning resources such as the Khan Academy[1]. However, improving skills for the 4IR world will require a more concerted effort. Some actions proposed include:

i. Focus on building a complete set of skills;
ii. Demand driven skills development;
iii. Increase STEM uptake;
iv. Making education more flexible and learning lifelong;

Getting Ready For Future – Digitalizing the Economies

Beyond skills, the other key dimensions for a strong 4IR ecosystem include: (i) infrastructure; (ii) innovation systems and (iii) an improved regulatory system. In general, the ecosystems for readiness is weak with most countries ranked low in the global rankings of readiness. Strengthening these pillars will be key.

Many African countries economies are largely driven by agriculture. Though the service sector is the largest sector, many of the services depend on agriculture e.g. retail logistics, underscoring the importance of agriculture. Another key feature of Africa's economies is informality. Therefore, a 4IR strategy should seek to upgrade agriculture and service sectors and also formalize these sectors.

Building a platform to help deliver services not only helps formalize the sector but also improves productivity of the sector. A stronger service sector can also help improve the crucially important agricultural sector. So the agricultural sector can be boosted by developing more services that can be offered to farmers. One example is providing inputs as a service so farmers need not to have to invest in equipment or expertise so that if one needs ploughing one just orders for a ploughing service.

Building platforms should be central in developing 4IR strategies. Care should be taken to ensure that platforms help build other sectors so that service becomes not stand alone industries but boost the other key sectors of the economy.

[1] Khan Academy is a 501(c)(3) nonprofit organization with the mission of providing a free, world-class education for anyone, anywhere: https://www.khanacademy.org

I. Introduction

Economic growth is the key to job creation. The key inputs are labor and capital and thus how each is deployed in driving growth which has an important bearing on jobs. Key to jobs is economic transformation that accompanies economic growth as this determines the quality and quantity of jobs. Indeed modern economies have followed a growth trajectory that transformed economic structure from agriculture to manufacturing and eventually to diversified industries providing services to various manufacturing sectors. This transformation process has seen people to move from low paying agricultural jobs to highly productive manufacturing jobs. This is the transformation which was seen in the Western world and which was more recently replicated in the Asia, the so-called "Asian Miracle. However, this transformation has yet to happen in Africa and this largely explains the high levels of poverty. Productive jobs are key to eradicating poverty. The future of work is therefore a key policy concern.

Technological progress has been a crucial driver of transformation and thus the nature of work. Thus technological breakthrough has seen human capacity multiplied and largely explains human progress as technology can augment human productive capacity. While technological progress is continuous, occasionally a breakthrough occurs launching humanity on a new trajectory of productivity. These breakthroughs have been referred to as Industrial Revolutions. The world is now at the cusp of a new revolution. Recent breakthroughs in Information and Communication Technologies (ICTs) are unleashing new capabilities and fundamentally changing the nature of work through automation. Increasingly, machines are available to replace or complement workers at all levels. Economic models are being disrupted creating new industries and business models. This technological revolution is being referred as the 4th Industrial Revolution (4IR) (WEF 2017).

The Africa Jobs Challenge

Providing jobs that can pull people out of poverty is one of the more assured pathways out of poverty. However, job growth has consistently failed to track economic growth in Africa. So while a fairly good growth rate of 5.5% was recorded between 2000 and 2008, the jobs growth rate over the same period was 2.8% (AfDB, 2017). The economic structures in Africa result in a very low employment elasticity. Every percentage point of economic growth during 2000-2014 yielded employment growth of 0.41 percentage point (AfDB, 2018). Further a majority of people remain in low productivity agricultural jobs and the few jobs created are largely (about 90%) in the low productivity informal sector[2]. The jobs challenge is particularly severe for the youth. Of Africa's nearly 420 million youth, ages 15–35, a third are unemployed, another third are in vulnerable employment, and only one in six is in wage employment (AfDB 2016).

The consequences of failure to create decent jobs are very evident. Poverty remains stubborn even after many decades and concerted efforts to eradicate it. This high level of poverty is driving immigration to urban areas, forming slums and increasingly illegal immigration to the richer countries especially Europe creating concerns[3]. More worrying for leaders in Africa is the rise of terrorism and extremism (with impacts that are not confined to countries borders) which has found fertile recruitment ground

[2] Workers in the informal sector can earn as little as six times less than the earnings of those in the formal sector (Bhorat and Tarp, 2016 cited in AfDB, 2017).

[3] The Africa youth immigration to Europe was one of the key agenda items at the 5Th Africa-EU summit. At the summit €44 billion of investments by 2020, thereby creating new job opportunities for young people across the African continent to in Africa was pledged ensure that people do not choose to migrate in the first place. (Fregenti and Rosati, 2017).

in the huge unemployed youth population.[4] Africa's youth population is expected to double to over 830 million by 2050[5]. This represents a huge opportunity if they can be made productive, or a population time bomb.[6] Meaning that job creation for the youth will become even a more pressing challenge in the coming years unless something is done. The jobs challenge is being complicated by new developments in technologies especially development information and communication technologies.

This paper explores the impact of the 4IR on future of work in Africa. It largely draws from other studies particularly drawing on studies done by the African Centre for Economic Transformation (ACET), World Economic Forum and Mckinsey and others. Section II explores the drivers of future of work and section III looks at their impact; section IV explores skills needed for this future and section IV looks at strategies to navigate the future and section VI concludes.

II. Drivers of Future of Work

As pointed out we are now in the cusp of what is being considered the fourth industrial revolution (4IR). Though technologies will be crucial in shaping future of work, other drivers are also key. WEF (2016) points that the future will be driven by technology on one hand and demographic and socio-economic factors on the other. Social economic factors matter and indeed how the social-economic drivers interact with technological drivers is essentially what will determine the future of work. Emerging global consensus on sustainable development will also have a major bearing on economic structures (hastening shift towards green economies) and thus jobs. Governance also matters as this will shape how the key trends evolve for example investment friendly governance regimes are likely to see more innovations. The world is also increasingly being globalized and new global governance structure are emerging that are dissipating power from countries outwards and increasingly dictating trade and investment flows and thus where jobs are created and where they are lost. The four megatrends are discussed below.

Megatrend 1: Technology Progress/Innovation -The 4th Industrial Revolution (4IR) technologies

The world has experienced a number of innovation breakthroughs that have been referred as industrial revolutions. Though technological developments play a key role in ushering new revolution, a deeper analysis of industrial revolution reveals that a revolution is more than just one technology change. It is a series of innovations across four domains that really make a revolution. Power/energy (i) is the crucial first step as power limits what human capacity can achieve. But once power is harnessed and new activities are undertaken facilitated by transportation (ii), there is need for production technologies and organization/management expertise (iii) (business models) and finally communication (iv) to coordinate new activities, inputs and finished goods need to be transported (see annex 1). Innovations in the four areas is what creates a new trajectory as costs go down and the distance is shrunk. This is best illustrated by the 1st Industrial revolution. The invention of steam power changed everything (Rifkind 2013). Production technologies could be mechanized (mechanical looms); steam powered

[4] Forty percent of youths who join rebel and terror groups cite the lack of economic opportunity as their main motivation (AfDB 2017).

[5] U.N. (2017) "*World Population Prospects: The 2017 Revision*", The United Nations. UN definition of youth is those in the age bracket from 15 to 24.

[6] It is instructive to note that the "Arab Spring" that got its start in Tunisia reflected the discontents of highly educated and unemployed youths. In Tunisia, the 2007 unemployment rate for university graduates was 40%, compared with 24% for non-graduates (AfDB, 2015). Observers have noted that high unemployment is not, in itself, enough to lead to an uprising; additional compounding factors tend to be present. For example, in North Africa, the compounding factors were a sense of social injustice and the need for dignity (UNESCO 2011).

printing presses lowered cost of printing and saw a rise of newspapers (crucial in development of markets). Entrepreneurs were quick to re-organize production through setting up factories that allowed economies of scale which made goods cheaper. Railways made markets accessible and newspapers created awareness. It is the convergence of several technologies and business model innovations that really makes a revolution. As we can see from table 1, annex 1, one can trace the 5 revolutions (the agrarian and 4 industrial revolutions) using this typology. As can be observed each revolution has seen a significant shift in production of goods. Developments in energy/power was the key mover of the first and second revolutions, the advent of computer technology propelled the third revolution, due to its impact on production and communication capabilities.

As shown in this table innovations are happening through energy, production/business organization and communication ushering new ways of working and ushering the so-called 4th Industrial Revolution. Though many technologies are at play the underlying technology driving this revolution are developments in Information and Communication Technologies. Therefore, ICTs are helping make renewable energies economically feasibility through smart grids that can help manage a variety of energy production sources including intermittent sources like wind. ICTs are at the heart of autonomous vehicles, ICTs at the heart of robotics and 3D printing and the internet is now synonymous with communication. ICTs have become the prime drivers of the 4th Industrial revolution. They are rapidly shaping the nature of work. The key technologies that are rapidly shaping the future of work are:

- Artificial intelligence (AI)/Machine learning
- Data mining
- Internet-of-Things (IoT)
- 3D printing (Additive Manufacturing)
- Blockchain technologies

(See appendix II for a discussion of these technologies).

These technologies are automating jobs, connecting many devices and allowing development of new business models through clever use of data generated, enabling new types of economies e.g. sharing economies and developing new models of trust systems that will fundamentally change how business is conducted and indeed how business are organized.

In general, while technological progress, as experienced in previous waves of industrial revolutions have eliminated some jobs and substituted for some tasks, they have in general enabled the creation of many new jobs powered by growing incomes and the emergence of new occupations. However, the current wave of disruptive technologies is causing great anxiety[7]. Because technology is encroaching on many tasks that were formerly thought to be out of reach of machines, and because technological growth could itself be affecting the mechanisms by which income growth translates into increased demand for human work, history might not repeat itself (Brynjolfsonn and McAfee, 2014; Susskind and Susskind, 2015).

Beyond disruption work these technologies are also exacerbating inequalities as the value created is disproportionately skewed towards those with high skills. This trend is best illustrated in the wealth creation and captured in the 2nd and the 3rd Industrial revolution sector. In 1990 the three biggest companies in Detroit (the epicenter of 2nd Industrial Revolution) had a market capitalization of $36bn,

[7] Anxiety about new technologies is not new, the rise of the 1st industrial revolution saw resistance by Luddites who violently opposed new machines and went on destruction rampages. Similar anxiety was seen as computing ushered the third revolution (see Author 2015)

revenues of $250bn and 1.2 million employees. In 2014, the three biggest companies in Silicon Valley (the birthplace of 4IR) had a considerably higher market capitalization ($1.09tn) generated roughly the same revenues ($247bn) but with about 10 times fewer employees (137,000) (Ellicot, 2016).

Megatrend 2: Socio-Economic drivers

How societies are changing in terms of structure, incomes and perceptions will shape consumption and thus demand and supply responses. Indeed, technologies will largely mediate much larger drivers that social and political drivers. WEF (2016) argues that the demographic and socio-economic shifts are expected to have nearly as strong an impact on business models and organizational structures as technological change.

Demographics: The world population, estimated to be 7.3 billion people in 2015, may reach 9.7 billion by 2050[8], an increase of 33%. More crucially the urban population will rise from 40% to 66% of the populations and the middle class[9] will also grow significantly. Kaufman et al. (2012) estimates that in 2000 the global middle class counted 1.33 billion people, while in 2030, the global middle-class may comprise 4.7 billion people. Demographics are going to fuel aggregate demand and thus job growth. The growth of middle class and urbanization are of particular concerns as this will create demand for durable goods, infrastructure. This is likely to create many manufacturing jobs.

Societal values: Society values are changing with profound impact on demand and investment. Consumers in the West (also the global middle class) are increasingly demanding ever more sustainably produced products and requiring that global supply chains provide these guarantees. This is resulting in re-arrangement of global supply chains. Thus, actors at different positions of the supply chain are starting to request information about the extent to which sustainability is assured. This is creating demand for standard setting platforms, whereby compliance can be verified by the business itself or by third parties. This consumers' demand is also providing a business opportunity for some to charge a premium under various ethical labels such as fair trade branded goods

.

Other social economic drivers seen as important (WEF 2016) include:

- Changing Work Environment and flexible work arrangement
- New Consumer concerns about ethical and privacy issue
- Longevity and aging societies
- Woman's rising aspiration and economic power
- Growing desire for better work-life balance

Megatrend 3: Shift Towards Green Economy

There is a growing concern about the impacts of carbon-based economies and in particular, the climate change impacts due to greenhouse gases. This concern has seen a strong push for greening the economy though reduction in the use of fossil fuels and decoupling economic growth from resource use and environmental degradation (UNEP, 2011). This push is being led by consumers who want to see sustainable production and consumption. This has seen global efforts to curb CO2 emissions. The Paris Agreement under the United Nations Framework Convention on Climate Change commits countries to cut their greenhouse gas emissions.

[8] United Nations Population Division, 2015, median scenario

[9] The definition of "middle-class" by Kaufman *et al.* (2012), is a person that pertains to a household earning or spending between 10 and 100 $US per day, on the 2005 purchasing power parity corrected basis

This movement has seen the promulgation of the Sustainable Development Goals (SDGs) as the new global development agenda[10]. Sustainability is becoming an essential investment criterion. These types of investments accounted for $3.74 trillion in total assets under management at the end of 2011 (Macpherson & Ulrich, 2017). Many market players have started using sustainable, responsible and impact-based strategies for investing in assets. For example, PFZW, the Dutch giant healthcare pension fund, has announced that it intends to quadruple its sustainable investments to a value of $16 billion before 2020 (WEF, 2015). Over the past decade, green bonds[11] have also emerged.

Macpherson & Ulrich (2017) indicate that green finance will likely be supported across the investment value chain and bolstered by the Paris Agreement in 2016. Furthermore, investment for the achievement of the SDGs, which have become a framework for environmental and social investment themes, will gain momentum, especially among millennial, value, and impact investors.
The shift towards green economy has good potential for job creation:

- The drive to have more energy derived from Renewable Energy Sources (RES) has seen rapid growth of the renewable energy sector which is now a major employer and with good job growth prospects.
- New industries are also arising to recycle products.

Megatrend 4: Governance - Dissipation of power

Central governments have been losing power and authority to supra-national bodies through the use of international conventions The most apparent is trade and investment conventions that has led to what Rodrik (2016) has described as hyper-globalization which undermine countries abilities to shape growth policies also leading to deterioration democratic institutions. Globalization has deepened the economic and cultural divisions between those who can take advantage of the global economy and those who don't have the resources and skills to do so. Indeed, Liberalization of trade and rising FDI are reshaping manufacturing. This has seen the emergence of complex manufacturing value chains spanning several locations and supported by global supply chains. Ability to be part of this value chains determines were jobs will be and also likely to lead to deterioration of working conditions as countries compete to attract jobs (a race to the bottom). This trend is however being mediated by 4IR technologies. Automation is making low cost production location less and less important in being part of the global value chains.

A related trend is the dissipation of power from labor to capital. Increasingly owners of capital are having a bigger say than owners of labor. So increasingly shareholders are capturing greater and greater value creating huge inequalities and worsening job conditions. As pointed out 4IRs are exacerbating these inequalities.

New technologies and changing social norms have changed the way people coordinate and make decisions at individual, organizational, and societal levels. The term "network society" has been applied to this mode of organization. Through networks, people leverage informal relationships to exchange ideas, build rapport, identify common interests, work together, share power, and solve

[10] The Sustainable development agenda also address many of challenges and opportunities that come with 4IR including inequality, gender disparities, decent jobs, transformation of economies. The, SDGs, being the global development template then provides a framework for shaping the trajectory of the 4IR.

[11] According to the Climate Bonds Initiative, the total value of green-labelled bond issuances amounted to USD 42.2 billion at the end of 2015. It then doubled to USD 86.1 billion at the end of 2016, supported by large-scale issuances from China.

problems of mutual interest. Therefore, people are increasingly capturing power and maybe able to have a greater political voice in future and shape the nature of jobs and how value is shared.

III. Impact on Jobs and Regional Variations in Impact

The four key megatrends have important impact on number of jobs quality of jobs and the nature of jobs as summarized below.

Megatrend	Quantity	Quality	Nature	Comment
Technology (4IR)	Very High	Very High	Very High	4IR will obliterate many jobs, create new jobs, change how people work
Socio-Economic drivers	High	Medium	Low	Impact mainly though mainly aggregate demand
Green Economy	High	High	High	
Governance	High	Low	Low	

The trends have impact on each other thus amplifying the impact. The technological driver is particularly crucial as it has impact on the other drivers. For example, technologies like social media can allow consumers to know whether the product has been produced sustainably and at the same time provide a platform to agitate for better governance and at the same time 4IR technologies are giving unprecedented power of owners of capital and thus further entrenching inequality.

Given the importance of technology and specially the unfolding the 4IR industrial revolution, much of the literature on future of work has focused on the impact of the 4IR Industrial Revolution. For this reason, the rest of this paper will focus on impacts of the 4th industrial revolution and its impactions on skills.

a) General impact (see also annex 2)

The 4th Industrial Revolution is seen as presenting unprecedented opportunities. MGI (2016) argues that systems enabled by machine learning can provide value everywhere and these technologies could generate productivity gains and an improved quality of life:

- At a macroeconomic level, they point that automation could raise productivity growth on a global basis by as much as 0.8 to 1.4 percent annually.
- At a microeconomic level, businesses everywhere will have an opportunity to capture benefits and achieve competitive advantage from automation technologies, not just from labor cost reductions, but also from performance benefits such as increased throughput, higher quality, and decreased downtime[12]. Safety is another area that could benefit from increased automation[13].
- The 4IR technologies have enhanced consumer welfare by providing access to goods and services more cheaply, faster and with more convenience e.g. e-books, Uber cabs, social media, etc. Their impact has been to transfer enormous amounts of value-add to consumers, freeing up

[12] Rio Tinto has deployed automated haul trucks and drilling machines at its mines in Pilbara, Australia, and says it is seeing 10–20 percent increase in utilization as a result. Google has applied artificial intelligence from its DeepMind machine learning to its own data centers, cutting the amount of energy they use by 40 percent (MGI 2017).

[13] . For example, of the approximately 35,000 road death in the United States annually, about 94 percent are the result of human error or choice.

their buying power for other goods and services (Hatzakis, 2016). This creates opportunities for entrepreneurs to create new products and experiences as new-found buyer power can support these new industries.

The crucial story of the IR is data. Data is becoming the new competitive advantage[14] as new platforms build on the new technologies are allowing companies insights never hitherto available, allowing new business models to be built and blurring business boundaries. For instance, Google is developing autonomous cars while Tesla, a car company, sees itself as an energy company. Data and analytics are changing the basis of competition. Today, Uber, the world's largest taxi company, owns no taxis, and Airbnb, the world's largest accommodation provider, owns no real estate (Brynjolfsson and McAfee, 2017). The new platforms are also creating new forms of capital. For instance, "Couch Surfing" service allows people to invite other to stay in their houses for free. The social capital created from developing new friends and networks is more valued than what the owner could earn from say listing the house on Airbnb and getting a paid visitor (Rifkind, 2013).

The 4IR is seen as a technology which is likely to benefit the developed countries that are dominated by formal economic sectors and significant manufacturing sectors that can be automated as opposed to developing countries that have economies dominated by agriculture and informal service sectors. However, the 4IR technologies have the potential to help drive transformation of economies of developing countries especially African countries. The 4IR technologies can help improve productivity of agriculture through better crop surveillance by drones, and the 4IR technologies can help formalize the informal sector by using the platform business model to link service providers to buyers and also to provide a way to rate services, pay for services etc. Table 2 shows the various ways the 4IR can impact on transformation pathways proposed for African economies. In this regard the 4IR technologies provide many opportunities to young people in Africa.

b) Similarities and differences between developed and developing countries

The 4-IR is a challenge to both developed and developing worlds. However, different countries have very different initial conditions and thus likely to be impacted differently. Table 3 shows risk or the potential of automation across regions. Across the regions 48 to 71% of jobs are at risk of automation with risk rising the less developed the region is.

Table 3: Potential of Automation – Regional Variations

Region	Occupation
Africa	0.71
Developing Asia	0.73
Developed countries	0.48
European Countries*	0.6
Latin America and Caribbean	0.67

[14] Already an underlying barter system is at work, particularly in the consumer space, as individuals gain access to digital services in return for data about their behaviors and transactions (MGI 2016) e.g. facebook. Further As data becomes increasingly commoditized, thus value is likely to go to players that aggregate data in unique ways. This requires data scientists but also business translators who combine data savvy with industry and functional expertise. This demand is creating new and well-paying job opportunities. It is estimated that there could be demand for approximately two to four million business translators in the United States alone over the next decade[14] (MGI 2016). WEF (2017) also points to the fact that computer, mathematical-, architecture- and engineering-related jobs are likely to surge in the 4IR era.

Source: (AfDB, ADB, EBRD, IDB, 2018), * Members of European Bank of Reconstruction and Development (EBRD)

AfDB, ADB, EBRD, IDB, (2018). report makes the following observation on what will drive the different impacts across regions:

- Differences in the skill base across regions alter the incentives to automate and the potential to create new jobs and occupations. New technologies are increasing the demand for skills complementary to technology, including digital skills and high-level cognitive skills (such as creative thinking, the ability to learn, and problem resolution), as well as soft skills. At the same time, technological progress is reducing the demand for routine-based work. This implies that limitations in the skill base of the population may constrain technology adoption or the creation of new jobs.
- Cost pressures to automate also differ substantially across regions. Countries with faster wage growth and/or shrinking working-age populations in relation to the overall population will experience greater incentives to automate. Developed countries, on average, face rapid aging of their labor forces and declining shares of the working-age population.
- While in developed countries the effects of automation will be driven by production costs, in developing and emerging countries they may result from changing international trade patterns. To the extent that automation can increase the competitive advantage of producing in developed countries, the offshoring trend that has occurred since the 1980s may come to a halt and may even be reversed as a higher share of production takes place in developed countries. Such adverse effects could be potentially more important for Asia and European countries because of their higher specialization in the production of industrial goods
- The welfare costs of automation may be higher in developing and emerging economies because their safety nets are less developed than in higher-income economies. The costs of job dislocation are higher for workers without access to unemployment insurance or unemployment assistance. Social security coverage is typically low in emerging and developing regions. While more than 65 percent of people in the labor force are contributing to social security in developed countries, only 9.6 percent do in Africa[15].
- Chandy (2017) argues that in the industrialized economies the spread of automation implies the risk of redundancy for many workers. In developing economies, many workers are engaged in economic activities that already have some distance from the technology frontier—in other words, they could feasibly be done with greater technology and efficiency—and are paid accordingly. Automation needs not imply the loss of that work, but rather the possibility of a further diminishing of income. Thus, estimates of the share of jobs at risk of being eliminated in rich and poor economies have different consequences.

A more detailed review of the literature on impact of the 4IR in general and the likely impact in the African context is given in appendix II.

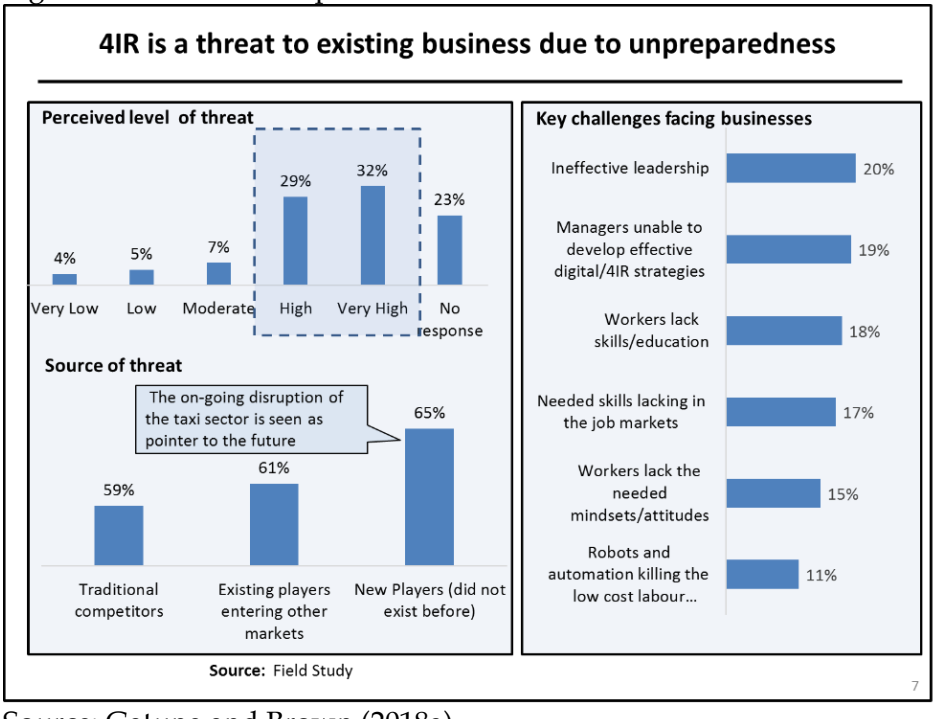
IV. Navigating the Future of Work -Implication on Skills

The 4IR can play a huge role in driving the Africa transformation and thus creating jobs. What matters is whether the countries have what it will take to drive the transformation. A survey by ACET (Gatune and Brown, 2018) shows that while awareness of the 4IR technologies and their potential for

[15] Between 36 percent and 48 percent do so in the European Bank of Reconstruction and Development (EBRD) regions, 30 percent in Latin America and the Caribbean, 17 percent in Asia and the Pacific.

transformation is quite high. Further many survey respondents and focus group participants[16] were very optimistic about future prospects in the 4IR world. However, many also felt that Africa's private sector may not be able to take advantage of the opportunities as many businesses are not prepared for the competitive landscape that will come with the 4IR. The biggest threat is seen as coming from new entrants to existing industries – for example, the taxi industry that has seen the entry of new companies rapidly disrupting the sector in a way that incumbents in other industries can expect.

Figure 1: Business Perceptions of the 4IR threat



Source: Gatune and Brown (2018a)

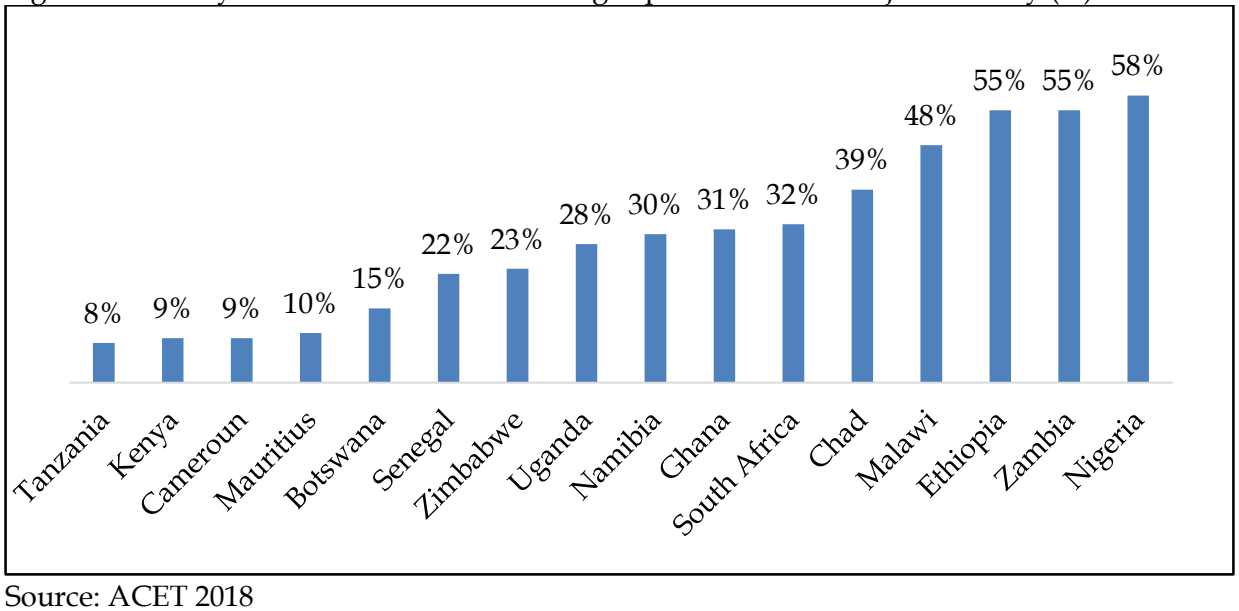
The key challenge for business was seen as lack of leadership and inability to develop effective digital strategies. Workers lacking requisite skills and mind sets and also a general lack of skills in the job market are other major reasons given for the inability to compete. Policy-makers awareness of the 4IR and what it means was seen as very low underscoring the challenge of making Africa ready for the 4IR.

A skilled workforce is key to leverage the 4IR. Indeed, the Overseas Development Institute (Banga and te Velde, 2018) finds that in Kenya, companies with higher internet penetration (a proxy for the 4IR integration or digitization) have a higher share of skilled workers and higher productivity. A skilled workforce can not only increase the impact of technological progress on productivity, but this impact is also found to be higher for Low Income Countries (Bang and te Velde, 2018). Cirera (2016) also finds that inadequate education can lower the capacity of firms to transform knowledge into innovation. WEF (2017) finds that employers across Africa identify inadequately skilled workforce as a major constraint to their businesses; this includes 30% of all firms in Kenya. The education foundations are very poor making skills development a challenge. Some observations on education performance with regards to Kenya, Uganda and Ethiopia are made below.

[16] The respondents were drawn from an array of stakeholders including policy makers, academics, private sector, developing partners across in 11 countries: Cameroon Côte d'Ivoire, Egypt, , Gabon, Ghana, Kenya, Morocco, Rwanda, Senegal, South Africa, and Tunisia.

- Though enrollment in primary education has rapidly improved in the three countries[17], a key challenges is poor learning outcomes at the foundation level which them becomes a challenge for building higher level skills. For example, in Ethiopia, 55% of students are not mastering materials required at their grade level (see figure 4).

Figure 4: Primary school children not reaching expected level of subject mastery (%) reference



Source: ACET 2018

- Though Kenya and Ethiopia have made great efforts to expand TVETs education, Uganda has not made similar efforts and thus has a highly slewed systems where out of the 189 tertiary institutions 71% of the enrollment is in the Universities, leaving little room for TVET institutions in skills development (Ecuru and Kawooya, 2015). MGI (2016) estimates that Africa needs to enroll 33 million young Africans in vocational and technical education in secondary schools by 2025 compared to 4 million in 2012 to support transformation!

- Enrollment in Universities has grown rapidly in the three countries as part of government policies to expand access to universities. This has created serious challenges for universities trying to cope with huge numbers of students. In Kenya most universities are now technically insolvent (Wanzala, 2018). In Ethiopia quality has fallen drastically as universities have lowered admission standards so as to admit fee-paying students to public universities (Feleke, 2015). In Uganda the enrolment in Science Technology Mathematics and Engineering (STEM) programs is also still under 25% for all universities as non-STEM courses are cheap to deliver (Ecuru and Kawooya, 2015)[18].

[17] Approximately 40% of the eligible school-age population has no access to any form of post-primary education (ACET 2018) and those excluded are disproportionately separated from marginalized groups (poor households, girls, specific ethnic and religious groups). Further the completion rates through secondary school are low. Just 30% of students who enroll go on to complete lower secondary education. One in four young Africans enroll in upper secondary school and just 15% of those complete the phase (ACET 2018).

[18] AfDB (2018) points that too few scientists and engineers in Africa work in sectors that drive economic transformation. African college graduates with a STEM degree represent only two percent of the continent's total university-age population. Yet these are crucial skills required in the 4IR world. In 2010, for example, the share of college students in engineering, manufacturing, and construction programs was 7.3 percent in Burkina Faso, 3.0 percent in Burundi, 4.3 percent in Cameroon,4.5 percent in Mozambique, 5.6 percent in Madagascar,

All the same there are bright spots pointing to potential opportunities to develop new skills.

- In Kenya and Ethiopia tremendous effort are underway to upgrade the TVET system and make it more relevant. Both countries have introduced Competence-Based Education and Training (CBET) approaches. CBET has evolved due to a recognition of the need for making education and training demand-driven by linking the supply side to the demand side (the world of work)[19].
- As part of its TVET reforms Ethiopia has also introduced cooperative training between vocational training institutions and firms as a means of increasing the relevance of training and facilitating the transition from school to work. The cooperative training system aims at providing 70 per cent of training content at the industry site and 30 per cent in the vocational institution (Yamada et al 2018).
- There is the emergence of entrepreneurial universities that are embedding themselves and solving local problems. Examples include the Egerton University of Agriculture in Kenya, Jimmah University in Ethiopia, and Makerere University in Uganda. The entrepreneurial universities are helping develop innovation clusters (de Boer and Langatt, 2014).

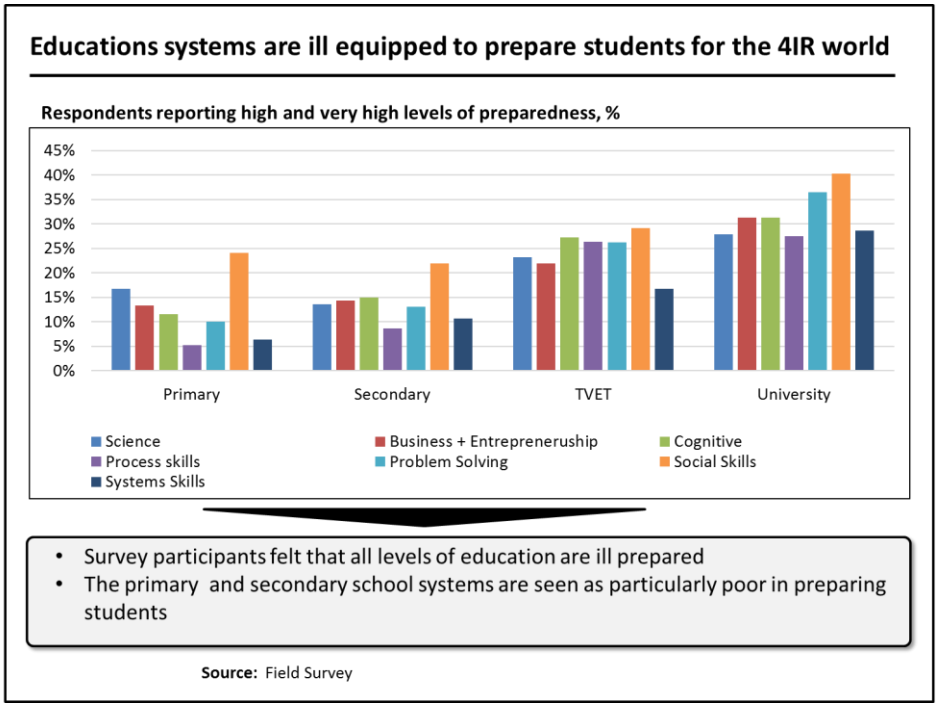
Skills for 4IR World

WEF (2017) argues that beyond STEM, which is the foundation of the 4IR skills, other key skills are: business and entrepreneurship skills, complex problem-solving skills, social skills, process skills (critical thinking, active listening), system skills (judgement) and cognitive skills (logical reasoning and creativity). ACET (Gatune and Brown, 2018) has explored the readiness of African countries along these skills. They found that all levels of education are ill prepared to deliver these. Less than half of the survey respondents felt that the school system was well prepared, with the primary school system seen as the least prepared (see figure 5).

Figure 5: Education Systems Preparedness for 4IR

5.9 percent in Ghana, and 12.8 percent in Morocco. In 2014 the shares in Austria, Germany, Malaysia, and Mexico were all above 20 percent (AfDB, 2018).

[19] CBET involves the reorganization of curriculum, instruction/delivery, and assessments based on an articulation of learning outcomes or competencies. Trends driven by the need for redirection of the goal of education and training towards development of capabilities or competences rather than issuance of diplomas in certain qualifications or disciplines (i.e., educational attainment).



Source: Gatune and Brown (2018a) Based quantitative data from field surveys and qualitative data from focus group discussions in 11 countries: Cameroon Côte d'Ivoire, Egypt, , Gabon, Ghana, Kenya, Morocco, Rwanda, Senegal, South Africa, and Tunisia

Efforts to overcome some of the challenges at the primary and secondary school levels include providing laptops to students, introducing e-learning platforms and blended learning (combining traditional and online learning), using computer games for learning, and increasing access to online learning resources such as the Khan Academy. However, improving skills for the 4IR world will require a more concerted effort. Some actions proposed in ACET (2018) report include:

v. **Focus on building a complete set of skills:** Students should have good foundational skills—both cognitive and non-cognitive, including basic Science Technology Engineering and Math (STEM) and digital literacy skills. Entrepreneurial and business skills should also be included throughout the primary and secondary education phase (with a focus on business creation and more technical skills in secondary).

vi. **Demand driven skills development:** Skills development should be driven by demand, not supply, which will entail much closer engagement with the private sector in both the formal and informal sectors. It will also mean a much higher proportion of students taking STEM-related subjects and clear pathways into and between technical and academic routes.

vii. **Increase STEM uptake**: There has been calls to ramp up STEM intake[20]. However, increasing STEM uptake and performance will require large improvements in the quality of STEM education in the primary and secondary phases. This means implementing measures to address the acute shortage of (high-quality) STEM teachers, ensuring enough resources to meet the relatively high cost of teaching as well as updating and adapting the curricula to reflect the ability range and with examples that students can relate to (Tikly et al 2018 cited in ACET 2018). This underscores the huge challenge ahead. Some ways forward include:

[20] The AU Agenda 2063 (ACET 2018) sets STEM goals of 70 percent of all high-school graduates going to tertiary education, with 70 percent of those graduating in science and technology related subject That target is twice the global average enrolment of 32 percent and more than eight times the Sub-Saharan African average of 8 percent (Tikly et al 2018 cited in ACET, 2018).

- Partnerships with other countries, donors and the private sector to share expertise and bring in financing to improve STEM performance. One such example is the World Bank–funded Partnership for Skills in Applied Sciences, Engineering and Technology which brings governments from Sub-Saharan Africa, the private sector, and partners, including Brazil, China, and India, to work together and share expertise to help build human capital in the region, including STEM skills in priority areas.
- Changing attitude towards STEM especially for women is key. This can be achieved through Extra-curricular STEM camps and clinics for example, STEM clinics in Ghana for females aim to demystify STEM through information and discussions with female role models, (Tikly et al 2018 cited in ACET 2018) while Senegal holds an annual Festival of Science and Innovation, a two-week event featuring workshops, experiments, and laboratory visits. Just providing information on returns to STEM subjects saw an uptake of STEM by girls rise by 5% (Hicks et al 2011 cited in ACET 2018).

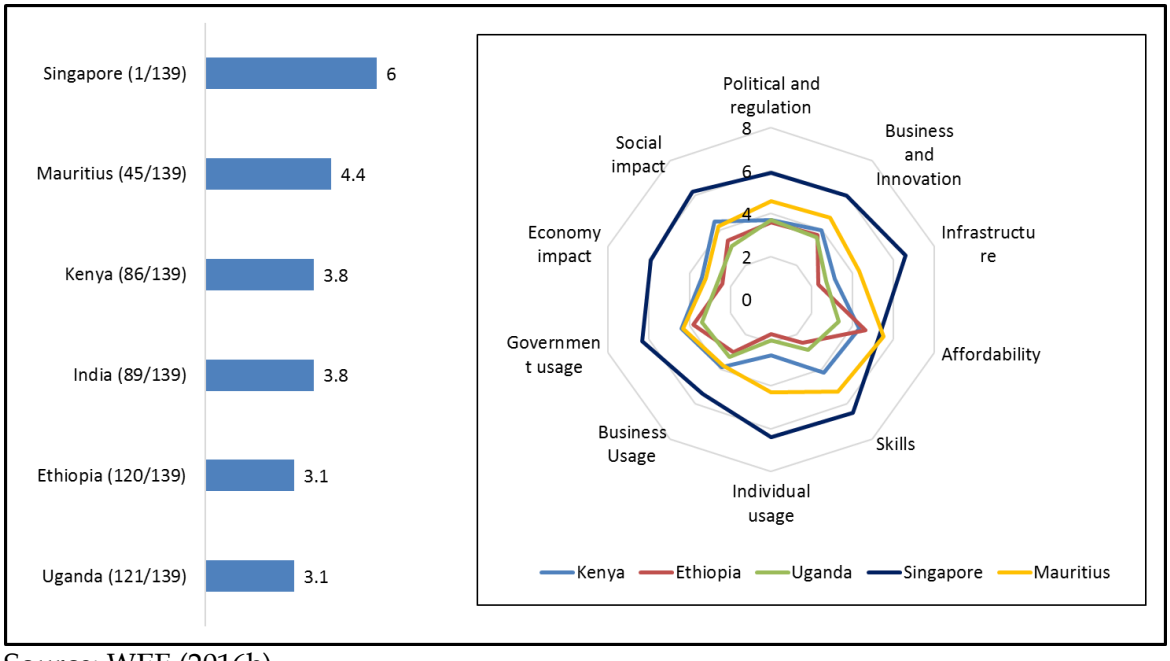
viii. **Making Education More Flexible and Education/learning lifelong:** Secondary education and TVET should be complementary and flexible thus allowing the opportunity for higher level and specialized TVET study in priority sectors, with clear pathways into work or further study (OECD 2016 cited in ACET 2018). For example, Singapore's "bridges and ladders" system gives flexibility for students—not just between and within TVET and secondary education but also between employment and the education system—and opportunities for students to progress as far as their interests and ability allows them (Oketch and Lolwana 2017; ILO 2018; and R4D 2013 and 2015 cited in ACET 2018).

V. Towards a Strategy To Drive Development

While skills are key to get ready for the 4IR, this is not sufficient. To get a better idea on what it will take the Network Readiness Index (NRI) developed by the World Economic Forum has identified 10 key pillars. The best performing country is Singapore while in Africa the best performing country is Mauritius. To get a perspective on level of readiness we have mapped three countries (Kenya Uganda and Ethiopia alongside 2 benchmark countries (Mauritius and Singapore). Figure 3 shows a spider web diagram of the 5 countries mapped along the 10 pillars of the NRI.

The performance of Kenya is commendable as it is ranked above India which is a well-established powerhouse in the field of ICT. All the same the graph shows that the three countries are significantly behind the global leader with Ethiopia and Uganda particularly challenged. Kenya shows good potential. In the dimension of usage (individual, business and government) and translating that to social and economic impact, Kenya is already ahead of Mauritius (Africa's leader). Uganda and Ethiopia can learn from Kenya here. Ethiopia performs well on affordability; however, this is probably due to a state monopoly of the government on telecommunication. The irony is that Ethiopia has one of the lowest scores in individual usage. This indeed runs counter to the idea of a competitive sector that is likely to lower prices. It is not likely that Ethiopia's model of a state monopoly can be replicated by others.

Figure 3: NRI scores



Source: WEF (2016b)
*Scores range from a high of 7 to a low of 1

Digitizing Economies

Beyond developing strong pillars, a strategy is needed to digitalize economic sectors. For many African countries economies are largely driven by agriculture. Though the service sector is the largest sector, many of the services depend on agriculture i.e. logistics retailing underscoring the importance of agriculture. Therefore, the 4IR strategy should seek to upgrade agriculture and service sectors.

Another key feature of Africa's economies is informality.[21] Medina et. al. (2017) finds that there is significant heterogeneity in the size of informality in SSA, ranging from a low of 20 to 25 percent of the formal sector output in Mauritius, South Africa and Namibia to a high of 50 to 65 percent in Benin, Tanzania and Nigeria. The share of informal economic activity in Sub-Saharan Africa remains among the largest in the world. Informality tends to be a drag on economies due to low productivity of the sector and low paying and vulnerable jobs that come with the sector (Medina et. al. 2017). Yet about 93% of jobs created in Africa tend to be in the informal sector. Additionally, informal economic activity severely limits tax revenues for developing countries which are in need of a stable tax base. African economies have an incentive to understand how to shift production from the informal to the formal sector (Medina et. al. 2017).

Services is already the biggest sector in Ethiopia, Kenya and Uganda. However, service driven growth will need rethinking. Much of the service sector is largely informal and as pointed out the informal sector tends to provide low productivity and highly vulnerable jobs.

The 4IR is essentially digitalizing economies. As pointed before there is an emerging platform economy that is the result of a shift towards digital. Therefore, the key to success in the 4IR world is building effective platforms. The digital platforms put services at the centre of economies as platforms really help coordinate various sectors more effectively. This can be crucial to boosting performance of economies of Ethiopia, Kenya and Uganda.

[21] Specifically, the informal sector emphasizes self-financed, under-capitalized, small-scale, unskilled-labor intensive production. Alternative definition is, a 'process of income generation' that is 'unregulated by the institutions of society, in a legal and social environment in which similar activities are regulated' (Pratap and Quintin, 2006).

Building platforms to help deliver services not only help formalize the sector[22] but also improve productivity of the sector. A stronger service sector can also help improve the crucially important agricultural sector. So agricultural sector can be boosted by more developing services that can be offered to farmers. One example is providing inputs as a service so farmers need not to have to invest in equipment or expertise so that if one needs ploughing one just orders for a ploughing service though a platform and the platform can then match the farmers to the needed service provider.

Platforms offer a number of advantages especially for these economies (see also box 2):

- **Embedding trust system;** In conjunction with platform economies where various apps can be built to provide a suite of services, a trust system can be built on top so that people need not have a personal connection with a service provider. The platform can vet service providers and monitor them through rating systems and other means. Providers do not need personal referrals to get work as the platform becomes the referral system.
- **Upskilling and quality incentive**; A platform allows for providers to be rated by users so that a good service provider get more work and can even charge a premium. This has the effect of improving quality and can also incentivize service providers to upgrade their skills. So a carpenter who only had apprentice training may register to get a certification from a TVET to signal better ability to deliver quality.
- **Greater specialization;** As platforms can aggregate a large number of buyers and service providers it can more effectively matching buyer and providers thus providing opportunities for greater specialization (another form of upskilling). This can further boost productivity.
- **Worker Services provision**; By aggregating many small providers and freelancers, the platform also provides an opportunity for providing giving informal many of the services associated with formal jobs including health insurance, social security etc. Providers of various human resources service (including government) can use the platform to build services targeted at informal workers. These can make informal work less vulnerable.

Box 2: Lynk – Platform for Informal Work

Lynk's mission is to see a successful and equitable growth of the Kenyan informal sector. Lynk is a platform that connects households and businesses with verified domestic workers, *fundis*, artisans, and blue-collar professionals in Nairobi. The Lynk platform is a network of professionals that seeks to address two issues. Lynk envisions a world in which informal sector workers can enjoy job security, fair wages, a safe work environment, and the opportunity for career growth. Additionally, for households and businesses, hiring someone should be safe, convenient, and fair. As on September 2018 we had successfully Lynked 20,000 jobs.

References
ww.Lynk.co.ke
https://ke.linkedin.com/company/lynk-kenya

Building platforms should be central in developing 4IR strategies. Care should be taken to ensure that platforms help build other sectors so that service becomes not a standalone industry but boost the other key sectors of the economy especially agriculture.

[22] Being on a platform and using some of the facilities e.g. mobile payments is already formalizing economic activities.

VI. Conclusion

Developing technologies are ushering a new industrial revolution with significant impact on jobs. Many jobs are likely to be obliterated as jobs are automated and new platform economies make many business models obsolete. The 4IR is also poised to create many jobs as it boosts productivity and spawns new industries.

While urbanization and the rise of the middle class will continue driving growth and thus creating many and a shift towards green economy further boost jobs and growth. Globalization has a large say in where many of these jobs will be located and the impact of the 4IR are likely to dominate the future of work.

For countries, reaping the ultimate benefit from use of the 4IR will require digitalizing their economies. This will not be easy but also not out of reach. Indeed, the 4IR could provide new opportunities for leapfrogging. Having the right skills be key. Skills level will determine how value will be captured with those endowed with skills capturing greater and greater share of value. Skills needed to succeed in this new world will be a mix of skills including STEM skills, entrepreneurial skills, creative skills, cognitive skills, problem solving skills and social skills. Unfortunately, education foundations are very weak and all levels of education ill-equipped to deliver the needed skills. This underscores the challenge ahead. Building strong skills will require increasing STEM enrollment, greater collaboration with private sector to make skills development demand driven, make education more flexible to allow life-long learning.

Beyond building skills, getting the strategy right will be crucial. The other pillars (infrastructure, innovation systems and regulation) must be strong. The ultimate benefit will come from the strategies built on these pillars. Services will probably be the sector that will be able to leverage the 4IR most. Agriculture can also benefit from the 4IR especially when new services based on the 4IR are deployed to upgrade the sector.

The full impact of the 4IR will become apparent when all the domains that define an industrial revolution unfold and a new economic landscape emerges. For African economies dominated by the informal sector, the 4IR provides an opportunity to leapfrog to new business models that might not need the substantial capital that traditional businesses need. Production and trust platforms, the key element of a modern business, can be built quickly with the new technologies. But much preparatory work is needed to help Africa leapfrog into the Fourth Industrial Revolution.

References

AfDB, ADB, EBRD, IDB (African Development Bank Group, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank). 2018. *The Future of Work: Regional Perspectives.* Washington, DC.

AfDB. 2015. *African Development Report 2015 Growth, Poverty and Inequality Nexus*. Abidjan: African Development Bank Group.

AfDB (2017). "Growth and Job Creation: Policy Options for Pro-Employment Growth." Background paper for the *African Economic Outlook 2018* report of the African Development Bank. African Development Bank Group, Abidjan.

AfDB (2018). *Africa Economic Outlook 2018*. Abidjan: African Development Bank Group.

AfDB (2016). Jobs for Youth in Africa-Strategy for Creating 25 Million Jobs and Equipping 50 Million Youth 2016-2025. African Development Bank Group.

Autor, David H "Why are there still so many jobs? The history and future of workplace automation," Journal of Economic Perspectives, volume 29, number 3, 2015.

Autor, D., and A. Salomons .2017. "Does productivity growth threaten employment?" Working paper prepared for ECB Forum on Central Banking, June 2017

Banga K. and D. W. te Velde .2018. Digitalisation and the Future of Manufacturing in Africa. Draft report. February 2018. ODI SET Programme

De Boer D. and L. Langaty (2014). Dairy Clustering in Kenya. In Akinyoade, A., W. Klaver, S. Sooters and D. Foeken (Ed).(2014). Digging Deeper: Inside Africa's Agricultural, Food and Nutrition Dynamics. Brill. Leiden, Boston

Bhorat, H., and F. Tarp, eds. 2016. *Africa's Lions: Growth Traps and Opportunities for Six African Economies*. Washington, DC: Brookings Institution Press.

Brynjolfsson, E. and A. McAfee, *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies,* 2014.

Chandy, L. 2017. *The Future of Work in the Developing World.* Brookings Institution, Washington, DC. https://www.brookings.edu/research/the-future-of-work-in-the-developing-world/

Cirera, X (2016). Catching Up to The Technological Frontier? Understanding Firm-Level Innovation and Productivity in Kenya. Innovation and Entrepreneurship, Trade and Competitiveness Global Practice, the World Bank.

Dittrich, Paul Jasper (201 Reskilling For The Fourth Industrial Revolution. Formulating A European Strategy. *The Jacques Delors Institut – Berlin* **Policy Paper 175 3 November 2016**

Gatune and Brown E. (2018). The Future Of Work In Africa: The Impact Of The Fourth Industrial Revolution On Job Creation And Skill Development In Africa; Report for Africa Development Bank (AfDB). African Centre for Economic Transformation (ACET). Accra Ghana.

Gatune (2018). The 4th Industrial Revolution and Future of Work. Working Paper. African Centre for Economic Transformation.

Gillespie, Patrick. (2017). Intuit: Gig economy is 34% of US workforce. CNN Money. Available at http://money.cnn.com/2017/05/24/news/economy/gig-economy-intuit/index.html

Goos, Maarten, and Alan Manning. (2007). "Lousy and Lovely Jobs: The Rising Polarization of Work in Britain." *Review of Economics and Statistics*. 89(1): 118–33

Economist (2015). The promise of the blockchain: The trust machine. *The Economist*. Oct 31st 2015.

Economist (2012). "The third industrial revolution", The Economist. April 21, 2012

Gardner (2017). Ethiopia's remarkable education statistics mask a system in crisis. Quartz Africa December 28, 2017. https://qz.com/africa/1163797/ethiopias-remarkable-education-statistics-mask-a-system-in-crisis/

Feleke K. M.(2015).Revenue Diversification Strategies in Ethiopian Higher Education System: A Brief Reflection. BJE Vol. 15 No. 1 January 2015

Frey, C. and M. Osborne, *The Future of Employment: How Susceptible are Jobs to Computerisation?* Oxford Martin School Programme on the Impacts of Future Technology, September 2013.

Hallward-Driemeier, M and Nayyar, G (2018). Is automation undermining Africa's industrialization prospects?

Hatzakis, E. D. (2016). The Fourth Industrial Revolution. CIO REPORTS • The Weekly Letter FEBRUARY 2, 2016. Bank of America Merrill Lynch.

Iansiti , M and K. R. Lakhani (2017). The Truth About Blockchain. Harvard Business Review. January-February, 2017 Issue https://hbr.org/2017/01/the-truth-about-blockchain

ILO (International Labour Organization). 2018. ILOSTAT http://www.ilo.org/ilostat (accessed January 25, 20118)

Kariuki, James (2018). Drones firm in plea to reduce fees for would be owners. Business Daily. TUESDAY, MARCH 20, 2018 15:51. https://www.businessdailyafrica.com/corporate/tech/Drones-firm-in-plea-to-reduce-fees-for-would/4258474-4349910-35uwp8/index.html

Kaufman, D., Kharas H., Penciakova V. (2012). Development, aid and governance indicators (DAGI). Brookings Institute. http://www.brookings.edu/research/interactives/development-aid-governance-indicators. Accessed 15 June 2016

Maasho, A. (2018). Ethiopia opens telecoms sector to limited competition. Reuters, May 23, 2018 http://www.reuters.com/article/Ethiopia-telecoms

Macpherson, M. and E. Ulrich (2017). Evaluating Sustainable Investment Trends. S& P Dow Jones Indices January 2017.

Mann, K. and L Püttmann. (2017), Benign Effects of Automation: New Evidence from Patent Texts (September 22, 2017). Available at
SSRN: https://ssrn.com/abstract=2959584 or http://dx.doi.org/10.2139/ssrn.2959584

Marsh, P. (2014). The Next Industrial Revolution: What's driving it – and what are the opportunities? OECD, Paris, March 5 2014

Marvin, Rob (2017). Blockchain: The Invisible Technology That's Changing the World. PC Mag. August 29, 2017
https://www.pcmag.com/article/351486/blockchain-the-invisible-technology-thats-changing-the-wor

Medina, L., Jonelis, A. and Cangul, M (2017). The Informal Economy in Sub-Saharan Africa: Size and Determinants. IMF Working Paper. WP/17/156. 2016 International Monetary Fund

MGI. 2012. Africa at Work: Job Creation and Inclusive Growth. McKinsey Global Institute

MGI (2013) "Disruptive technologies: Advances that will transform life, business, and the global economy," May 2013. McKinsey Global Institute

MGI (2016). The age of analytics: Competing in a data-driven world. Mckinsey Global Institute. December 2016

MGI (2017a). A Future That Works: Automation, Employment, And Productivity. Mckinsey Global Institute. January, 2017

MGI (2017b). What the future of work will mean for jobs, skills, and wages. Mckinsey Global Institute. November 2017

MGI (2017c). Jobs Lost, Jobs Gained: Workforce Transitions in A Time of Automation. Mckinsey Global Institute. December 2017

Mutisya, J. (2018). Innovation: Kenya Punching Above Its Weight. Nation Newsplex. 26/1/2018
Https://Www.Nation.Co.Ke/Newsplex/Innovationleaders/2718262-4280194-12e0s8mz/Index.Html

Pratap, S. & Quintin, E. (2006) The Informal Sector in Developing Countries: Output, Assets and Employment. Research Paper 2006/130. Helsinki: UNU-WIDER.

Rifkin, J. (2013). The Third Industrial Revolution. Palgrave McMillan

Rodrik, Dani (2016). Put Globalization to Work for Democracies. New York Times. Sept. 17, 2016

Simbanegavi, W., Patel, S., Senbet, L. W., Mouelhi, R., B. A., Gatune, J. Amaoko, K., Y., Mutanga, S., Altennurg, T. Coulibaly, Prakash, A., (2018). World of Work in the 4th Industrial Revolution: Inclusive and Structural Transformation for a Better Africa. COOPERATION WITH AFRICA. T20

Wanzala, O (2018) Universities Face Financial Crisis After Sh1bn Budget Cut. The Daily Nation.

Https://Www.Nation.Co.Ke/News/Education/Universities-Face-Financial-Crisis-Sh1bn-Budget-Cut/2643604-4822484-Fwnkli/Index.Html

UNEP (2011). Decoupling natural resource use and environmental impacts from economic growth. In M. Fischer-Kowalski, M. Swilling, E.U. von Weizsa¨cker, Y. Ren, Y. Moriguchi, W. Crane, F. Krausmann, N. Eisenmenger, S. Giljum, P. Hennicke, P. Romero Lankao, A. Siriban Manalang (Eds.), A report of the working group on decoupling to the international resource panel. United Nations Environment Program

WEF (2016). Mastering the Fourth Industrial Revolution. World Economic Forum Annual Meeting 2016 Davos-Klosters, Switzerland 20-23 January

WEF (2016b). The Global Information Technology Report 2016 : Innovating in the Digital Economy. Silja Baller, Soumitra Dutta, and Bruno Lanvin, editors. World Economic Forum (WEF)

WEF (2017).The Future of Jobs and Skills in Africa-Preparing the Region for the Fourth Industrial Revolution. World Economic Forum. May 2017. May 2017.

WEF(2015). Mining & Metals in a Sustainable World 2050. World Economic Forum. September 2015.

World Bank Group. 2016. World Development Report 2016: Digital Dividends. Washington, DC

Appendix I: Industrial revolutions and 4IR technologies

Table 1. Summary of Industrial Revolutions[23]

	Energy/Power	Transportation	Production/ Organization	Communication
Agrarian Revolution (10,000 BC)	• Animal power	• Roads	• Irrigation • Crop rotation • New crops • Breeding	• Writing
First Industrial Revolution (1789)	• Coal • Steam engine	• Railway	• Factories • Professional management and bureaucracies	• Newspapers • Telegraph
Second Industrial Revolution (1870)	• Electricity • Electric motor • Internal combustion engine	• Motor car	• Mass production	• Telephone • Radio • Television
Third Industrial Revolution (1945)	• Jet engine • Cheap oil	• Aircraft • Express motorways	• Automation (repetitive tasks) • Petrochemical industry (plastics, clothes, fertilizers)	• Computing • Information systems
Fourth Industrial Revolution (1990)	• Distributed power (Renewable energies, hydrogen fuel cells, smart grids)	• Electric cars • Autonomous vehicles (drones, driverless cars)	• Machine learning Artificial intelligence/ (automation) • Additive manufacturing (3D printing) • Digitization (digital products)	• Internet technologies (World Wide Web, email, social media)

Source: Gatune (2018a)

Technologies driving the 4IR

i. **Processing technologies:** Computing power continues to be key as it enables new applications that were not possible due to limitations of computer power. Computer power has been doubling every 18 months (Moore's Law) however the limits of computer under the current designs is being

[23] Marsh (2014) argues for four industrial revolutions as follows: First Industrial Revolution (1780-1850) characterized by steam power, textile machinery; Second Industrial Revolution (1840-1890) characterized by communications, railways, telegraph; Third Industrial Revolution (1860-1930) characterized by science-based methodology; electricity, chemistry; Fourth Industrial Revolution (1950-2000) characterized computers, electronics. Ellicot (2016) characterizes the first Industrial Revolution as about harnessing steam power so that muscle could be replaced by machines; the second was driven by electricity and a cluster of inventions from the late 19th century onwards – including the internal combustion engine, the airplane and moving pictures; a third revolution began in the 1960s based on digital technology, personal computing and the development of the internet. And a 4th Industrial Revolution is underway that will be shaped by a fresh wave of innovations in areas such as self-steering cars, smart robotics, materials that are lighter and tougher, and a manufacturing process build around 3D printing.

reached. But new designs are now being proposed with quantum computing being the new frontier in computing. So, we expect the unrelenting growth in computer power to even accelerate further allowing more and more powerful applications to be built on top of it.

ii. **Machine Learning /Artificial Intelligence (AI)/Robotics:** Perhaps this is the aspect of technology that most defines the 4th Industrial Revolution. AI is enabling machines to undertake tasks that were previously thought to be the domain of human beings. Much like humans, machines are now being able to learn and become better continuously improving their capabilities. Significant milestones in this arena include the first computer to beat a human being in the "Go" game. More recently a machine has been able to do a better job of lip reading than a human expert[24]. Companies are investing in these technologies as they seek to capture the benefits. In the past 10 years, the number of global industrial robots in the U.S. has grown 72%, while the number of U.S. manufacturing jobs has fallen 16%. The robotics technology market is expected to grow at 9 to 11% (Hatzakis 2016).

iii. **Internet Communication and Proliferation of Devices linked to Internet (Internet of Things (IoT):** Computing and communication power is increasingly being embedded in all kinds of hardware and devices e.g. washing machines, coffee makers. Further these devices are being connected to the internet. The Internet-of-Things (IoT) is this giant network of connected "things" (which also includes people). The reality is that the IoT allows for virtually endless opportunities and connections to take place, many of which we can't even think of or fully understand the impact of today. It is estimated that the number of connected devices will reach 50 to 100 billion in 2020 (Hatzakis 2016).

iv. **Data Mining Technologies/Data Science:** The proliferation of mobile devices, online sensors and other means of collecting information digitally i.e. IoT has made it possible to obtain detailed, accurate and real-time data on everything from purchases to patient care. This has seen the capture of vast amounts of data and this is growing exponentially. Annual data traffic is expected to see a compounded annual growth rate (CAGR) of 40% (Hatzakis 2016). When huge amounts of data are combined powerful computing capabilities and Artificial Intelligence algorithms new insights generated creating new avenues for competitive power. It is putting so much power into the hands of a few entities that they become nodes of data capture e.g. *Facebook,* fueling a growing concern about their power.

v. **Blockchain or Trust Technologies:** Trust is crucial in enabling transactions. Indeed, contracts, transactions, and the records of them are among the defining structures in our economic, legal, and political systems. They protect assets and set organizational boundaries. They establish and verify identities and chronicle events. They govern interactions among nations, organizations, communities, and individuals. They guide managerial and social action (Iansiti and Lakhani, 2017). Currently big intermediaries including banks, government, big social media companies, credit companies, and so on, establish trust in economies. The blockchain lets people who have no confidence in each other collaborate without having to go through a neutral central authority. Simply put, it is a machine for creating trust (The Economist, 2012). More crucially, blockchain technologies can cut time of transactions drastically, from weeks or months to days, hours, or minutes. With blockchain, the economies are poised to undergo a radical shift, as new, blockchain-based sources of influence and control emerge. (Marvin 201).

[24] The computer read lips with 95 percent accuracy, outperforming professional human lip readers who tested at 52 percent accuracy. Hal Hodson, "Google's DeepMind AI can lip-read TV shows better than a pro," New Scientist, November 21, 2016.

As contracts or relationships are central to business, the blockchain will have a huge impact on how business are structures. The traditional organization as we know it maybe be drastically altered even the rationale of the business organization may cease to exist (Iansiti and Lakhani 2017).

vi. **Renewable Energy and related technologies:** As pointed before energy has been a crucial driver of revolutions. In the past fossil fuels were the drivers (coal then oil). A shift to a new energy regime is beginning to happen. The World Energy Outlook (2017) points that one of the defining trends in world energy outlook is the rapid deployment and falling costs of clean energy technologies. It forecasts that in the European Union, renewables could account for 80% of new capacity and wind power becomes the leading source of electricity soon after 2030. In general Renewable Energy Sources (RES) are likely to be the least cost source of new energy generation by 2040 (World Energy Outlook, 2017). RES also have the potential to bring a paradigm shift in how energy is generated, shifting from a centralized utility model where one large generator supplies to many consumers to a distributed generation model where many consumers are also generating power at other times. Any consumer with a roof is potentially a generator of solar power. Thus the shift to RES will have significant implications on geopolitics as well as local politics, as power is literally moved to the people leading to an emergence of a more lateral (as opposite to a hierarchical) society in its wake.

Appendix II

Table 1: Variations in Impact of 4IR

General Impact of 4IR	Likely Impact in the African Context
There is significant variation in estimates of the impact of 4IR technologies on jobs loss. Highly pessimistic estimates are being revised downwards as the impact is becoming better understood. Early estimates had put jobs susceptible to automation at 47 percent in the United States. In recent estimates only 5-10 percent of jobs are susceptible to automation, though for 60 percent of the jobs, at least 30 percent of the tasks can be automated (MGI, 2017a). McKinsey's latest estimate puts global job losses due to automation at 15 percent through to 2030 (MGI, 2017b).	Very high estimates have been given for Africa, for example 85 percent of jobs in Ethiopia could be automated (World Bank, 2016 cited in Frey and Osborne, 2013). This is the same methodology that found that 47 percent of US jobs could be automated. Estimates of job losses in Africa need to be treated with caution.
Jobs are more susceptible to automation in developing countries. This is because jobs there tend to be more routine and industries more labour intensive. Cost pressures to automate also differ substantially across regions.	Susceptibility is not inevitability. What is technologically feasible may not be economically feasible. A robot is paid between $10 and $20 per hour. Even though the cost of robots is falling, there is a significant window of opportunity before they become feasible in Africa. Using the wage rate of a high-end robot (costing $28 per hour) that can be used to make furniture and assuming an annual decline in the cost of robots of 6.5%, Banga and te Velde (2018) find that it will take until 2032 for robots to take over this sector in Kenya. Thus, a significant window of opportunity exists before robots take over.
Countries with faster wage growth and/or shrinking working-age populations in relation to the overall population will experience greater incentives to automate. Developed countries, on average, face rapid aging of their labor forces and declining shares of the working-age population (AfDB, ADB, EBRD, IDB, 2018)	Note that Africa has the fastest growing working age population and it is expected that by 2050 it will have the highest number of working age population (AfDB, 2018)
The impact on productivity is a given, however the actual impact is hard to estimate. The latest estimate puts productivity growth between 0.8 percent and 1.4 percent (MGI, 2017a).	Banga and te Velde (2018) find that the impact of productivity in low-income countries is muted (9-10 % lower) due to lower preparedness in particular lower-level skills. At the same time, the impact for sub-Saharan Africa (SSA), if all conditions are met is higher due to convergence effects.
The sector that is likely to experience most impact is manufacturing due to automation/robots. While in developed countries the effects of automation will be driven by production costs, in developing and emerging countries they may result from changing international trade patterns. To the extent that automation can increase the competitive advantage of producing in developed countries, the offshoring trend that has occurred since the 1980s may come to a halt and may even be reversed as a higher share of production takes place in developed countries. Such adverse effects could be potentially more important for Asia and European countries because of their higher specialization in	The manufacturing sector is very small in Africa, employing less than 7%. So even though the sector might be more susceptible to automation, the impact in Africa is small. The most important impact is loss of "could have been jobs" as low-cost labour advantage is no longer a factor. Hallward-Driemeier and Nayyar (2018) point that the adoption of robots varies considerably across sub-sectors. Some manufacturing industries are relatively unaffected and will therefore remain feasible entry points for less-industrialized countries. This includes a range of commodity-based manufactures such as basic metals, non-metallic mineral products, wood products, paper products, and food

General Impact of 4IR	Likely Impact in the African Context
the production of industrial goods (AfDB, ADB, EBRD, IDB, 2018).	processing, which are also less traded and therefore subject to less international competition. Thus, Hallward-Driemeier and Nayyar (2018) argue that there is still scope for countries using Industry 2.0 technologies to compete if other ecosystem requirements are met. If countries in Africa can integrate their growing labor force with substantial improvements in their business environments, logistics and other backbone services, regulatory requirements, and so on, this approach might slow down the adoption of Industry 4.0 technologies in the higher-income countries
Differences in the skill base across regions alter the incentives to automate and the potential to create new jobs and occupations. New technologies are increasing the demand for skills complementary to technology, including digital skills and high-level cognitive skills (such as creative thinking, the ability to learn, and problem resolution), as well as soft skills. At the same time, technological progress is reducing the demand for routine-based work.	This implies that limitations in the skill base of the population may constrain technology adoption or the creation of new jobs. Very low levels of skills mean that Africa may lag behind considerably. The danger of missing out on the 4IR is very real
The focus of studies tends to be on robotics and automation, the impact of other 4IR technologies is given less attention.	For Africa, the other technologies of 4IR are showing much more dynamism with many potential applications. As pointed above the small share of manufacturing make automation less of a concern.
The likely impact on jobs is loss of middle-income jobs resulting in polarization into low-paying and high-paying jobs (what has been termed as Lousy and Lovely jobs (Goos and Manning, 2007).	This polarization is already a reality where a small formal economy operates side-by-side with a large informal economy. 4IR is, if anything, more likely to improve the situation as new platforms and applications – e.g. mobile payments – start formalizing this sector. Emerging economies may see a rise in middle-wage occupation as result of 4IR spurring new occupations in services, construction, etc. (MGI, 2017b).
The impact on jobs is also different: Chandy (2017) also points that in industrialized economies the spread of automation implies the risk of redundancy for many workers. In developing economies, many workers are engaged in economic activities that are already some distance from the technology frontier—in other words, they could feasibly be done with greater technology and efficiency—and are paid accordingly. Automation needn't imply the loss of that work, but rather the possibility of a further diminishing income. Thus, estimates of the share of jobs at risk of being eliminated in rich and poor economies have different consequences. The welfare costs of automation may be higher in developing and emerging economies because their safety nets are less developed than in higher-income economies[25].	Africa is the most vulnerable region from impact on worker's perspective. Thus developing welfare systems will be key to adopting 4IR technologies especially in automation. Otherwise there is a significant risk of being left behind

[25] Data from the International Labour Organization indicate that while more than 65 percent of people in the labor force are contributing to social security in developed countries, only between 36 percent and 48 percent do so in the EBRD regions, 30 percent in Latin America and the Caribbean, 17 percent in Asia and the Pacific, and 9.6 percent in Africa

General Impact of 4IR	Likely Impact in the African Context
The costs of job dislocation are higher for workers without access to unemployment insurance or unemployment assistance. Social security coverage is typically low in emerging and developing regions (AfDB, ADB, EBRD, IDB, 2018).	
Loss of job security and other job-related benefits as on-demand jobs (part-time) and "Gig Economy" grows.	Again, informality is reality in Africa and the "gig" economy (short-term jobs) has been a way of life for many in the informal sector. 4IR technologies are likely to increase opportunities by providing new platforms to find "gigs".
Though jobs will be lost, many new jobs are likely to be created as new industries emerge and also as new ways of connecting people to opportunities are found. Bessen (2017) finds that computer use is associated with a 3 percent per annum job loss in manufacturing and a 0.3 percent per annum rise in national employment. Productivity growth in an industry tends to generate positive employment spill overs elsewhere in the economy (Autor and Salomons, 2017). Also Mann and Putterman (2017) find that a one-unit increase in new automation patents lead to a 0.20 percent increase in the employment-to-population ratio.	The transformational impact of technologies is seldom fully appreciated. The new economies that arise in the wake of an industrial revolution have always tended to create new opportunities. The potential is huge for 4IR to help transform Africa economies and unleash new opportunities. This transformational impact needs to be given more attention (see table 2).

Table 2: Potential Impact of 4IR Technologies on ransformation Pathways

			4IR technology			
Transformation Strategy	**AI/Machine Learning**	**Internet of Things (IoT)**	**Big Data/Data Science**	**3D Printing**	**Blockchain Technologies**	**Net Impact on competitiveness**
Agricultural transformation	– Application in breeding to speed varietal selection – Intelligent robots are reducing inputs applications by over 90 percent	– Use of drones for crop monitoring – Internet-enabled irrigation systems	– Telephone farming – E-extension – Inputs-as-service business models – Big Data for credit scoring	– Locally fabricated agricultural machines	– Food traceability systems for international trade	Very High – Agriculture has potentially many entry points and little downside in terms of job losses
Modernized services	– Self-steering cars will kill jobs in transportation – Potentially very many applications, e.g. credit scoring using non-standard data	– M-Kopa selling solar power as utility/service through internet-enabled cookers and solar panels	– Shared economy e.g. Airbnb – Financial inclusion e.g. Micro-insurance – E-commerce e.g. Jumia, iRoko	– Toll/contract manufacturing – Community workshops	– Numerous trust-based applications (land registries, contracting) – Cryptocurrency- based transactions	Very High – This sector is already very dynamic. An e-commerce company, M-Pesa, valued at $1 billion, is the biggest money transfer service in the world
Local content	– Potential for development of sophisticated machine-learning algorithms for interpretation and/or exploration data	– Drone-based services, – e.g. facilities inspection, mapping etc.	- Geological data mining may create new opportunities	-Locally manufactured parts	–	High to Moderate – Much potential here but will require much support to build new capabilities, especially in AI, data science and 3D printing
Export-led manufacturing	– Advanced robots will kill cheap labour advantage		Will enable fine- grained market segmentation and kill mass markets	Will kill the factory manufacturing model		Very Low – This will not be a viable strategy in the 4IR world
Infrastructure		Alternative infrastructure e.g. drones	Smart cities and other tools to help optimize infrastructure	On site manufacture of part		
Creative industries	-New tools		-Platforms for distribution	Ability to covert designs to products		Very high – products highly amenable to digitalisation
Tourism	-New tools to showcase e.g. virtual reality		Better targeting of marketing efforts			High – 4IR can help create new experiences and improve service delivery

			-new platforms e.g. Airbnb expanding potential tourist			
Overall impact of 4IR technology	Will kill traditional paths to industrialization		The most dynamic of the IR technology for Africa. Potential to create many jobs	Presents great opportunity for leapfrogging into manufacturing	Potential to formalize the huge informal sector	