Emerging African Economies:Digital Structures, Disruptive Responses and Demographic Implications

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EMERGING AFRICAN ECONOMIES: DIGITAL STRUCTURES, DISRUPTIVE RESPONSES AND DEMOGRAPHIC IMPLICATIONS

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ABSTRACT

Indeed, the world economy is a complex system that has undergone many different phases in the past century. Particularly, the African economy is undergoing a series of transformations (transitions) that subject the future to considerable uncertainty, complexity and unpredictability. In fact, some transformations are cyclical while others are longer-term and more structural in nature. Yet, these transitions or emergence interact in shaping the future; making extrapolation from the past an increasingly unreliable source for future predictions. Thus unlike the previous revolutions, the fourth industrial revolution is characterized by the emergence of various technologies such as virtual (augmented) realities, nanotechnologies, 3D printing, machine learning, big data, cloud computing, drones, autonomous vehicles, robotics, artificial intelligence and blockchain technologies. Again, in this digitization era, work is constantly reshaped by technological progress, while firms adopt new ways of production and markets expand. In other worlds, digital technology brings opportunity, pave the way to create new jobs and increase productivity. Unfortunately, this paper argued that while the digital revolution has forged ahead, its analog complements (regulated entry and competition, new economy skills access and accountable institutions) have not kept pace in Africa. Consequently, African governments should formulate digital development strategies that are much broader than current ICTs strategies. That is, they should create a policy and institutional environment for technology that fosters the greatest benefits to African people of twenty-first century and beyond.

KEY WORDS: Africa, Digitization, Industrial Revolution, Technologies, Disruptions, Development, Old Work, Innovation, Automation, ICTs, E-commerce Robotics, Artificial Intelligence Block Chain, Cryptology, Fintech, Productivity, New Skills, Human Capital, Institutions, Policies, Emergence, Transformations, Economies, Analog Complements, Unemployment, New Jobs, Social Protection.

JEL NO:

D80, D83, E24 G10, I20, J40 J60, J10, L50, 010, 030, 031, 032, 033, 038

1.0 INTRODUCTION

In the age of the fourth industrial revolution, a new global architecture may be needed to enshrine international cooperation, overcome rising social polarization and protect the environment. This is in addition to a new social contract between governments and citizens; going beyond social safety nets and targets affordable and scalable access to education as well as mobility of works and workers plus new economic models that combine the narratives of wealth creation and wealth distribution. Indeed, Africa is embracing digital revolution and most enterprises are providing a wide range of services from e-commerce to fintech and cloud computing for their customers while other services offered includes ride-hailing, logistics and digital payments. Again, some enterprises are exploiting recent advances in artificial intelligence, robotics, cryptography and big data that promise to reshape the global economy and fundamentally alter the way we live and work. In fact, Africa digital revolution is rippling across industries from retailing and banking to manufacturing and transportation. However, the continent will face distinct challenges as the new technologies disrupt global value chains (network of interlinked stages of production for the manufacture of goods and services) and undermine the model of labor intensive, export-led natural resources that has powered the region's growth.

However, these new technologies are expected to open new opportunities for small business while offering the potential of enhanced productivity that is needed by African economies in order to move beyond low-income status. Notably, E-commerce has the potential to support growth and make it more sustainable. And for consumers, e-commerce may translate into better access to a wider range of products and services at lower prices via consumption booting. While for firms, e-commerce provides new business opportunities and access to larger markets which supports investment. Again, financial technologies (Fintech) can support potential growth and poverty reduction by strengthening financial development, inclusion and efficiency. Essentially, fintech can help millions of individuals as well as small and medium sized enterprises leapfrog a mess to financial services at an affordable cost in poor African countries. In fact, these technologies may drive substantial efficiency gains in the financial sector by providing cross-border payments that reduce both risk and cost for participants. Again digitalization presents opportunities for improving public finance; since adaption of digitalization by governments can (through better reporting of transactions) increase revenue from value-added taxes (VAT), tariffs and other sources.

Yet, these new technologies are automating increasingly complex activities that could previously be performed only by people. Thus, major transitions lie ahead that could match the scale of historical shifts out of agriculture and manufacturing which creates new challenges for policy makers. Certainly, this new wave of creative destruction will transform jobs and skills (with old jobs and firms disappearing while new ones emerging). Historically, African adjustment to change his been difficult with gains unevenly spread. This is because of the fact that the continent has been largely dismissed as a case of regional economic delinquency with levels of growth necessary to reduce poverty and inequality deemed to be consistently unattainable. Consequently, as a global agenda, all countries and stakeholders (acting in collaborative partnership) decided to implement the 2030 sustainable development goals (SDG). Essentially, United Nations (2015) resolved to free the human race from the tyranny of poverty as well as healing and securing the earth planet by shifting the world unto a sustainable and resilient path. Conceptually, this plan led to the emergence of 17 SDG's and 169 targets.

Specially, the aim of goal nine is to build resilient infrastructure, promote inclusive and sustainable industrialization and faster innovation. Here, the key target is to significantly increase access to information and communication technology while strive to provide universal and affordable access to the internet in least developed countries (inclusive of Africa).

As a driver for economic growth, global digital connectivity is essentially seen as having significant potential to help attain the sustainable development goals. Although, there is evidence that some poor people benefit (economically and socially) from connectivity; such initiatives do not go to scale or unsustainable (World Bank, 2016). In other words, large numbers of poor people generally do not benefit appropriately from such digital interventions. In fact, without such connectivity, people do not even have the chance to benefit from the potential of information and communication technologies (ICTs). Notably, an increasingly digitally marginalized and disenfranchised population constitutes a danger to the sustained economic growth that dominates global (continental) agenda on development.

Certainly, this observed situation requires appropriate policies by governments at all scales and in particular through their regulatory mechanisms as well as private sector and civil-society engagements. Therefore, at this moment of change, when people look to connectivity to bring about sustainable (inclusive) digital economic development; we intend to analyze divergent wears about digital economies outside global centers. As a research focus, this paper will show how

those processes are inherently political, socially embedded, path dependent and highly uneven in the African context. The rest of the paper is organized as follow: The second section presents the state of African Economies; the third section focuses on digital revolution, foundation and structures; the fourth sections dedicated to the digital evidence in Africa; the fifth section presents the disruptive responses in Africa while demographic implications are shown in section six. Policy options are presented in section seven while the last section concludes the study with emphasis on challenges and prospects.

2.0 STATE OF AFRICAN ECONOMIES

Spatially, Africa is the second largest of the earth's continents and perhaps the most diverse of any continent's inhabitants (with thousands of ethnic groups and different languages). At independence, Africans had high hopes of rapid development and starting from a low base; African countries significantly raised life expectancy expanded literacy and improved health care. Notably, in 1961, overall economic growth in sub-Saharan Africa averaged 3.4 percent and the pace quickened after 1967. But as the 1970s advanced countries began to stumble and by the 1980s, output was actually declining (World Bank, 1989). In fact, during this period, African's generally poor performance were reflected in weak growth in the productive sectors, poor export performance, mounting debt, deteriorating social conditions, environmental degradation as well as increasing decay of institutional capacity. Here, both domestic and external factors contributed to the disappointing overall performance. Again, all countries in the region were confronted with deep rooted developmental constraints (rapid population growth, low human capital development and inadequate infrastructure) which constituted major impediments to private sectors development and the supply response of the economies.

Furthermore, ethnic conflicts, political instability, adverse security conditions and protracted civil wars aggravated the economic performance of several countries. Regrettably, governance concerns were compounded by the legacy of repressive regimes in several countries; by bloated and inefficient public administration; by ineffective judicial systems as well as by complex administrative (institutional) frameworks. Again, inappropriate policies which resulted in relative price distortions in most of the key sectors adversely affected economic incentives and production. Basically, the price distortions combined with the severe external shocks of the 1970/80s (declining terms of trade, drying up of foreign capital inflows and rising world interest rates) weakened many economies of Africa (Elbadawi, Ghura and Uwujaran, 1992; Gura and Hadjimichael, 1996).

Consequently, the failure of many countries in the 1970s and early 1980s to accommodate the adverse effects of negative external shocks compounded the negative impact of these shocks. Hence the urgent need to address the short-term balances of payment crises as well as medium to long-term productivity improvements. Thus, the World Bank structural adjustment programs were designed to enable countries reform their policies in order to boost the various sectors. However, United Nations agencies criticized adjustment programmes for their neglect of the human dimensions and elements. Subsequently, a joint initiative called Poverty Reduction Strategy Paper (PRSP) was launched by the joint institutions (in 1990s) to fight against poverty at the heart of growth and development policies (World Bank, 2002). Unfortunately, these partnerships between Africa and international organizations did not yield the expected development of the African nations.

Yet, other existing partnerships or initiatives include United Nations New Agenda for the plan of Action; IMF-led Poverty Reduction Strategy Papers; Japan – led Tokyo Agenda for Action; African Growth and Opportunity Act (AGOA); Economic Commission for Africa (ECA) led Global Compact with Africa; United Nations Millennium Declaration (MDG); G8 Okinawa Declaration; Copenhagen Declaration; Skagen Declaration; Cotonou Agreement; TIKAD; SINO-AFRICAN PROCESS, Generalized System of Preferences (GSP); Everything but Arms (EBA); New Partnership for Africa's Development (NEPAD); Senegal's Millennium Partnership for Africa's recovery program (MAP); New African Initiative (NAI); Organization of African Unity (OAU) and African Development Bank (ADB) as instruments for fostering African development, Unity and Growth. Later, the above commitment was reiterated in the Lagos plan of action and Abuja Treaty which envisions the ultimate creation of the African Economic Community (African Union) in Lusaka.

However, the desire to overcome the establishment of various treaties and regional institution with overriding objective of creating self-reliant development of member states. These include: CUSTOMS AND ECONOMIC UNION OF CENTRAL AFRICA (UDEAC) OR CENTRAL AFRICAN ECONOMIC AND MONETARY COMMUNITY (CEMAC); EAST AFRICAN COMMUNITY (EAC);SOUTH AFRICAN CUSTOMS UNION (SACU);SOUTHERN AFRICAN DEVELOPMENT COORDINATING CONFERENCE (SADCC);SOUTHERN DEVELOPMENT COMMUNITY (SADC); COMMON MARKET FOR EASTERN AND SOUTHERN AFRICA (COMESA);WEST AFRICAN ECONOMIC COMMUNNITY (CEAO); ECONOMIC COMMUNITY OF WEST

AFRICAN STATES (ECOWAS); WEST AFRICAN ECONOMIC AND MONETARY UNION (UEMUA);PREFERENTIAL TRADE AREA (PTA) AND ARAB Maghred Union (AMU).

Despite the dismal outcome from the above generation of integration initiatives, current integration initiatives were broading the objectives of economic cooperation and regional integration to include and emphasize the coordination and harmonization of macroeconomic policies.

Although, the 1980s are often referred to as the continents host decade; the mid-1990s socioeconomic indicators (poverty, inequality, access to social services, institution development, and infrastructure levels) remain weak in Africa as well as typically lag behind developing nations in other regions of the world (Collier and Gunning 1999). Table 2.1 presents an overview of inflation, exchange rates, current and fiscal accounts, external debt as well as real GDP per capita for the various African sub-regions (Bhorat et.al, 2015). And clearly, over this period, these economic regions experienced slight exchange rate depreciation against the United States dollars. And subsequently, the exchange rate stabilized towards their equilibrium value. Yet, despite significant currency depreciation, exports did not increase sufficiently to improve the current account balance. Again, table 2.1 demonstrates that most regions experienced real annual GDP growth exceeding four percent between the periods 2000 and 2014 with the exception of South Africa (as the most dominant economy) which experienced contractions.

However, Africa's economic growth continued to deteriorate in 2016 due mainly to lower commodity prices. Specifically, Africa's growth slowed to 2.2% in 2016, down from 3.4% in 2015 (ADB, 2017). In the wake of challenges emanating from falling commodity prices and shrinking revenues; some African

TABLE 2.1 AFRICA MACROECONOMIC OVERVIEW (1990 – 2014)

S/N	Macroeconomic Indicators	Period Averages	Central Africa (CA)	East Africa (EA)	North Africa (NA)	Southern Africa (SA)	West Africa (WA)
1.	Inflation (%)	1990-1994 2000-2004 2010-2013	923.05 28.59 3.15	17.58 4.43 4.57	11.21 2.04 4.94	78.5 21.55 7.25	11.43 4.77 5.44
2.	Official Exchange (PER US$)	1990-1994 2000-2004 2010-2013	284.13 596.12 553.94	174.13 411.55 553.94	22.22 36.60 61.17	3.83 22.06 243.12	253.35 648.79 933.39
3.	Current Account Balance (% of GDP)	2005-2009 2010-2012	22.50 - 1.55	- 6.67 - 7.86	7.95 0.78	- 5.55 - 9.50	- 7.21 - 11.00
4.	Fiscal Balance (% of GDP)	1990-1994 2000-2004 2010-2012	-3.82 1.98 4.46	- 3.29 - 3.88 - 2.55	2.78 5.25 2.74	- 3.50 - 2.02 - 0.70	- 0.66 - 2.66 - 2.65
5.	External Debt Stocks (% of GNI)	1990-1994 2000-2004 2010-2013	113.36 129.74 24.02	86.51 79.06 45.75	92.58 67.16 36.87	111.12 72.69 32.48	116.91 166.08 43.51
6.	Real GDP (% Change)	1990-2000 2000-2014	0.50 5.80	2.80 9.10	4.60 2.20	2.00 3.90	2.40 6.40
7.	GDP Per Capita	1990-	1.80	- 2.1	5.80	1.80	1.30

	(% Change)	2000 2000- 2014	3.20	12.60	0.00	- 0.80	1.90

governments had to operate within an increasingly constrained fiscal space. Thus, as a result of commodity price falls, the overall fiscal deficit for the continent weakened from 6.3% in 2015 to 6.6% in 2016 as well as falling from 5.5% in 2017 to 4.5% in 2018 (by projection) as shown in table 2.2 (ADB, 2017). Although the recovery in sub-saharan Africa continued in 2018, activity lost momentum in several countries. Unfortunately, this reflected a sluggish expansion in the region's largest economies (Angola, Nigeria and South Africa). In fact, the region faced a more difficult external environment in 2018 as global trade growth moderated; financing conditions tightened and United States dollar strengthened. In contrast, growth in the other regions of Africa was generally steady; although performance varied between country groups.

Structurally, growth in some of the Africa countries is anticipated to pickup in 2019 and subsequently in 2020/2021 (as shown in table 2.3). This is predicated on diminished policy uncertainty and improved investment in large economies as well as continued robust growth in non-resource intensive countries. However, per capita income growth is predicted to remain well below its long-term average in many countries (World Bank, 2019). Again, inflation is expected to pick up across the region in 2019 reflecting the pass-through of currency depreciations and domestic price pressures. In contrast, fiscal balances are expected to improve further, reflecting fiscal consolidation efforts among the large oil exporters continued adjustment in some countries. Notably, policy tightening is likely to yield smaller fiscal deficits in metal exporters while fiscal deficits in non-resource-intensive countries should continue to narrow as public investment spending slows to stabilize public debt.

As a risk factor, shower-than-projected growth in China and Europe (which have strong trade and investment links with Africa) would adversely affect the region through lower export demand and investment. Furthermore, a faster than-expected normalization of advanced-economy monetary policy could result in sharp reductions in capital inflows, higher financing costs and disorderly exchange rate depreciations (such as in countries with weaker fundamentals or higher political risks). Clearly, sharp currency declines would make the serving of foreign-currency-denominated debt more challenging. Again, the increased reliance on foreign currency borrowing has heightened refinancing and interest rate risk in

debtor countries. In fact, the rise in non-resident participation in domestic debt markets has exposed

TABLE 2.2 AFRICA MACRO ECONOMIC OVERVIEW (2015 – 2018)

S/N	Indicator	Period	Central Africa	East Africa	North Africa	Southern Africa	West Africa	African Region
1.	Real GDP Growth (%)	2015 2016 2017 2018	3.6 0.8 2.2 3.8	6.5 5.3 5.7 6.0	3.3 3.0 3.4 3.7	1.9 1.1 1.9 2.6	3.3 0.4 3.5 5.5	3.4 2.2 3.4 4.3
2.	Consumer Prices (Inflation In %)	2015 2016 2017 2018	2.2 3.1 2.2 2.4	10.2 12.4 9.9 8.9	7.5 8.1 10.3 8.2	5.7 10.5 8.7 7.7	8.3 13.0 11.4 9.8	7.4 10.1 9.8 8.3
3.	Overall Fiscal Balance (% GDP)	2015 2016 2017 2018	-2.9 -4.0 -3.5 2.4	-5.1 -4.7 -4.5 -3.3	-13.3 -13.5 -11.1 -9.5	-3.9 -4.3 -3.8 -3.2	-2.0 -2.9 -2.8 -2.5	-6.3 -6.6 -5.5 -4.5
4.	External Current Account (% GDP)	2015 2016 2017 2018	-7.4 -8.1 -5.9 -5.1	-7.7 -7.0 -7.6 -8.2	-9.1 -9.8 -7.5 -5.8	-6.2 -6.4 -5.4 -4.9	-4.1 -2.8 -0.9 0.3	-6.8 -6.5 -5.0 -4.1

TABLE 2.3 AFRICA GROWTH FORCAST (2019 – 2012): SELECTED COUNTRIES

S/N	Country	2019	2020	2021	S/N	Country	2019	2020	2021
1.	ANGOLA	2.9	2.6	2.8	33	RWANDA	7.8	8.0	8.0
2.	BENIN	6.2	6.5	6.6	34	SENEGAL	6.6	6.8	6.9
3.	BOTSWANA	3.9	4.1	4.1	35	SEYCHELLES	3.4	3.3	2.9
4.	BURKINA FASO	6.0	6.0	6.0	36	SIERRA LEONE	5.1	6.3	6.3
5.	BRUNDI	2.3	2.5	2.8	37	SOUTH AFRICA	1.3	1.7	1.8
6.	CABO VERDE	4.7	4.9	4.9	38	SUDAN	3.6	3.8	3.8

7.	CAMEROON	4.2	4.5	4.5	39	TANZANIA	6.8	7.0	7.0
8.	CHAD	4.6	6.1	4.9	40	TOGO	4.8	5.1	5.1
9.	COMOROS	3.1	3.1	3.1	41	UGANDA	6.0	6.4	6.5
10.	CONGO DEM REP	4.6	5.5	5.9	42	ZAMBIA	3.6	3.8	3.8
11.	CONGO REP	3.2	-0.1	-1.5	43	ZIMBABWE	3.7	4.0	4.0
12.	COTE D'IVORE	7.3	7.4	6.8					
13.	EQUATURIAL GUINEA	-2.1	-5.8	-5.6					
14.	ESWANNI	1.7	1.8	1.8					
15.	ETHIOPIA	8.8	8.9	8.9					
16.	GABON	3.0	3.7	3.7					
17.	GAMBIA	5.4	5.2	5.2					
18.	GHANA	7.3	6.0	6.0					
19.	GUINEA	5.9	6.0	6.0					
20.	GUINEA-BISSAU	4.2	4.4	4.5					
21.	KENYA	5.8	6.0	6.0					
22.	LESOTHO	1.2	0.2	1.8					
23.	LIBERIA	4.5	4.8	4.8					
24.	MADAGASCAR	5.4	5.3	5.3					
25.	MALAWI	4.3	5.3	5.5					
26.	MALI	5.0	4.9	4.8					
27.	MAURITANIA	4.9	6.9	6.9					
28.	MAURITIUS	4.0	3.6	3.6					
29.	MUZAMBI QUE	3.5	4.1	4.1					
30.	NAMBIA	1.8	2.1	2.1					
31.	NIGER	6.5	6.0	5.6					
32.	NIGERIA	2.2	2.4	2.4					

some countries to the risk of sudden capital outflows. Similarly, in some countries, sizable loans to state-owned enterprises (backed by commodity exports) have increased the risk that a negative commodity price shock could trigger financial crises. In particular, domestic risks remain elevated where political uncertainty and a concurrent weakening of economic reforms could continue to weigh on the economic outlook in many African countries. In other words, domestic political considerations would undermine the commitment needed to uphold in fiscal deficits

or implement structural reforms (especially where public debt levels are high and rising). Unfortunately, insurgencies and armed conflicts with their adverse effects on economic activity remain an important risk in several African countries. Also, weather shocks and rising financial sector stress constitute major constraints on the emergence of these economies. On the other hand, pervasive informality contributes to lower government tax revenues which limits the fiscal resource available for much-needed public investments and socio-economic programs.

3.0 DIGITAL REVOLUTION: FOUNDATION AND STRUCTURES

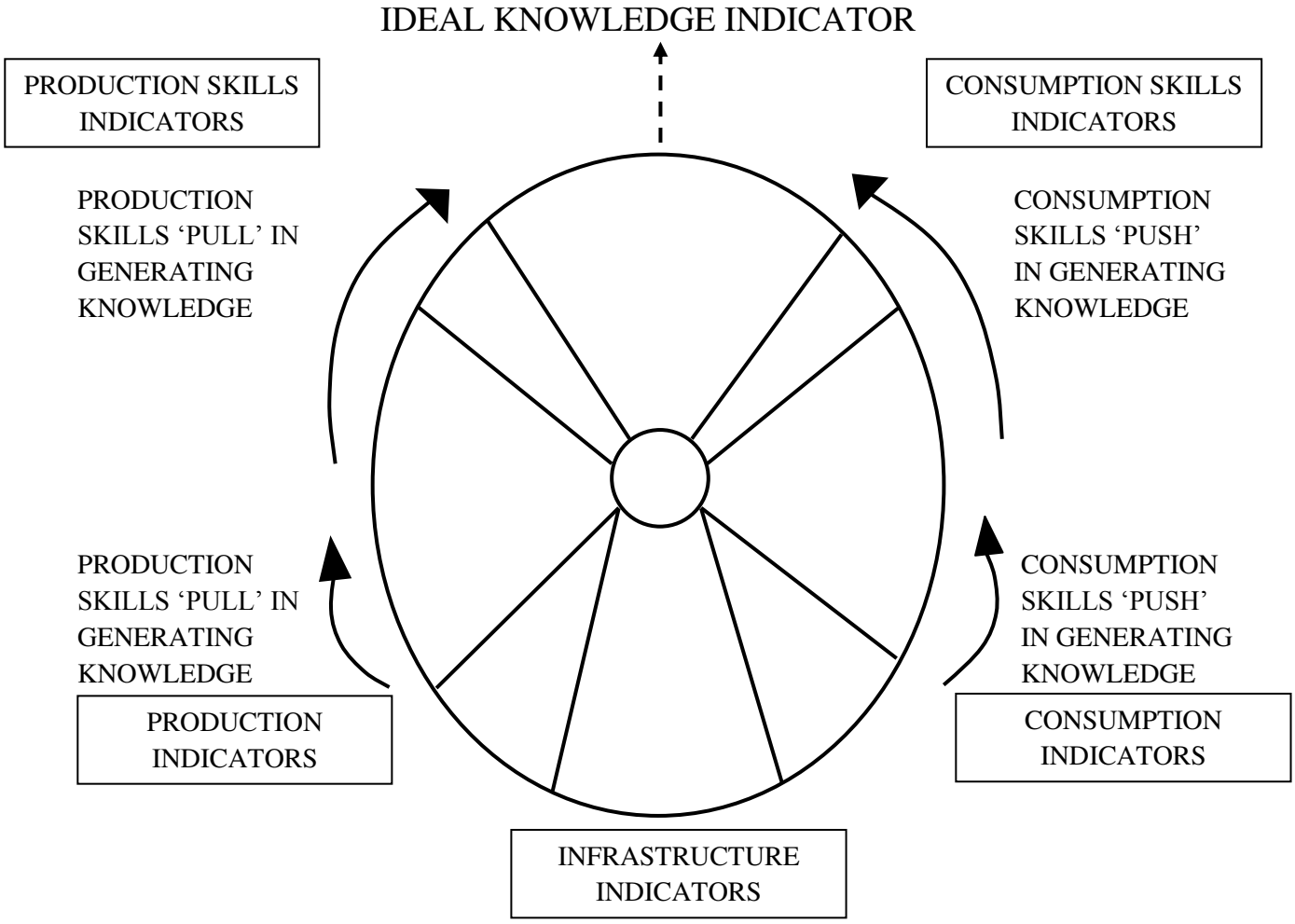
Indeed, digital technologies (internet, mobile phones, other tools to collect, store, analyze and share information digitally) have spread rapidly in much of the world. Essentially, these technologies have dramatically expanded the information base; lowered information costs and created information goods. In fact, this has facilitated searching, matching and sharing of information and contributed to greater organization and collaboration among economic agents while influencing how firms operate, people seek opportunities and citizens interact with their governments (world bank, 2016). Technically, the internet promotes development through the following mechanisms: search and information (inclusion), automation and coordination (efficiency) and scale economies and platforms (innovation). Across these domains, four major enablers of digital technologies are digital finance, social media, social media, digital identity and data revolution (big data vs. open data).

Since technological change means that many routine tasks will be done by machines, skills development should start at birth and lasts a lifetime. In fact, this puts a premium on different types of skills that automation complements in a modern economy as shown in figure 3.1 (World Bank, 2016; Pierre, et. al 2014). However, figure 3.2 displays the indicators of infrastructure development as a means of assessing how broad or narrow the foundation is for the development of experience and skills. Clearly, a much undeveloped infrastructure provides a narrow base for the development of either production or consumption experience as well as a similarly specialized foundation for the skills application. Thus, experience with production and consumption operates to push the new technologies into roles in the creation of knowledge. Again, neither production nor consumption alone will bring infrastructure assets and experience into productivity use in the creation of knowledge. Basically, this requires ‘pull’ influences from the production or consumption skills as represented by a second set of arrows leading to the skills level (Nwaobi, 2000; United Nations, 1998).

FIGURE 3.1 DIGITAL ECONOMY SKILLS FOUNDATION

S/N	COGNITIVE	SOCIAL AND BEHAVIORAL	TECHNICAL
1.	LITERACY, NUMERACY AND HIGHER-ORDER COGNITIVE SKILLS SUCH AS REASONING AND CREATIVE THINKING	SOCIO EMOTIONAL SKILLS AND PERSONALITY TRAITS	MANUAL DEXTERITY AND THE USE OF METHODS MATERIALS, TOOLS AND INSTRUMENTS
2.	RAW PROBLEM-SOLVING ABILITY VERSUS KNOWLEDGE TO SOLVE PROBLEMS	OPENNESS TO EXPERIENCE, CONSCIENTIOUSNESS, EXTRAVERSION AGREEABILITY, EMOTIONAL STABILITY	TECHNICAL SKILLS, DEVELOPED THROUGH POSTSECONDARY SCHOOLING OR TRAINING OR ACQUIRED ON THE JOB
3.	VERBAL ABILITY, NUMERACY, PROBLEM SOLVING, MEMORY AND MENTAL SPEED	SELF-REGULATION, GRIT MIND-SET, DECISION MAKING AND INTE-PERSONAL SKILLS	SKILLS RELATED TO SPECIAL OCCUPATIONS SUCH AS ENGINEER, ECONOMIST, IT SPECIALIST

FIGURE 3.2 INFRASTRUCTURES, EXPERIENCE AND SKILLS FRAMEWORK



For the purpose of technology acquisition and exploitation, technology-specific skills are needed which can be found from education and training system. Thus, we can distinguish between three diffusion phases and associated modes of technological usage. Here, substitution occurs when a new or improved technology merely substitutes for an existing one. Similarly, enhancement occurs when the new technology leads to substantial performance enhancement while a third graduation exists where the adoption opens up opportunities for the redefinition of tasks via a whole sale transformation of work practices and organizational structures. Clearly, figure3.3 sets out the three I.T (information technology) diffusion phases or levels of IT in use. Basically, enhancement is the usual driver for technology adoption; substitution is the initial diffusion reality while transformation is the eventual realization of often unforeseen potential (Nwaobi, 1999; Hanna, et.al, 1995).

Specially, electronics (as largest and fastest growing industry) enables a veritable revolution in communications and information that lies at the root of modern economic development as well as emerging digital economies. Essentially, the output of the electronics industry comprises a wide variety of products ranging from the most sophisticated computer hardware and software to home appliances. As enabling technology of the information economy, the classifications of critical electronic products are shown in table 3.1 (Wellenius, 1993). Here, five subsectors of electronics are distinguished: telecommunications, computers, industrial consumer electronics and semiconductors. However, specific enterprises and products shift easily among subsectors and share common requisites for effective utility in market place. Basically, this shift can be characterized as a transition from a telephony world (in which technologies, applications and providers operated in separate store pipes) to an IP world (in which an ever increasing variety of combinations of technologies, applications and providers is possible. Consequently, the size of the internet infrastructure is a good indication of a country's progress towards information driven economy or digital economy.

FIGURE 3.3 INFORMATION DIFFUSION PHASES

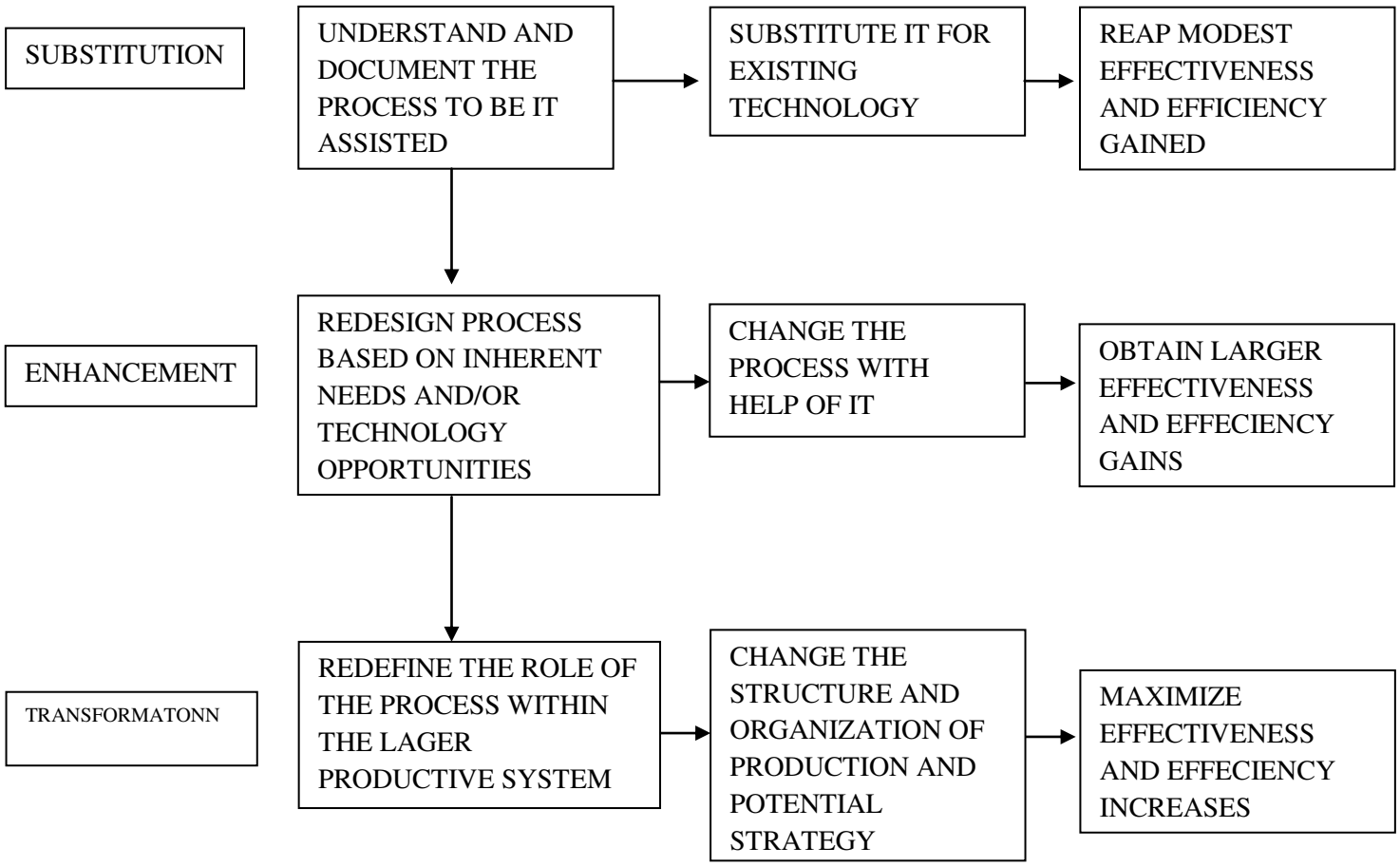


TABLE 3.1 ELECTRONIC INDUSTRY PRODUCT CATEGORIES

(A) CONSUMER ELECTRONICS

VIDEO EQUIPMENT	AUDIO EQUIPMENT	HOME INFORMATION EQUIPMENT	OTHERS
MONOCHROME TV	AUDIO COMPONENTS	HOME COMPUTERS	ELECTRONIC WATHES
COLOR TELEVISION	DIGITAL AUDIO	COMPUTER SOFTWARE	TOYS AND GAMES
ADVANCED TELEVISION	ADD-ON COMPONENTS	COMPUTER ACCESSORIES	MUSICAL INSTRUMENTS
PROJECTION TV	PACKAGED AUDIO SYSTEMS	DEDICATED WORD PROCESSORS/TYPE-WRITER	CHILDREN ELECTRONICS

VIDEO SYSTEMS	AUDIO ACCESSORIES	COMPACT FACSMILE	HOME SECURITY SYSTEM
VIDIO CASSETTE RECORDERS/PLAYERS	AUDIO TYPE EQUIPMENT	PERSONAL COPIERS	HEALTH CARE PRODUCTS
CAMCORDERS	AUTO SOUND	TELEPHONES	CALCULATORS
PERSONAL VIDEO	PORTABLE AUDIO	CELLULAR TELEPHONE	CEBUS OR INTELLIGENT HOME
STILL VIDEO CAMERAS	RADIO	ELECTRONIC ORGANIZERS	
VIDEO DISC SYSTEMS		ACCESSORIES	
VIDEO SOFTWARE		COMMUNNICATIONS	
VIDEOTEX SYSTEMS			
CAPTIONING			
HOME SATELITE			
EARTH STATIONS			

(B) COMPUTERS AND INDUSTRIAL ELECTRONICS

COMPUTERS	PERIPHERAL EQUIPMENT	INDUSTRIAL AUTOMATION	ARTIFICIAL INTELLIGENCE	OTHERS
PERSONAL COMPUTERS	STORAGE EQUIPMENT	INDUSTRIAL CONTROLS	ROBOTICS	INDUSTRAIL MATERIALS
WORKSTATIONS	OPTICAL DISCK TECHNOLOGY	ELECTRONIC TEMPERATURE CONTROLS	MACHINE VISION	
MINICOMPUTERS SUPER MINICOMPUTERS	COMPUTERS TERMINALS		MATERIALY HANDLING	
MAINFRAMES	PRINTERS		BAR CODING	
MINI-SUPER COMPUTERS SUPER COMPUTERS	SOFTWARE AND OPERATING SYSTEMS		COMPUTER-AIDED DESIGN	
			COMPUTER-AIDED MANUFACTURING	

			COMPUTER-AIDED ENGINEERING	
			COMPUTER-INTEGRATED MANUFACTURING	

COMMUNICATION EQUIPMENT

MAIN	NETWORKS	OTHERS
CENTRAL OFFICES	INTEGRATED SYSTEMS	TELE TEXT VIDEOTEX
FIBRE OPTICS	DIGITAL NETWORK	
FACSIMILE	NETWORK MANAGEMENT SYSTEMS	LAND MOBILE RADIO
MICROWAVE TRANSMISSION	LOCAL AREA NETWORKS	
TELEPHONES ANSWERING MACHINES	WIDE AREA NETWORKS	
CABLE TELEVISION	VALUE-ADDED NETWORS	
CELLULAR RADIO	METRO AREA NETWORKS	
PBX, CENTREX, KEY STEMS		
DATA COMMUNICATION MODEM		

(C) ELECTRONIC COMPONENTS

ELECTRON TUBES	SOLID STATE PRODUCTS	ELECTRONIC PARTS
TELEVISION PICTURE TUBES	DISCRETE SEMICONDUCTORS	CAPACITORS
RECEIVING TUBES	INTEGRATED CIRCUITS	RESISTORS
POWER AND SPECIAL PURPOSE TUBES	OTHER SEMICONDUCTOR SERVICES	NETWORKS
		SWITCHES & RELAYS
HIGH VACUM, GAS AND VAPOR AND OTHER SPECIAL PURPOSE		ACCESSORY PARTS

TUBES		
ELECTRO-OPTICAL SERVICES		CONNECTORS
MICROWAVE TUBES		TRANSFORMERS
		QUARTZ DEVICES
		FILTERS
		PRINTED-CIRCUIT BOARDS
		WIRE AND CABLE

(D) ELECTRONIC-RELATED PRODUCTS AND SERVICES

MAIN	PHOTOGRAPHIC	OTHERS
AEROSPACE	PHOTOGRAPHIC EQUIPMENT	
AUTOMATIC CONTROLS	OPTICAL EQUIPMENT	CLOCKS AND WATCHES
SYSTEM INTEGRATION AND COMPUTER SERVICES		MUSICAL INSTRUMENTS
MOTOR VEHICLES		
ELECTRONIC-RELATED OFFICE EQUIPMENT		

Indeed, information and communication technologies (ICTs) are one of the most pervasive technologies in the world. However, they are superseded by the human brain in terms of intelligence or creativity. Thus, if it is assumed that wide diffusion of ICTs will occur and that African countries will possess extensive and well-functioning higher education sectors; then there is need for special skills and training consideration. In other words, there is need for a range of associated skills and training necessary to utilize, diffuse, maintain and benefit from them.

However, lifelong learning means that people must be able to move into and out of formal education institutions at different stages of their working lives. Thus, new forms of certification and accreditation that are not based on hierarchies among institutions of education are necessary. Yet, the major goal of any initiative to

implement ICT applications in African countries will be to ensure that the applications are perceived by their users as being useful.

Although, the internet system is universally available and affordable, technological change is continuous and frequently disruptive. Consequently, there are modern technologies that promise to be far-reaching in their impact on development. Specifically, as the next generation of mobile networks, 5G networks are expected to outperform current 4G networks by providing data at a speed several hundred gigabits per second. Even though mobile technology has been in early existence, it is its combination with the internet that makes it a disruptive force. As one of the technologies with potentially greatest impact for the developing world, African countries need to closely follow its development and eventual adoption. Similarly, Artificial Intelligence (AI) refers to computer systems that can perform tasks that normally require human intelligence (such as visual and speech recognition, decision making and language translation). Notably, faster computing, big data and better algorithms have helped propel recent breakthroughs in AI. While recognizing the potential risks of AI, such technologies can provide important insights and generate value in virtually every sector relevant to development. In fact, the benefits of AI are beginning to be seen in education (with personalized learning), in health (with deep diagnostics), in agriculture (with crop planning, precision farming and optimized resources application), in banking and finance (with customer service, risk management and compliance). However, advances in AI will prove to be disruptive, resulting in new opportunities for collaboration between humans and machines with loss of tradition jobs.

ROBOTICS refers to machines or mechanical systems that can automatically handle tasks. Generally, it is divided into two groups:

(A) Industrial Robots(automotive, chemical, rubber, plastics and food industries):

(B) Service Robots (logistics, medicine, elderly assistance, agriculture, floor – clearing, civil construction and exoskeletons).

Essentially, Robots can provide benefits through their computing power, precision, strength and sensing capabilities. While robots have been primarily used in physically difficult or dangerous jobs, they are becoming more advanced and gaining senses, dexterity and intelligence. In fact, they are more compact, adaptable and intelligent; have manipulation capabilities and able to work along with humans. Eventually, they may displace or augment humans (such as in low skilled areas and high – tech fields). Basically, demand for industrial robotics is driven by the desire

to reduce labor costs and the need for accuracy in undertaking repetitive process. Fortunately, Robots are not paid nor get sick and they can work as long as power remains constant. Again, they can take on dangerous or risky tasks such as detecting landmine. However, the deployment of robots is expected to rise as a function of their falling costs and growing intelligence.

THE INTERNET OF THINGS (IOT) refers to the interconnection of objects to internet infrastructure through embedded computing devices such as radio frequency identification (RFID) chips and sensors. Essentially, IOT products can be classified into five broad categories: wearable devices, smart homes, smart cities, environmental sensors, and business applications. Notably IOT is redefining service industry and unlocking opportunities in multiple areas:

(A) Smart fitness sensors and trackers are transforming healthcare and improving personal fitness and health.
(B) Embedded sensors accurately relay moisture, air and water pollution levels and resource levels while allowing for closer monitoring of environmental problems
(C) Factories and supply chains use smart sensors to improve the efficiency of manufacturing and distribution of goods.
(D) Marker spaces are created where people can gather to build and learn with electronics, software and digital fabrication. In fact, these spaces have democratized access to tools and participants empowerment to build and learn on their own.
(E) Combating climate change and its effects. Surely, African farms can use intelligent sensors to monitor soil conditions and guide autonomous irrigation systems.
(F) Smart traffic synchronization systems in cities can save on travel time and fuel consumption.
(G) Deployed smart networks can use global positioning systems (GPS), sensor information from monitoring, cameras and other sources to sense population movements, ease traffic congestion as well as the-rusting traffic in the case of emergencies. Clearly, it is evident that IOT has the potential to revolutionize the way people live, work, interact and learn.

3D PRINTING is a process where machines can print objects from digital files or scans which consist of adding successive layers of material to make a three

dimensional (3D) object. Given its transformational potential for manufacturing, this technology enables users to create smaller at batches of highly customizable products at declining prices. Recently, 3D printing has advanced to printing of body parts (titanium jaws, spines), exoskeletons, rocket parts as well as food. And given fallen prices, consumer – oriented devices have appeared on the market, allowing individuals to make three-dimensional solid objects locally (often using computer assisted design that can be downloaded from the internet). Usually, the link used in the printer is plastic but other materials (such as epoxy resin-silver, titanium, steel and wax) are equally available. Indeed, the revolutionary aspect of 3D printing can be found in its digital nature where physical objects become digital information that can be remixed, reformulated, improved and shared. Although desktop 3D printers are still relatively expensive, but as the performance improves and the cost of the printers and their inputs decline, it should be adopted by African countries. Specifically, the adoption of industrial printers for highly customizable objects that are relatively expensive and require replicable results. Essentially, this can be applied to the construction industry where 3D printed buildings can provide lower cost housing solutions as well as waste plastics conversion using on-demand manufacturing.

CRYPTOGRAPHY (CRYPTOLOGY) is the practice and study of techniques for secure communications in the presence of third parties (Known as adversaries). Basically, cryptography is about constructing and analyzing protocols that prevent third parties or the public from reading private messages. Here, various dimensions in information security (data confidentiality, data integrity, authentication and non-repudiation) are key features of modern cryptography. Essentially, the applications of cryptography include electronic commerce, chip-based payment cards, digital currencies, computer passwords and military communications. Clearly, cryptography is synonymous with encryption (conversion of information from a readable state to apparent nonsense).

Consequently, the originator of an encrypted message shores the decoding technique only with intended recipients to preclude access from adversaries. Theoretically, it is possible to break such a system but it is infeasible to do so by any known practical means. Therefore, these schemes are termed computationally secure mechanisms. On one hand, ENCRYPTION is the process of converting information (plaintext) into unintelligible form (Cipher text). On the other hand, DECRYPTION is the process of moving from the unintelligible cipher text back to plaintext. However, a cipher (cypher) is a pair of algorithms that create the

encryption and the reversing decryption. However, the detailed operation of a cipher is controlled by the algorithm and a secret key (which is a short string of characters needed to decrypt the cipher text). Thus, a cryptosystem is the ordered list of elements of finite possible plaintexts, finite possible cipher texts, finite possible keys as well as the encryption and decryption algorithms which correspond to each key.

Technically, there are two types of cryptosystems: Symmetric and Asymmetric. In Symmetric systems, the same secret key is used to encrypt and decrypt a message. In contrast, asymmetric systems use a public key to encrypt a message and a private key to decrypt it. Similarly, cryptanalysis is the term used for the study of methods for obtaining the meaning of encrypted information without access to the required keys. In other words, it is the study of how to crack encryption algorithms or their implementations. Unlike ancient cryptography of the 20^{th} Century (using linguistic and lexicographic patterns); modern cryptography makes extensive use of mathematics, information theory, computational complexity, statistics, combinatorics, abstract algebra, number theory, finite mathematics and engineering. Unlike classical traditional ciphers (letters or digits) which only encrypted written language texts; modern computer ciphers can be characterized by their operation on binary bit sequences (usually in groups or blocks).

Traditionally, a **BLOCKCHAIN** is a growing list of records (blocks) which are linked using cryptography. Here, each block contains a cryptographic hash of the previous block, a timestamp and transaction data (in the form of markle tree). Technologically, as n open distributed ledger that can record transactions between two parties efficiently in a verifiable permanent way; blockchains typically managed by a peer-to-peer network collectively adhering to a protocol for inter-node communication and validating new blocks. Here, once recorded, the data in any given block cannot be altered retroactively without alteration of all subsequent blocks (which requires consensus of the network majority). Basically, decentralized consensus has been claimed with a block chain. In fact, the invention of the block chain for **BITCOIN** made it to be the first digital currency to solve the double – spending problem without the need of a trusted authority or central server. As a blockchain formation, the main chain consists of the longest series of blocks from the genesis block to the current block.

Structurally, a block chain is a decentralized, distributed and public digital ledger that is used to record transactions across many computers so that any involved record cannot be altered retroactively, without the alteration of all

subsequent blocks. Consequently, this allows the participants to verify audit transactions independently (inexpensively) while using a peer-to-peer network as well as distributed time-stamping server. In fact, the use of a block chain removes the characteristics of infinite reproducibility from a digital asset. Here, block hold bathes of valid transactions that are hashed and encoded into a merkle tree while each block includes the cryptographic hash of the prior block in the block chain (using dual linkage process). Basically, this linked blocks from a chain. However, the blocktime is the average time it takes for them to generate one extra block in the block chain.

And by storing data across its peer-to-peer network, the block chain eliminates a number of risks that come with data being held centrally. Essentially, block chain security methods include the use of public-key cryptography (a long, random- looking string of numbers) as an address on the block chain. In contrast, a private key is like a password that gives its owner access to their digital assets or the means to otherwise interact with the various capabilities that block chain support. Generally, data stored on blockchain is considered incorruptible. Here, mining nodes validate transactions; add them to block building and then broad cast the complete block to other nodes. Indeed, the great advantage to an open (permission less or public) block chain network is that guarding against bad actors is not required and no access control is needed. This implies that applications can be added to the network without the approval or trust of others (using block chain as a transport layer). Operationally, block chain technology can be integrated into multiple areas; acting as a distributed ledger for crypto currencies (such as bit coin). It can also be used to create a permanent, public, transparent ledger system for compiling data on sales; tracking digital use and payments to content creators such as wireless users. Again, following the adoption of block chain, new distribution methods are available for the insurance industry (such as peer-to-peer insurance, parametric insurance and micro insurance) yet, the online voting and sharing economy is another application of the blockchain technology.

Absolutely, a public blockchain has no access restrictions and anyone with a network access can send transactions to it as well as becoming a validator (participating in the execution of a consensus protocol). On the other hand, a private blockchain is permissioned and one cannot join it unless invited by the network administrators (with restricted participant and validator access). However, a hybrid blockchain is a combination between different characteristics (both public and private blockchains) has by design. Depending on the hybrid blockchain, its architecture, multicloud solutions allow to store data in compliance with general

data protection regulation. Instead of keeping transactions inside their own network of community run on private nodes, the hash (with or without payload) can be posted on completely decentralized blockchains. Yet, by submitting the hash of a transaction (with or without the sensitive business logic) on public blockchains (such as bitcoin or ethereum) some of the privacy issues are resolved (since no personal identifiable information is stored on the public blockchain layers).

CRYPTOCURRENCY is a digital asset designed to work as a medium of exchange that uses strong cryptography to secure financial transactions; controlling of additional units creation as well as verification of assets transfer. Operationally, the decentralized control of each cryptocurrency works through distributed ledger technology known as blockchain which serves as a public financial transaction database. The summary of the evolution of cryptocurrency is shown in the table 3.2 below:

TABLE 3.2 CRYPTOCURRENCY EVOLUTIONS

S/N	YEAR	INVENTOR/MODUS	TYPOLOGY
1.	1983	AMERICAN CRYPTOGRAPHER AND DAVID CHAUM	ECASH
2.	1996/1997	NSA: MIT AND AMERICAN LAW REVIEW	CRYPTO ARTICLES
3.	1998	WEI DAI	E-MONEY
4.	1998	NICK SZABO	BIT GOLD
5.	1998	HALFINNEY	REUSABLE CURRENCY SYSTEM
6.	2009	SATOSHI NAKAMOTO	BITCOIN
7.	2011	SHA – 256 (HASH FUNCTION)	NUME COIN
8.	2011	SCRYPT (HASH-FUNCTION)	LITE COIN
9.	2011	HYBRID PROOF OF STAKE	PEER COIN
10.	2012	CRYPTOWORLD	ALTCOIN (BITCOIN ALTERNATIVES)
11.	2014	JORDAN KELLEY	ROBO COIN/BITCOIN ATM
12.	2017	BITCOIN FORKE	BITCOIN CASH (BTC)
13.	2018	RUGER VER JIHANWU	BITCOIN CASH ABC (TRADED)
14.	2018	CRAIG STEVEN WRIGHT CALVIN AYE	BITCOIN SV (TRADED)

Structurally, the validity of each cryptocurrency's coins is provided by a blockchain which solves the double-spending problem without the need of a trusted authority or central server. Thus, cryptocurrencies use various time stamping

schemes to “prove” the validity of transactions added to the blockchain ledger without the need for a trusted third party. Unlike the proof-of-work systems that run difficult hashing algorithms to validate electronic transactions; the proof-of-stake is a method of securing a cryptocurrency network and achieving distributed consensus through requesting users to show ownership of a certain amount of currency. Again, for the validation of transactions, successful miners obtain new cryptocurrency as a reward. On the other hand, a cryptocurrency wallet stores the public and private keys or addresses which can be used to receive or spend the cryptocurrency. Generally, cryptocurrency exchanges allow customers to trade cryptocurrencies for other assets while an initial coin offering (ICO) is a controversial means of raising funds for a new cryptocurrency venture. However, a cryptocurrency system in a decentralized network needs to overcome three main challenges:

I. How to establish a consensus in a distributed network?

II. How to discourage double spending behaviors?

III. How to encourage proper transaction validation?

Clearly, in the absence of a central authority, the cryptocurrency relies on a distributed verification of transactions, updating and storage of the record of transaction histories. This therefore necessitates that consensus between the user is maintained about the correct record of transactions. Finally, the legal status of crypto currencies varies substantially from country to country and is still undefined or changing in many of the countries. While some countries have explicitly allowed their use and trade, others countries may have restricted its operations.

Yet, since bitcoin, crypto assets have come a long way. In fact, what started as P2P (person to person) payment system has extended beyond the original designation of cryptocurrency. Indisputably, digital currencies can now be used for more than merely paying for goods and services. Thus, there are several use cases for crypto assets that demonstrate the extent of the fintech revolution and these include Digital Cash System, Programmable Money Contracts, Collateral Securities, Governance networks and Collectible Assets. Surely, crypto-currencies are still evolving and hence many of the envisioned use cases are yet to fully materialize. Notably, security tokens, hybrid tokens, derivatives, crypto commodities, privacy coins, stable coins, work tokens, discount tokens and other digital assets are yet to be established. However, these assets are likely to gain a foot hold as crypto adoption increases and ecosystem matures. In other words, the crypto space has evolved in leaps and bounds over the past decade. But for the future trend, it is anticipated that crypto assets will be serving functions that are yet to envisage or design.

4.0 AFRICA: DIGITAL EVIDENCES

Indeed, over the past decades, there has been much debate about the potentials of information and communication technology for development. In fact, it has been argued that ICTs create new modes of connectivity and enable the integration of the marginalized businesses and regions into commercial value chains in the globalized world.

Consequently, large programs and activities have been brought into being by private firms, donors, small business and national governments using ICTs to integrate their local economies into global markets (UNDP, 2012). However, the discourses on Africa's lack of development firmly resolve around the idea of global connectivity. But remedies are underway and Africa's connectivity is being addressed in various domains (at various scales) inside and outside of the continent. Notably, a more connected Africa lies at the core of many contemporary development programs. Similarly, Africans seems to be developing connectivity from within while some parts of Africa are being hailed as new frontiers of locally grown technological innovations. In fact, Africa may be experiencing a boom in technology entrepreneurship. Thus, high hopes have been invested in the continent's home-grown digital economy; envisioned to become an engine of rapid socioeconomic development and transformation.

Specifically, within Africa, iHub in Nairobi (2010) was the first widely recognized organization using the hub nomenclature. Here, the main purpose of iHub was to connect individuals scattered around Nairobi while allowing them to collectively develop and implement ideas. Although Nairobi had a growing virtual tech community, they needed a physical space in which to interact, collaborate and gain more respect and attention from the outside world. In other words, it is all about getting cool people into a cool place with the goal of having something cool happen. However, the ambition behind iHub was fueled by the aspiration that Kenya and other African countries (following the arrival of broadband connectivity) could catch up with and become more closely connected to the Global North-West (Graham and Man, 2013). Basically, the ideology was that through iHub, the technology community, industry, academic, investors and venture capitalists could meet, share ideas and collaborate and thus transform their ideas into actions. In other words, the iHub "brand" was meant to provide "exposure" for innovators by pooling and providing access to opportunities such as jobs, freelancer group contracts or training. Here, the hub's community was structured to enable

knowledge sharing and mentorship thereby raising the skill levels of members (such as University graduates).

In general, iHub was meant to be a place that attracted visits from local technology business people and representatives of international technology corporations while allowing young Kenyan innovators (occupying the hub) to make connections that they could not make otherwise.

Essentially, the iHub organizers look for gaps in the local business ecosystem and try to fill them. And yet through the conceptual blending of connections made within the hub and those existing in its environment; iHub was envisioned to have positive effects on the local, national and regional level. Clearly, this vision proved hugely appealing for a range of actors seeking technology-driven economic development in Africa with ihub quickly living popularity and acceptance (Hersman, 2012).

Subsequently, the confluence of several events and dynamics allowed the spread across Africa of organizations similar to iHub (resulting in at least partial recognition of hubs as a distinct organizational form). In fact, several organizations were founded after iHub (in 2010 and 2011). These include ACTIVE SPACES of Cameroon, KLAB of Rwanda, KINU of Tanzania, HIVE COLAB of Uganda, BON GOHIVE of Zambia, NAILAB of Kenya, BONTA LABS of Senegal, and CCHUB (Co-creation) of Nigeria.

However, some of the above national labs formed AFRILABS (a network of tech innovation hubs in Africa) with the mission to build the capacity of hubs which support the growth of tech communities around them.

Comparatively; it is akin to a traditional business association with independent member organizations. Geometrically, hubs were affirmed as an important Africa-wide phenomenon through widely noted stock-taking exercises as shown in table 4.1 below. In general, in the context of increasing attention from media and development organizations, iHub's vision of being a positive contributor to local economic development became attributed to African hubs. Unfortunately, hubs have consistently been understood to consist of a Wi-Fi-connected space with hot desks and meeting rooms, allowing for Laptop-based work. Here, activities have been described as including events, presentations, small innovation competitions, group meetings on topics of interest, training and mentorship sessions. Consequently, two divergent macro-level grand discourses about African hubs (as an organizational form) have developed out of the original ihub conceptualization. These are Network infrastructure expectation and incubator expectation. However, these expectations are not entirely contradictory. Rather, the distinction is their

implied level of optimism about hubs and the degree to which they retain elements from

TABLE 4.1 AFRICAN HUBS: SELECTED REGIONAL LOCATIONS

S/N	COUNTRY	HUBS LOCATIONS	PROTOTYPE
1.	MORROCO	JOKKOLABS CASABLANCA NEWWORK LAB GIRLS IN TECH (MORROCO CHAPTER) OCP ENTREPRENEURSHIP NETWORK	CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED HYBRID
2.	SENEGAL	JOKKOLABS DAKAR CTIC DAKAR AFRICA URING LAB MOBILE SENEGAL JJIBUENE TECH HUB	CIVIL SOCIETY LED CIVIL SOCIETY LED ACADEMIC INSTITUTION LED HYBRID CIVIL SOCIETY LED
3.	GAMBIA	JOKKOLABS BANJUL WOE LAB	CIVIL SOCIETY LED CIVIL SOCIETY LED
4.	LIBERIA		
5.	COTE D'VOIRE	JOKKOLABS ABIDJAN THE WHUB AKENDEWA AMN CO-WORKING SPACE MWASI TECH HUB	CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED
6.	GHANA	MFRIDAY MELTWATER ENTREPRENEURIAL SCHOOL OF TECHNOLOGY (INCUBATOR) GSPACE LSPACE GHANA MULTIMEDIA INCUBATOR CENTRE MOBILE WEB GHANA KUMASI BUSINESS INCUBATOR OGUAA BUSINESS INCUBATOR HUB ACCRA	CIVIL SOCIETY LED ACADEMIC INSTITUTION LED CIVIL SOCIETY LED CIVIL SOCIETY LED GOVERNMENT LED CIVIL SOCIETY LED HYBRID CIVIL SOCIETY LED HYBRID
7.	TOGO	MARA LAUNCH PAD	CIVIL SOCIETY LED
8.	BENIN	E-TRILARS JOKKOLABS COTONOU	CIVIL SOCIETY LED CIVIL SOCIETY LED
8. A	ETHIOPIA	ICEADDIS X HUB	ACADEMIC INSTITUTION LED CIVIL SOCIETY LED
9.	NIGERIA	L5LAB CO-CREATION HUB WENNOVOTION HUB TECHNOLOGY INCUBATION CENTRE MINNA TECH INCUBATION CENTRE INFORMATION DEVELOPERS ENTREPRENEURSHIP ACCELERATION/IDEA FOCUS HUB	CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED GOVERNMENT LED GOVERNMENT LED HYBRID CIVIL SOCIETY LED HYBRID GOVERNMENT LED

		ENSPIRE INCUBATOR CALABAR TECHNOLOGY INCUBATION CENTER BB MPH (400 N6)	HYBRID
10.	TUNISIA	WIKI START UP	CIVIL SOCIETY LED
11.	MALI	JOKKOLABS BAMAKO	CIVIL SOCIETY LED
12.	BURKINA FASO	YAM PUKRI JOKKOLABS OHAGADOU GOU	CIVIL SOCIETY LED CIVIL SOCIETY LED
13.	CONGO REPUBLIC	BANTU HUB	CIVIL SOCIETY LED
14.	CONGO DEM. DE PUBLIC	IMANI HUB	CIVIL SOCIETY LED
15.	ANGOLA	ANGOLAN INSTITUTE OF SUPPORT FOR MICRO, SMALL AND MEDIUM ENTERPRISE (INAPEM) (ICT INCUBATOR)	GOVERNMENT LED
16.	ZAMBIA	BONGOHIVE ZAMBIA	CIVIL SOCIETY LED
17.	NAMIBIA	NAMBIA BUSINESS INNOVATION CENTRE (NBIC)	ACADEMIC INSTITUTION LED
18.	BOTSWANA	BOTSWANA INNOVATION HUB FIRST STEPS VENTURE CENTER	GOVERNMENT LED HYBRID
19.	CAMEROON	ACTIVE SPACES	CIVIL SOCIETY LED
20.	UGANDA	HIVE COLAB CTHEHUB QUTBOX HUB GRAMEEN FOUNDATION APPLAB WOMEN IN TECHNOLOGY UGANDA (WITU)	CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED
21.	SOUTH AFRICA	JOZIHUB CAPETOWN GARAGE BLACK GIRLS CODE THOUGHT WORKS TECHNBRAAM SILCON CAPE INITIATIVE IMPACT AMPLIFIER CODEBRIDGE ANGEL HUB EASTERN CAPE INFORMATION TECHNOLOGY INITIATIVE CAPE INNOVATION AND TECHNOLOGY INITIATIVE (CITI) SMART XCHANGE CODEDINBRAAM SOFTSTART TECHNOLOGY THE HOUSE 4 HACK MLAB SOUTHERN AFRICA START-UP GARAGE/9BMPH IMPACT HUB R FABS	CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED HYBRID CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCITY LED CIVIL SOCIETY LED HYBRID CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED HYBRID CIVIL SOCIETY LED CIVIL SOCIETY LED HYBRID GOVERNMENT LED

		INVO TECH INCUBATOR THE INNOVATION HUB (T/H) STARTUP 90 GRINDSTONE	CIVIL SOCIETY LED GRIND STONE
22.	MADAGASCAR	1 – HUB MALAGASY 2 – HABAKA	CIVIL SOCIETY LED CIVIL SOCIETY LED
23.	EGYPT	CAIRO HACKSPACE THE DISTRICT PLATE LABS ICE CAIRO FAB LAB EGYPT THE GREEK CAMPUS TECHNOLOGY INNOVATION ENTREPRENEURSHIP CENTER ALEXANDRA HACKER SPACE	CIVIL SOCIETY LED CIVIL SOCIETY LED HYBRID CIVIL SOCIETY LED CIVIL SOCIETY LED HYBRID GOVERNMENT LED CIVIL SOCIETY LED
24.	ZIMBABWE	SKY HUB INITIATIVE HYPERCUBE HUB MUZINDA UMUZI HUB	CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED
25.	MOZAMBIQUE	MICTI TECHNOLOGY AND BUSINESS CENTRE	GOVERNMENT LED
26.	KENYA	IHUB MLAB EAST AFRICA GROWTH HUB MAILAB C40 LAB AKIROCHIX LAKE HUB IBIZ AFRICA ILAB AFRICA FABLAB NAIROBI 88MPH/STARTUP GARAGE	CIVIL SOCIETY LED HYBRID CIVIL SOCIETY LED CIVIL SOCIETY LED CIVIL SOCIETY LED ACADEMIC INSTITUTION LED CIVIL SOCIETY LED CIVIL SOCIETY LED ACADEMIC INSTITUTION LED ACADEMIC INSTITUTION LED HYBRID
27.	RWANDA	KLAB THE OFFICE THINK TECHNOLOGY INCUBATOR	HYBRID CIVIL SOCIETY LED CIVIL SOCIETY LED
28.	TANZANIA	KINU INNOVATION AND CO-CREATION SPACE TANZICT DAR TEKINO HANZA BUSINESS INCUBATOR BUNI HUB	CIVIL SOCIETY LED HYBRID CIVIL SOCIETY LED CIVIL SOCIETY LED

The more elaborate hub vision that iHub had established. Here, while the network infrastructure expectation assumes that startups are created within wider ecosystem (which the hub supports), the incubator expectation assumes direct creation of hubs ventures. Therefore, for hubs to lead to better outcomes, implementers and funders should move beyond the hype (acknowledging the indirect and indeterminate nature

of hub outcomes) and working toward a more grounded understanding of what hubs can and cannot do for African technology entrepreneurs.

Indeed, the advent of the internet in the mid-1990s stimulated the rapid diffusion of e-government systems to automate core administrative tasks;, improve the delivery of public series and promote transparency and accountability. Consequently, African countries have invested more in core government administration systems (such as financial management, customs, tax management) than in transactional government to citizen and government to business services. However, emerging evidence suggests that digital technologies have made elections freer and fairer by improving voter registration and reducing error in voting as well as better monitoring so as to curb electoral fraud and violence. But significant barriers to more informed voting remains since digital technologies (by giving elites new ways of manipulating information to their advantage) can also disempower the poor.

Again, digital citizen voice initiatives for improving services delivery have multiplied rapidly but the focus is on digital channels that are initiated by civil society organizations and donors to pressure governments. Here, the African analysis distinguishes fire cases by whether the mechanism for expressing citizens preferences is individual or collective; whether the CSO or donor that led the initiative also had explicit partnerships with the concerned government; and whether there was also parallel offline mobilization accompany the digital voice channel as shown in table 4.2 (world bank, 2016). Here, impact is measured in two ways: citizensuptake (given that uptake can be considered a necessary condition for government responsiveness) and government action to resolve the service issue (as the ultimate object of the citizen voice initiative).

TABLE 4.2 AFRICAN DIGITALCITIZENENGAGEMENT: CLASSIFICATION CASES

S/N	CASE	LOCATION	ADDITIONAL OFFLINE MOBILIZATION	CSO PRAISE WITH GOVERNMENT	COLLECTIVE FEED BACK	IMPACT	
						CITIZEN UPTAKE	GOVERNMENT RESPONSE
1.	LUNGISA		YES	YES	NO	LOW	HIGH
2.	U.REPORT	UGANDA	YES	YES	YES	HIGH	LOW
3.	HUNDUMA	KENYA	NO	NO	NO	LOW	LOW
4.	DARAJ MAJI MATONE	TANZANIA	YES	NO	NO	LOW	LOW
5.	SAUTI ZA WANANCHI	TANZANIA	NO	YES	NO	LOW	LOW

As a public good, IDENTITY is now recognized as a sustainable Development Goal (SDG) target and the best way to achieve this goal is through digital identity (digital ID) systems, central registries storing personal data in digital form as well as credentials that rely on digital mechanisms to authenticate holders identity. Operationally, some African countries have some form of digital ID scheme tied to specific functions and serving a subset of the population. However, only few countries have a multi-purpose scheme that covers the entire population. Yet, unlike developed countries, African countries often lack robust civil registration systems and physical IDs while building their ID systems on a digital basis as well as leap frogging the more traditional physically based system. Here, identification (rather than e-services) is the major goal and the potential risk associated with leap frogging to civil identification system is that in many cases, the youngest population (0-18) is excluded and continues to be unregistered. Indeed, evidence of the impact of digital ID is still scanty but there are noticeable effects in three areas:

I. Efficient management of social welfare programs,
II. Removing ghost workers from government payroll and
III. Improving the sanctity of elections.

Specifically, the benefits of digital ID in reducing the leakages for social protection or security programs, health insurance and pension schemes due to duplicates, ghost beneficiaries and corruption are occurring in Egypt, Ghana and South Africa. Again, Nigeria recently implemented a digital ID system for civil servants that enabled it to remove about Sixty-two thousand ghost workers while saving about one billion dollars annually (Celb and Clark, 2013). Similarly, Nigeria used digital IDs to prevent vote rigging in her 2015 elections. Practically, the system enrolled about Sixty-eight million voters using biometrics and card readers to authenticate voters (and hence preventing duplicate votes). Although there were some operational challenges at the polls, the election was fairly conducted. However, other countries such as Kenya and Somalia may not have reaped the same benefits from the biometric voter IDs. In fact, digital ID schemes tend to be complex and often politicized which are subject to failure to deliver on high expectations. Thus, for a digital ID system to be effective, it must be rooted in an upgraded legal framework that considers the accessibility and protective measures of the system. Other factors include clear definitions for the interconnectively and interoperability with other registries and coordinated investment in ICT throughout the country so as develop a reliable and secured platforms.

Indeed, the internet and associated technologies have the potential to expand health services in African countries, increase health system efficiency and lead to better patient outcomes. Operationally, E-health encompasses the full range of uses of information and communication technologies ranging from traditional administrative reporting systems to broader Health Management Information

Systems (HMIS) to telemedicine, electronic medical records, clinical decision support and patient portals as well as full range of technologies including internet and mobile applications. As an African case study, the Ethiopian government had previously trained and deployed over forty thousand Health Extension Workers to serve rural and other hard-to-reach populations (Bilal, et-al 2011). However, these workers are often isolated and lack the capacity to prioritize urgent but unpredictable antenatal and postnatal care. Thus, to improve information flows, Ethiopian development partners developed the Frontline SMS platform. Using this tool, the health workers can register pregnant women and newborns; receive automated short message service (SMS) reminders to notify them of key appointments as well as tracking the stock of essential medicines.

Clearly, an evaluation of the new tool showed that by using existing mobile networks and low-cost feature phones; the system improved the ability of health workers to deliver services and improve health outcomes. Specifically, more women had skilled assistance with their delivery, more women delivered in health centres while other women received antenatal care. The new system also improved health workers capacity to respond in a timely manner and showed that in a context (where internet coverage is low) mobile phones can be an effective way to improve health system performance. In general, replacing paper-based patient registers with electronic registers could help improve local health care quality and inform management decision making. Again, increasing the use of e-health and m-health approaches and tools can support improved decision making by frontline providers inclusive of GPS-enabled tools and harnessing the revolution that smart phone access to broadband content will bring about in African countries. Consequently, more emphasis is needed to expand and improve the use and functionality of open-source software platforms as well as supporting open source frameworks.

Essentially, DIGITAL FINANCE makes businesses more productive and allows individuals to take advantage of opportunities in the digital world which helps streamline public sector service delivery. However, more than two billion people have no access to any financial services. Therefore, digital payment systems help overcome barriers to accessing financial services. Specifically, mobile money schemes allow people who own a phone but do not have a bank account to make and receive payments. In fact, theses systems can take off and reach massive size rapidly. For example, the Nigerian 2012 Growth Enhancement Support Scheme introduced mobile technology to transfer fertilizer subsides directly to farmers. Evidently, this action took the Nigerian government out of the business of procuring and distributing fertilizer. In fact, the adopted transfer system relied on a database of more than ten million farmers (as registered recipients of the subsidies) who now have a better chance of gaining access to formal or regulated financial services (Grossman and Tarazi, 2004). However, there are four major innovations in digital payments: Wrappers (credit cards), Mobile Money System (M-PESA), Credits and local digital currencies (alternative units) and Digital Currencies (Bitcoin or

cryptocurrencies). Practically, in contrast to cash, electronic transfer could leave a trail that can aid low enforcement. In other words digital technologies could also help establish registries of beneficial ownership of financial and commercial holdings and transaction monitoring systems. Thus, the opportunities of digital finance for inclusion, efficiency and innovation will likely outweigh the negative risk factors.

Statistically, Africa ranked among the largest continent in mobile penetration with a higher growth rate of mobile phone subscribers whereas there are a lower number of bank branches. Yet, Africa has witnessed a very high growth of cellular phones usage that was around six hundred and fifty million customers in 2012. Here, the banking services started slowly in 2000 in Zambia and South Africa (which launched the biometrical payment system in 2012). Since then, there has been a rise of other countries such as Kenya with the launch of M-PESA (a money transfer through SMS) and M-Shwari (a banking service without folders). However, the informal finance which appears to be important in the African context can be reabsorbed by the formal system which allow data availability and good investment as well as well informed governmental financial policy implementation (Nguena, 2017). Although mobile banking in Africa is at its infancy, mobile penetration is influenced by regulation in the mobile phone market whereas mobile banking is influenced by regulations in the banking industry.

Indeed, research evidence has shown that sub-saharan Africa is the only region where the share of adults with a mobile money account exceeds ten percent between 2014 and 2017. However, as at 2014 East Africa was the region's mobile money hub. Yet, mobile money accounts have since spread to new parts of sub-saharan Africa. In fact, the share of adults with a mobile money account has now surpassed thirty percent in Cote d'voire and Senegal as well as forty percent in Gabon (World bank, 2017). Table 4.3 shows comparative African financial indicators.

TABLE 4.3 COMPARATIVE ACCOUNT OWNERSHIP (2017): SELECTED AFRICAN ECONOMIES

A	B	C	D	E
S/N	**ECONOMY**	**ADULTS WITH AN ACCOUNT**	**GAP BETWEEN MEN AND WOMEN (%)**	**GAP BETWEEN RICHER AND POORER (%)**
1.	ALGERIA	43	27	13
2.	BENIN	38	20	11
3.	BOTSWANA	51	09	27
4.	BURKINA FASO	43	17	27
5.	CAMEROON	35	09	16
6.	CENTRAL AFRICAN REPUBLIC	14	08	08

7.	CHAD	22	14	13
8.	CONGO DEM. REP	26	-	14
9.	CONGO REP	26	10	13
10.	COTE D'IVOIRE	41	11	12
11.	EGYPT, ARAB REP	33	12	21
12.	ETHOPIA	35	12	21
13.	GABON	59	10	15
14.	GHANA	58	08	16
15.	KENYA	82	08	18
16.	LIBERIA	36	15	15
17.	MALAWI	34	08	21
18.	MALI	35	20	07
19.	MAURITANIA	21	11	13
20.	MAURITIUS	90	06	06
21.	MOZAMBIQUE	42	18	25
22.	NAMIBIA	81	-	17
23.	NIGER	16	09	08
24.	NIGERIA	40	24	25
25.	SENEGAL	42	08	13
26.	SOUTH AFRICA	69	-	11
27.	TANZANIA	47	09	16
28.	TOGO	45	15	18
29.	TUNISIA	37	17	26
30.	UGANDA	59	13	20
31.	ZAMBIA	46	11	24
32.	ZIMBABWE	55	08	19
33.	UNITED KINGDOM	96	-	-
34.	UNITED STATES	93	-	13

NOTES: (I) Only statistically significant gaps are shown

(II) Gaps that fall within the reported margin of error in an economy are considered to be statistically insignificant indicated by the use of a dash.

(III) Gaps in account ownership between adults in the richest sixty percents of households and those in the poorest forty percent.

(IV) Data are based on household income quintiles.

SOURCE: Global Findex Database

5.0 AFRICAN ECONOMIES : DISRUPTIVE RESPONSES

Indeed the potential gains from technological progress for workers and consumers in African countries are large. Specifically, these gains of digital technologies are as follows:

A. They can create jobs and increase earnings in the small information and communication technology (ICT) sector as well as sectors that use ICT
B. They can increase worker productivity by augmenting human capital and (especially critical for the poor) connecting people to work and markets
C. They can also benefit consumers by lowering prices and expanding the variety of goods and services available to consumers.

However, while digital technologies can raise productivity and enhance overall welfare, associated labormarket disruptions can be painful and can result in higher inequality between high-skilled workers and unskilled workers. Yet the impact of digital technologies on jobs depends on the type of tasks and how technology either complements or substitutes workers in those tasks. In fact, a job comprises many tasks and each characterized by the skills most used to perform it. These include cognitive, socio-emotional or manual skills and by how amenable it is to automation or codification. In other words, technology is skill-based while technological progress makes the jobs challenge more complex. Since digital technologies have different applicability to different kinds of work, the extent of disruption across countries will reflect differences in economic and occupational structures.

For instance, numerical clerks or secretaries (often users of digital technologies) also perform many tasks that can be easily automated. By contrast managers or software developers while intensively using digital technologies complement them by way of not easily substituted by machines and for occupations that use little technology some are hard to automate such as Hair dressers while others could be automated such as Assemblers (as shown in figure 5.1).

Comparatively, more advanced economics can expect larger disruptions in the near future since they use more technology at work and are experiencing faster changes in skill requirements (Crafts 2015). And while they have smaller shares of employment in routine occupations susceptible to automation; their higher wages make it easier for automation to be economically viable. On the other hand, low-and middle income countries can also expect substitution disruptions (with a time lag) given their rapid technological adoption and large number of workers in routine

occupations. However their low skill base suggests critical challenges ahead. But in poorer countries (like Africa) where wages are lower and technological adoption is slower while the disruptions are like to arrive slowly; and hence giving more time for policies and institutions to adapt. Basically all this has implications for countries to develop modern skills among children and youth as well as coming up with a strategy of the retraining and lifelong learning of the current stock of older workers.

Consequently, the current challenge is to start reforms to maximize the digital dividends and to prepare for any disruptions. However, skill systems vary widely and not all are prepared to equip workers with skills that complement technology. Therefore, this process needs to start very early in life since education and training systems are notoriously difficult to change. Thus, any reform takes many years to have effects which explain the race between skills and technology. In fact, the confluence of two digital forces will dramatically reshape tomorrow's workplace that leads to a sharp reduction in the reduction in the traditional employer-employee relationship. Here, new platforms will allow economic activity to be organized in ways that shift much of what was traditionally accomplished by full-time workers within an organization to a crowd of individual entrepreneurs and on-demand workers. The implication being an economy that increasingly relies on short-term freelance relationships rather than on full-time employments.

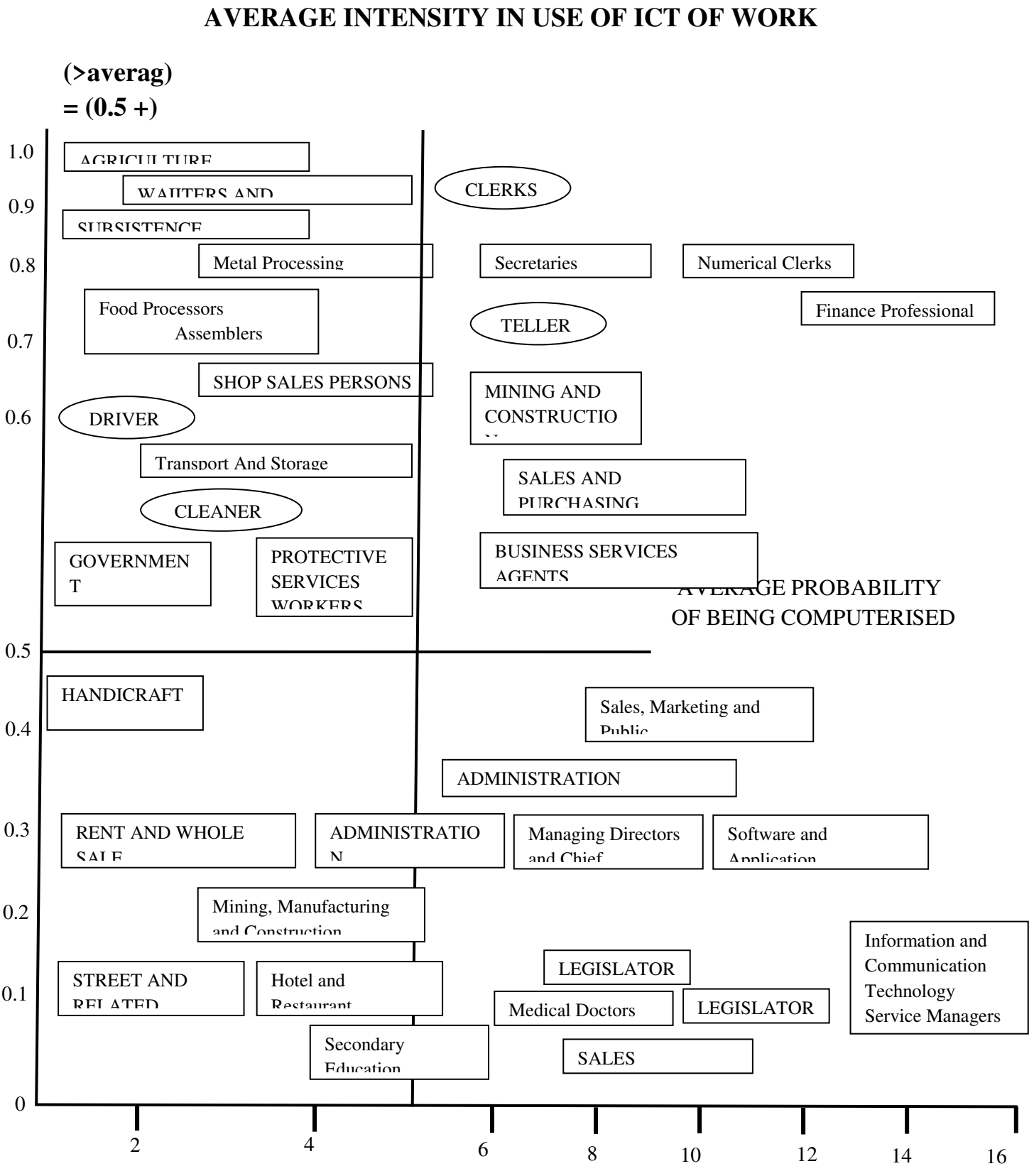
Again, artificial intelligence and robotics enabled technologies are getting increasingly better at the cognitive and physical tasks that comprise much of today's work; presaging the automation of complex human activities (such as vehicle driving or project management) as well as disrupting a range of occupations (such as law, consulting, retailing or transportation). Thus, the confluence of all these factors leads to a labor market in which full-time jobs may be broken up into tasks and projects. Operationally, this will make it easier to substitute capita in the form of automation technologies for human labor and talent. Indeed, such a future of large scale crowd-based capitalism will require fundamental rethinking of postsecondary education. This, to help those workers, new university like institutions are needed to provide structure and pedagogically sound transition education. In fact, as the cognitive capabilities of digital change expand, students may need less education in STEM courses while benefits from a greater emphasis on design thinking, entrepreneurship and creativity to prepare them for a micro-entrepreneurial career.

Yet the challenges facing present millennial workforce seem quiet daunting. Perhaps as digital machines compel us to reshape our world of work; they will also

show a path toward the more equitable society as desired. Thus in response to this confluence of a need for more jobs in places where they do not currently exist and the spreading of digital connectivity among billions of the world's population: millions of people have turned to outsourced digitally mediated work as a way to transcend some of the constraints of their local labor markets. In fact, many governments, third sector organizations and private sector actors see significant developmental potential in digital labor. Here, jobs can be created for some of the worlds poorest by taking advantage of connectivity and the willingness of an increasing number of firms to outsource business processes. In other words, anyone can do any work from anywhere and this could bring significant economic benefits to workers in parts of the world where good job are hard to come by. However the nature of the actual transaction and information costs in market exchanges are important in exploring disintermediation and digital technologies (as shown in table 5.1). Clearly, the property rights approach highlights additional directions for deeper scrutiny of digital technologies in terms of the nature of transactions, underlying institutions and digitally driven externalities that are crucial in characterizing how disintermediation practically occurs (Foster and Graham, 2017).

Perhaps creating formal jobs may be the best policy that is consistent with the global agenda to seize the benefits of technological change. Unfortunately, in many African countries, most workers remain in low-productivity employment (usually in the informal sector with little access to technology) while lack of quality private sector jobs leaves talented young people with few pathways to wage employment. Thus for societies to benefit from the potential that technology offers thy would need a new

FIGURE 5.1 TECHNOLOGY AND JOBS INTERACTION BY OCCUPATION VARIATIONS: PROBABILITY OF BEING COMPUTERIZED AND INTENSITY IN USE OF ICT WORK



(4 –) = (< Average) INTENSITY IN USE OF ICT OF WORK (TECHNOLOGY COMPLEMENTING WORKERS)

NOTES: (I) The probability of being computerized is obtained from Frey and Osborne (2013)

(II) ICT intensity is an index between O (no use of technology) and 16 (most use of technology)

(III) ICT implies information and communication technologies.

(IV) Inserted lines represent the average values of ICT intensity (X-GXIS) and of computerization (Y-axis) across the pooled sample of countries with STEP household surveys (World Bank, 2016).

TABLE 5.1 DIGITAL INFORMATION DISINTERMEDIATION: TRANSACTION COST PERSPECTIVES

S/N	UNDERLYING APPROACH	KEY CONCEPTS	PERSPECTIVES ON DIGITAL INFORMATION, TRANSACTIONS AND DISINTERMEDIATION
1.	NEOCLASSICAL	a) Drivers and Constraints of Market Exchange	Explore how transaction costs of market exchange change as a result of improved information flows I) Information cost affected by digital information flows II) Ability of ICT/Digital connectivity to disintermediate III) Disintermediation through digital platforms IV) Constraints in Digitally enabled exchange (competition rules)
2.	Property Rights	a) Nature of Transactions	Examine underlying properties of transactions and how they affect digitally enabled transactions I) Shared resources, product requirements II) Complexity of transactions and ability to ascertain and monitor quality
3.		b) Institutional Frameworks	Explore Digital information within a constellation of rules rights, and norms that orient transactions I) Underlying rights and norms that characterize exchange which affects digitally enabled transactions

			II) Nature and makeup of institutional Bodies III) Potential use of strategy and power in orienting Digital transactions
4.		c) EXTERNALITIES	Explore the spillover effects of digital information flows and problems. I) Impact on other elements of transaction costs II) Digital disintermediation and reintermediation

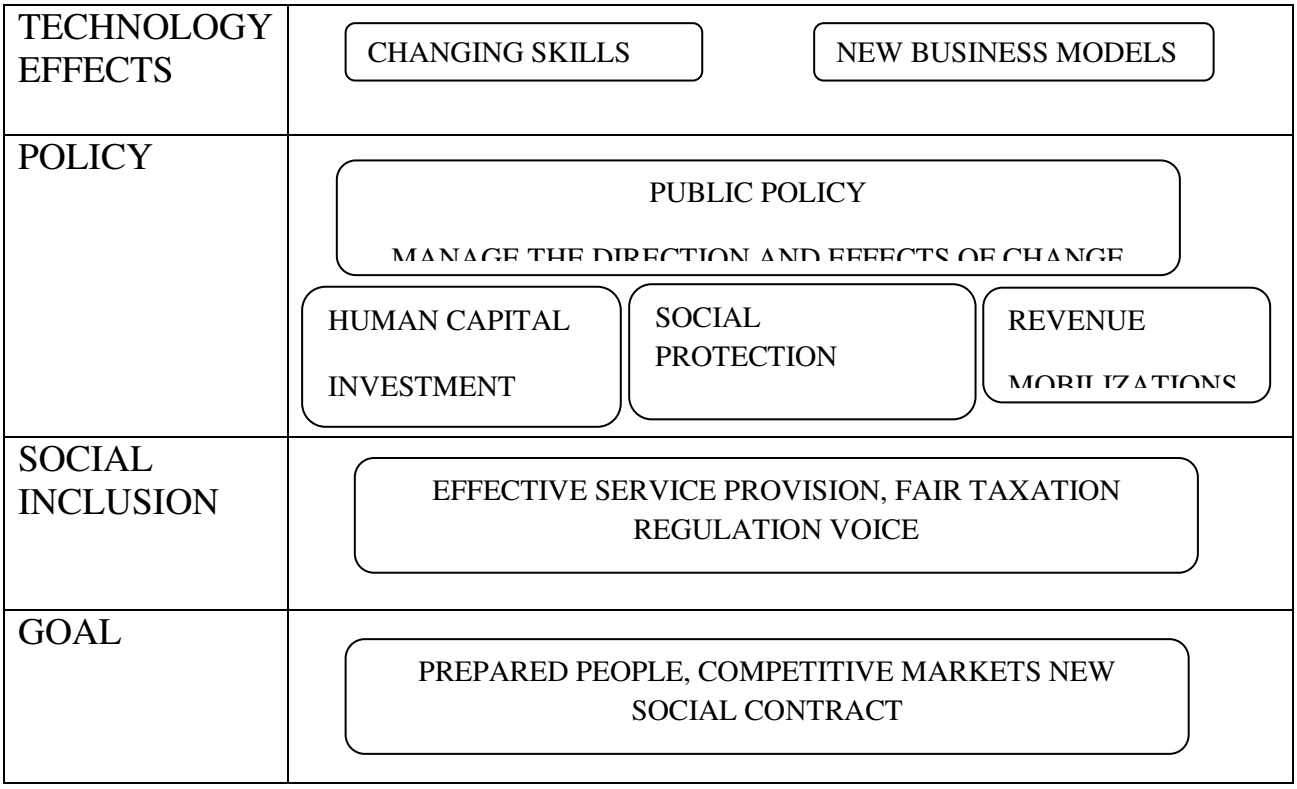
social contract centered on larger investments in human capital and progressively provided universal social protection (as shown in figure 5.2). However, social inclusion requires fiscal space and many African countries lack the finances because of inadequate tax bases, large informal sectors and inefficient administration (World Bank, 2019). In-fact, the advent of a jobless economy raises concern because tasks traditionally performed by humans are being (or are at risk of being) taken over by robots, especially those enabled with artificial intelligence. Comparatively, young workers may be more affected by automation than older workers.

However, technological progress leads to direct creation of jobs in the technology sector. Here, people are increasingly using smart phones, tablets and other portable electronic devices to work; organize their finances, etc. Here, workers create the online interfaces that drive growth and with consumer interest changing fast; there are more opportunities for careers in mobile app development and virtual reality design. Also, technology has facilitated the creation of jobs through working online or joining the gig economy. Similarly, technology increases proximity to markets while facilitating the creation of new efficient value chains. In other-words, during the process of technology adoption, some workers will be replaced by technology while workers involved in routine tasks that are 'codifiable' are the most vulnerable as well as some service jobs that are vulnerable to automation. Several examples include Robot industrial workers, Robot financial Analysts, Robot lawyers, Autonomous Buses and Driverless vehicles.

Indeed, technology is changing the skills being rewarded in the labor market. Here, the premium is rising for skills that cannot be replaced by robots: general cognitive skills such as critical thinking and socio-behavioral skills such as managing and recognizing emotions that enhance team work. Clearly, workers with these skills are more adaptable in labor markets. Similarly, technology is also disrupting production processes by challenging the traditional boundaries of firms;

expanding global value chains as well as changing the geography of jobs. Again technology is changing how people work by giving rise to the gig economy in which organizations contract with independent workers for short-term engagements.

FIGURE 5.2 WORK DYNAMICS AND RESPONSES



Basically, technology is disrupting the demand for three types of skills in the workplace:

I) Demand for Non-routine cognitive and socio-behavioral skills appears to be rising

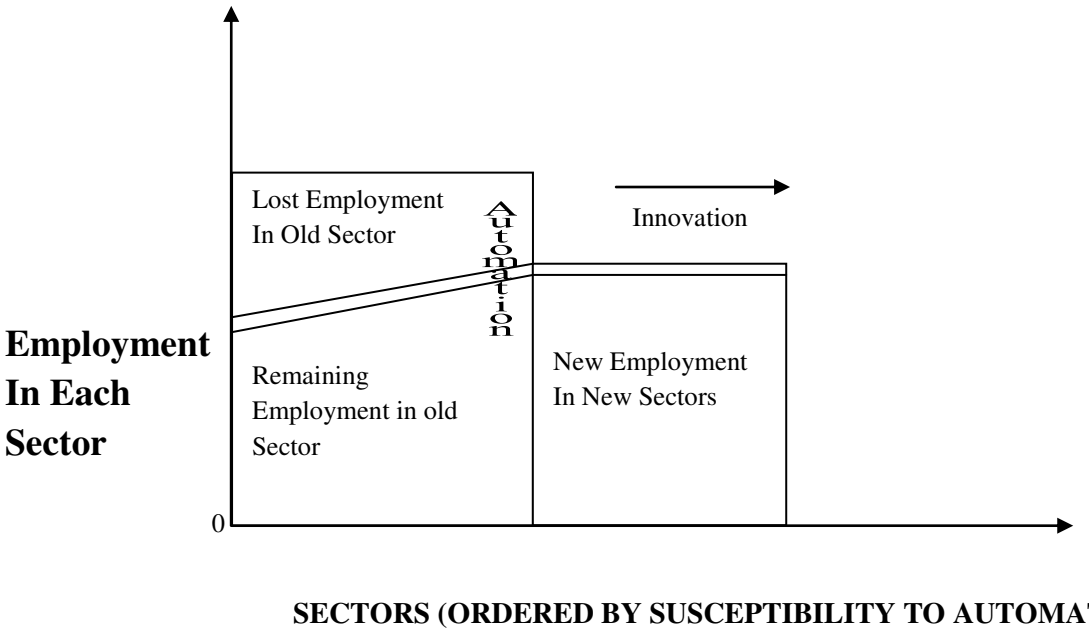
II) Demand for routine job-specific skills is declining

III) Payoffs to combinations of different skills types appear to be increasing.

However, these changes show-up not just through new jobs replacing old jobs; but also through the changing skills profile of existing jobs (World Bank, 2019). Operationally, digital technologies are enabling firms to automate (replacing labor with machines in production) and to innovate (expanding the number of tasks and products). Consequently, the future of work will be determined by the battle between automation and innovation (as shown in figure 5.3). Clearly, in response to automation, employment in old sector decline while in response to innovation, new sectors (tasks) emerge. Thus, the overall future of employment depends on both as well as depending on the labor and skills intensity of the new sectors or tasks that emerge (which in turn affect wages).

Consequently, automation has disproportionately reduced the demand for less skilled workers while the innovation process has generally favored the highly educated workers. Therefore, a big question is whether workers displaced by automation will have the required skills for new jobs created by innovation. Even though low-wages countries may not invest in the development of labor-saving innovations, they import labor-saving ideas from advanced economies. In-fact, the mechanization of agriculture in emerging economies represents the largest global shift in work. Therefore, cities in emerging countries must generate abundant new jobs to employ the farmers displaced by agricultural industrialization. However, if robust global connections arrive too slowly in Africa, then industrialization may no longer be a plausible path to job creation. Indeed, the future of work is uncertain since innovation may outpace automation while globalization may move quickly enough than industrialization allows

FIGURE 5.3 FUTURE EMPLOYMENT SHAPE: AUTOMATION AND INNOVATION FORCES

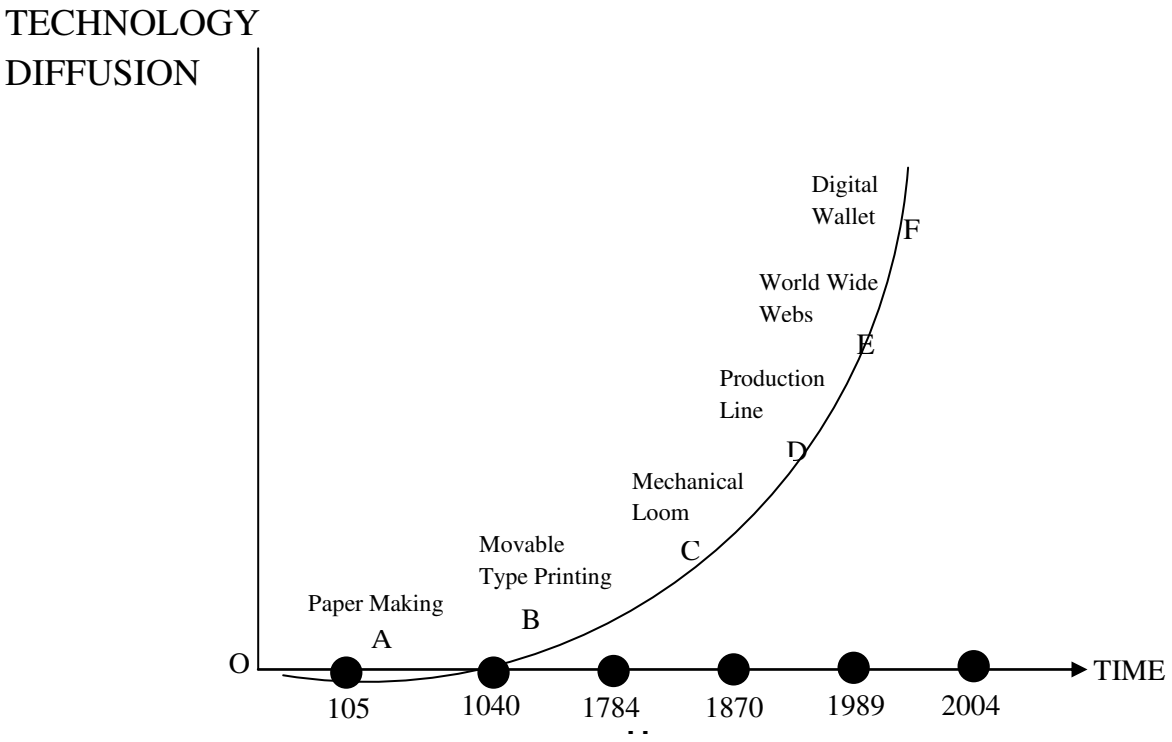


Africa to grow and prosper. And given the considerable uncertainty about the future of employment, governments should rethink policies that affect job creation. Meanwhile, many current jobs are being retooled into new forms which results in new and unexpected skill combinations. For instance, a marketing professional might well be asked to write algorithms while a physics graduate may get a job as a quantitative trader in the finance industry. Again, workers who bring emerging

skills into relevant technical fields of expertise (such as teachers that are good at web design and actuaries that are proficient in big data analytics) are likely to be in high demand. Specifically, in job polarization (expansion of high and low skill jobs coupled with the decline of middle-skill jobs); the demand for workers who can undertake non-routine cognitive tasks (such as high-skilled research) is increasing as well as the relative demand for workers able to handle non-routine tasks that cannot be automated easily (such as food preparation). On the other-hand, the demand for workers for procedural routine tasks (which are often performed in middle-skill jobs such as data entry) is declining because of automation processes.

Indeed, creating a skilled workforce for the future of work rests on the growing demand for advanced cognitive skills, socio-behavioral skills and adaptability. However, technological change makes it harder to anticipate which job-specific skills will thrive and which will become obsolete in the next future. As clearly indicated in figure 5.4, past shifts in skill requirements prompted by technological progress took centuries to manifest themselves while in the digital era, advances in technology call for new skills manifest quickly. Essentially, this ability to adapt quickly to changes is increasingly valued by the labor market. Here, the critical traits is ADAPTABILITY (ability to respond to unexpected circumstances and to unlearn and relearn quickly) which requires a combination of certain cognitive skills (critical thinking and problem solving) as well as socio-behavioral skills (curiosity and creativity).

FIGURE 5.4 TECHNOLOGY DIFFUSION: GLOBAL TIME TREND



NOTES:

A: AD105= PAPER MAKING (This was invested in AD105 and was used as the main writing medium in the 3rd century)

B: AD 1040 = MOVABLE TYPE PRINTING (This was introduced in 1040 and became widespread in China in the 17th century)

C: AD 1794 = MECHANICAL LOOM (This was invented in 1784 and it displaced almost all hard weavers in the U.K by 1860)

D: AD 1870 = PRODUCTION LINE (The production line appeared in 1870 and became part of Henry Ford's mass production of cars in the U.S around 1914).

E: AD 1989 = WORLD WIDE WEB (The first start-up for business process outsourcing (BPO) in India appeared in 2002 and around 2.8 million people were employed in the BPO industry in 2012.

F: AD 2004 = DIGITAL WALLET (Wechat pay was introduced in China in 2013 while its mobile payment users reached 600 million and total transactions surpassed us $8.1 trillion in 2017).

6.0 AFRICAN ECONOMIES: DEMOGRAPHIC IMPLICATIONS

Regrettably, a rapid demographic transition in sub-saharan Africa is fueling a youth bulge and urbanization while contributing to migration flows in a way that will affect the future of work. Statistically, the region's population is projected to nearly double in the next two decades: from approximately 900 million in 2015 to 1.7 billion in 2040 (Chio, 2019). In fact, more than half of the anticipated growth in global population between now and 2050 are expected to occur in Africa while half of the population in sub-Saharan Africa is under age twenty-five years (IMF, 2018). Again, between 2017 and 2030, the labor supply in the region is estimated to increase by one hundred and ninety-eight million with eleven million young Africans expected to enter the labor market each year for the next decade. Thus, as the labor force increases, there is a need to create twenty million jobs each year (ILU, 2018). Yet Africa is projected to experience rapid population growth over the next decades while sub-saharan Africa is urbanizing at lower per capita gross domestic product than other regions. However, Africa's growing population will be largely city dwellers but with low incomes.

Unfortunately, this low income means that sub-saharan Africa's urbanization is not accompanied by critical infrastructure investments in physical capital (transport and housing) as well as human capital (schools, health clinics, etc). In fact, those low investments undermine the agglomeration benefits of cities; raise the costs of doing business and make cities uncompetitive. Again, Africa's population transition is linked to increased levels of migration that is within the continent while contemporary African migrants are mostly young people (usually below thirty-five years of age). Consequently, the intersection of the population boom, youth bulge, urbanization and migration will have significant implications for cities and urban areas work. However, about 82% of the sub-saharan Africa's poor people still live in rural areas (earning their living primarily in farming). In other words, the combined trends of digitization and globalization are likely to affect no more than twenty percent of the workers due to the structure of the African economies as well as the low levels of formalization. However, most employment is in agriculture and consumer services of the informal sector that is characterized by income volatility.

Essentially, the digital economy offers African business and workers of the informal sector, an opportunity to realign markets by minimizing information asymmetry which has multi-dimensional benefits (including making formalization easier). Surely, by connecting more informal businesses with consumers, digital technologies can strengthen the backbone of sub-saharan African economies. Specifically, in low-income environments, low-skill-based digital technologies (through instructional videos, voice activated tactile screen and simple to use applications) can empower low-skilled informal workers to perform higher skilled tasks and learn as they work. Again, such technologies can enable workers without any collateral but with the ability to make savings to access credit and insurance products based on their recorded savings and purchase histories. However, appraising the level of informality is challenging because it is an endogenous feature of the African economy. Comparatively, informality can shape the growth path of African economies (by absorbing a large shore of unskilled labor or constraining the fiscal space). In contrast, the level of economic development (growth, poverty, inequality) can also affect the size and composition of the informal sector. Furthermore, trade policies and fiscal outcomes are key correlates of informality while trade reforms can shape the informal sector through competition.

Although there is growing consensus on the role that digital technologies play in the enhancement of business activities and economic development; there is still little evidence on the uptake and usage of these technologies by informal firms;

However, evidence shows that mobile phones are widely used among informal businesses as compared to other information and communication technologies (Choi, 2019). Indeed, women's access to information and communication technologies (ICTs) can be conceptualized as including availability, affordability and skills needed to use a set of ICTs as well as being affected by structural and gendered social norms governing mobility reproductive and productive roles within households as well as the use of space and time which structures access (Gester and Zimmermann, 2003; Kleine, 2010). Specifically, gendered digital divides structurally limit women's opportunities to harness ICT's emancipator potentials because of marginalization in terms of access to time, resources, education, mobility, technophobia, safety, religious and cultural constraints, socio-economic status, age as well as perceived relevance of technology to women's lives. Again, ICTs can also be used as a tool to control, harass and oppress women since many women experience severe constraints in using ICTs effectively as a result of cultural norms and power hierarchies (Buskens and Webb, 2014). Yet, within the ICT4D discourse, women are often trained as either consumers of ICTs whose relative lack of access represents a lost revenue opportunity for ICT-related goods and services (emerging or untapped market) or as budding entrepreneurs who just need to be equipped with ICTs to be successful (UNCTAD 2014). Clearly, both opportunities exist to a point but overemphasizing them may carry the risk of underplaying broader structural and cultural factors. Therefore, ICT-driven women's entrepreneurship could play an important role in increasing gender equality, creating employment, improving economic growth as well as reducing poverty levels at individual, household and community levels.

Although the major reason for many youth adoption of ICT facilities is entertainment; the new digital technologies are having wide-ranging effects on youth transitions. Essentially, new opportunities for work and study are opening up while the interactive and decentralized nature of these new technologies is providing youths with many more opportunities to obtain information outside the traditional channels. Apart from the direct jobs creation, ICTs provide information about non-ICT job openings to youth. In fact, online job databases offer information to those with internet access while mobile phones are particularly important for job information. In some Africa countries, many youths have identified mobile phones as essential for contacting employers and getting contacted about job openings, particularly in remote areas and areas of high crime (World Bank, 2007). Again, the newer uses of mobile technology are also proving useful for job information for African youths. Similarly, New ICTs also offer the potential for a second chance at

work for youth with disabilities. Specifically, speech synthesizers and text magnifier programs can allow visually impaired youth to use ICTs for work, while e-mail and SMS offer greater flexibility in work-related communication needs for the hearing impaired.

Indeed, youth use of ICTs matters indirectly for development outcomes through the impacts on youth transitions and directly through the large youth contribution to overall ICT use. And given the vast amount of information available, many youth may be unprepared to sort through and judge what is reliable and what is not. Thus, there is need to help youth become safer and more effective users of the internet. However, the main ICT priority for governments is to ensure a good investment climate that allows private companies to serve the growing demand for ICT services by enacting regulations that provide for easy entry and competition. In particular for youths, it is also important to provide good regulatory conditions for modes of communal access such as internet cafes. Furthermore, governments need to experiment with ways to provide youth with the skills needed to best take advantage of new technologies through teaching global languages; providing support for local language content development; and developing ways to teach youth responsible and safe use. Furthermore, rigorous evaluations of such policies are needed to find out what works and to share lessons across African countries.

7.0 AFRICAN ECONOMIES: POLICY OPTIONS

Practically, as digital development proceeds from emerging to transitioning and then to transforming, policy reforms because more complex. Hence it may be useful to consider a sequence of policy priorities in line with technology's increasing penetration as shown in table 7.1 (World bank, 2016). Clearly, in countries where the digital economy is still emerging and internet use is low, the priority will be to lay the foundations. However, technology adoption and the quality of complements vary not only across countries but also across sectors and across firms in the same sector. Thus, African countries need to look at the digital economy as a source of growth and jobs. In fact, they should focus on enforcing existing business regulations and competition and antitrust laws. In other words, they should focus on reducing the implementation gap in enforcing existing laws while required changes for implementation could be handled through secondary legislation or guidelines.

Basically, the use of digital technologies requires basic cognitive skills such as literacy and numeracy. Yet, a well-educated worker in the 21st century also needs skills that are easily transferable across jobs and occupations and that will help respond to changing labor market demands: higher order cognitive, socioemotional and technical skills. Therefore, countries with strong skill development systems are best prepared to leverage digital technologies; to manage some of the labor market disruptions that technology creates; and to ensure that the benefits of digital technologies are widely shared. Consequently, every African country should have multiple skill development systems. In other words, incorporating advanced ICT skills in the general curriculum can teach computational thinking in the emerging African economies. For instance, incorporating coding in general education can strengthen not only ICT skills but also critical thinking that can be used to teach logic and learning strategies for solving problems, designing projects and communicating ideas.

Again, addressing shortages and deficiencies in the teaching of science, technology, engineering and mathematics (STEM) requires preparing and equipping teachers properly as well as including STEM across the educational system. It also requires creatively involving the employers, connecting the teaching and research activities as well as establishing financial incentives or compensatory mechanisms to make STEM education viable and affordable to underrepresented groups.

TABLE 7.1 EMERGING AFRICAN COUNTRIES: POLICY PRIORITIES

S/N	POLICY GOALS	DIGITAL TRANSFORMATION NEEDS		
(A)	Registrations: A business environment in which firms can leverage the internet to compete and innovate for the benefit of consumers	(I) Low barriers to Internet adoption including access, affordability and basic open and safe issues: trade and basic competition issues	(II)Effective regulation Competition and enforcement (including ease of market entry)	(III) Critical 'new economy' regulation including platform competition and the legal basis for private sector data collection.
(B)	Skills: workers, entrepreneurs and public servants who can take advantage of opportunities in the digital world.	(I) Digital literacy and foundational basic cognitive skills and socioemotional skills	(II)Higher Order cognitive and socioemotional skills	(III) Advantaged ICT skills and STEM Education as well as lifelong learning
(C)	Institutions: An accountable government that effectively uses the internet to empower its citizens and deliver services	(I) Adoption of Informational services and monitoring by public sector and non-state providers	(II)Effective e-Government delivery systems, provider management and citizen engagement	(III) Widespread citizen use of E-Government service and participatory policy making
(D)	Accountability: A Transparent Governance System	**(I)** Increased Electrical Accountability	**(II)** Trust and safeguards against Privacy and Security	**(III)** Social protection systems for a changing labor market

Indeed, the labor market disruptions that accompany technological change increase the demands on active labor market policies and social assistance systems. These disruptions are likely to be greatest for workers in routine occupations. On one hand, some workers are going to need intermediation and retraining services to find new jobs. On the other hand, if they have difficulties transitioning, they may need social assistance. Thus, by giving workers a stake in digital capital could diversify workers assets and reduce their costs of displacements through pension funds, mutual funds or digital firm intervention (Freeman, 2015). Therefore, the solution is to protect workers rather than jobs and to level the playing field for regulations and taxation across work contracts. Here, the first step is to do away with regulations that almost prohibit flexible work arrangement while the second step is to reform tax systems that tax part-time work at higher per hour rates than full time work. Reforms are also necessary in working time arrangements and table 7.2 presents different reform programs classifications as applicable (Kuddo, 2015; Choi, et. al., 2019, World Bank, 2019).

Essentially, government policies and regulation of the internet will help to shape the digital economy. Specifically, through their policies for the ICT sector, governments and regulatory agencies create an enabling environment for the private sector to build networks, develop services and provide content and applications for users. After market competition and private participation, another policy ingredient is independent regulation: establishing ICT regulatory agencies that are independent of leading operators and of government departments. In fact, effective regulation creates a level playing field for operators and helps promote market entry. Furthermore, telecom sector regulation should work primarily in favor of the consumer addressing market failure, fostering effective competition, protecting consumer interests as well as increasing access to technology and services. Particularly, the regulator should seek to ensure that the benefits from technological change, greater efficiency and reduced costs are passed on to consumers rather than appropriated in higher profits for private firms or extortionate taxes to governments.

Empirically, data are the lifeblood of decision making and the raw material for accountability. And without high quality data providing the right information on the right

TABLE 7.2 POLICY REFORMS: PROGRAM CLASSIFICATIONS

S/N	INTERVENTION SECTORS	REFORM CATEGORIES	REFORM SUB CATEGORIES
1)	Social Insurance Areas	(A) Contributory Pensions	(i) Old age pension (All schemes, national, civil servants, veterans, other special) (ii) Survivors pension (All schemes,

			national, civil servants, veterans other special) (iii) Disability pension (All schemes, national, civil servants, veterans, other special)
		Supporting Social Insurance	(i) Occupational insures benefits (ii) Paid sickness leave benefits (iii) Health (iv) Maternity/paternity benefits
2.	LABOR MARKET AREAS	(A) Labor market policy measures (active LM programs)	(i) Training (Vocational, life skills, cash for training) (ii) Employment incentives/wage subsidies (iii) Employment measures for disabled (iv) Entrepreneurship support/startup incentives (cash and in kind grant, microcredit) (v) Labor market services and intermediation through PES (vi) Other active labor market programs
		(B) Labor market Policy support (Passive LM Programs)	(i) Out-of-work income maintenance (unemployment benefits, contributors) (ii) Out-of-work income maintenance (unemployment benefits, non-contributory)
3.	SOCIAL ASSISTANCE AREAS	(A) Unconditional Cash Transfers	(i) Poverty targeted cash transfers and last resort programs (ii) Family/children/orphan allowance (including orphan and vulnerable children benefits) (iii) Non-contributory funeral grants, burial allowances (iv) Emergency cash support (including support to refugees/returning migrants) (v) Public charity
		(B) Conditional cash transfers (C) Social pensions (non-contributory)	(i)Conditional cash transfer (i)Old age social pensions (ii)Disability benefits/war victims noncontributory related benefits (iii)Survivorship
		(D) Food and In-kind Transfers	(i) Food stamps rations and vouchers (ii) Food distribution programs (iii) Nutritional programs (therapeutic, supplementary feeding) (iv) In-kind/non-food support (education supplies, free texts uniforms for schools)
		(E) School Feeding	(i) School Feeding
		(F) Public works, workfare and direct job creation	(i) Cash for work (ii) Food for work (inclusive of food for training and food for assents)
		(G) Fee waivers and subsidies	(i) Health insurance exemptions and

			reduced medical fees (ii) Education fee waivers (iii) Food subsidies (iv) Housing subsidies and allowances (and "privileges") (v) Utility and electricity subsidies and allowances (vi) Agricultural inputs subsidies
		(H) Other Social Assistance	(i) Scholarships/education benefits (ii) Social care services, transfers for care givers (iii) What is left out from above categories
4.	Private Transfers Area	(A) Domestic Private Transfers	(i) Domestic transfers inter-family in kind gifts and monetary transfers (ii) Alimony (Divorce and Food) (iii) Income and support from charity/private zakat, support for churches and NGOs
		(B) International Private Transfers	(i) Remittances from Abroad

things at the right time, designing, monitoring and evaluating effective policies becomes almost impossible. Therefore, recognizing the potential for harnessing the ongoing explosion of data, this paper calls for a data revolution that could aid in the achievement of the sustainable development goals. Yet, in harnessing this data explosion for development, there are two overlapping innovations: 'bigdata' and 'opendata'. Here, the big data are voluminous or fast which comes from satellite and ground sensors and as by products from electronic transactions inclusive of mobile phone calls. In contrast, open data are those that are freely and easily accessible, machine readable and explicitly unrestricted in use. In other words, open data are not necessarily big while big data are not necessarily open. Thus, there is continental need for sustained commitment to openness and for investment in high quality data if the dream of a data revolution is to be realized. In fact, African countries can seek ways to discourage data hoarding by adequately funding data holders and showing them that they can attain a higher profile by opening their data. Similarly, Donors and International can support these actions through funding, capacity building and ensuring that their own data are also open.

As an environmental concern, smart public policy can help make the most of the new technologies for monitoring and reducing pollution. And apart from stronger requirements for public disclosure of monitoring data; governments can play an important role in setting standards for data collection, reporting and sharing; offering guidance on best practices for use of technologies; as well as rating performance devices used by consumers. Thus, to keep up with the pace of technological change, it is critical for governments to regularly review policies and

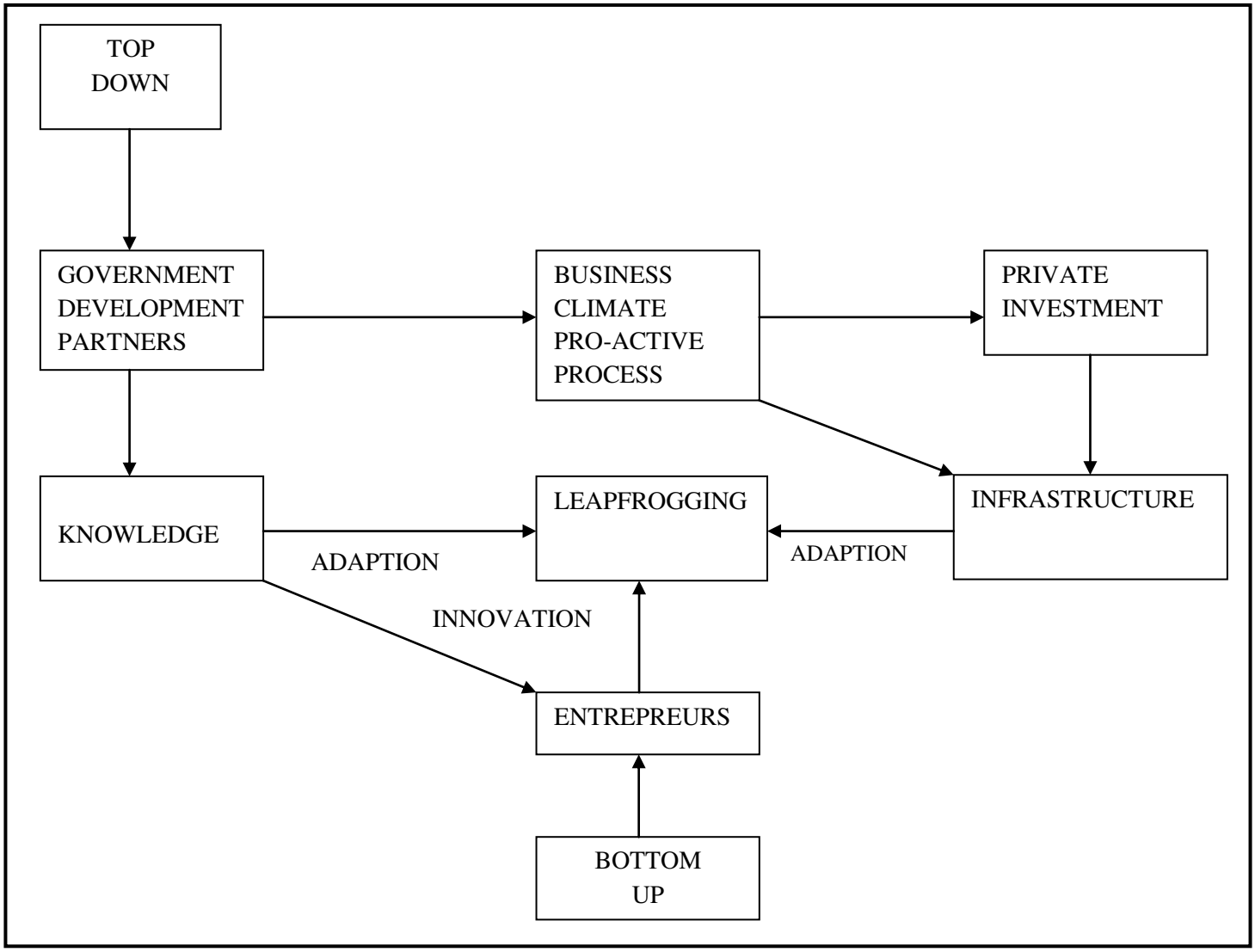
standards in recognition of new data services that can form an important part of the broader air quality management strategy.

Indeed, a potential symbiotic relationship exists between the development of information and communication technologies and increasing energy access in Africa. Specifically, the SMART GRID (defined as a broad range of sensors, meters and controls enabled by information technology as well as large-scale and real-time data collection) can enhance the operational efficiency of the electricity system by optimizing energy transactions. Therefore, having high-quality easily accessible information on energy resources, demand and usage is crucial to supporting the formation of government policies and can be a catalyst for commercial investment. Clearly, agriculture is becoming increasingly knowledge-intensive and high-tech. Operationally, digital soil maps, remote sensing and global positioning system (GPS) guidance are critical tools for modern farmers. Also, 'Big data' for precision agriculture increases yields and efficiency. However, these high-tech tools mostly benefit big farms that can make large investments in technology. But, there are also many innovative ways in which illiterate and disadvantaged people use digital technologies (such as mobile phone applications). Therefore, greater efforts to close the digital divide in rural areas can have great payoffs. Yet, in the long run, that the internet can have an even greater impact on rural growth depends on finding sustainable business models to encourage its spread in the poorest parts of Africa.

Regionally, Africa is growing more connected and digital development is accelerating. However, countries in the region need to adopt a bottom-up approach to unlock the power of technological entrepreneurship as shown in figure 7.1 (World Bank group, 2017). Illustratively, this figure presents the Top-down and bottom-up framework for sub-saharan Africa's innovation ecosystem. Unfortunately, these bottom-up initiatives have often been neglected and yet they are key complement for success. Consequently, this problem presents a unique case to explore opportunities offered by the increasing digitization of the region to create conditions for new jobs. Essentially, this will require critical interventions that start with a coherent pragmatic national ICT strategy; building infrastructure that supports the digital economy as well as producing a strong and large pool of digital entrepreneurs and high-skilled youth with strong ICT skills base. In addition to investing in physical infrastructure expansion and improvements in the regulatory environment, African countries must act fast to create the human capital conditions that are needed to leverage the opportunities of digital technologies for job creation in the region clearly, the basis of this strategy is to train and enable a critical mass of inventors and entrepreneurs to develop and scale digital technologies to boost the

productivity of all workers (such as low-skilled workers in current and new occupations) and to strengthen the

FIGURE 7.1 AFRICA'S INNOVATION SYSTEM: FRAMEWORK INITIATIVE



delivery of education and health services. Again, African regional policy makers must address critical constraints such as the funding of startups at their early stage and incorporate entrepreneurship in the mainstream educational curriculum.

Operationally, African ecommerce is well underway involving business-to-business, business-to-consumer, business-to-government as well as goods and services. With action, e-commerce can become a force for sustainable development. Yet, there are challenges to African's e-commerce growth and these include uncompetitive delivery infrastructure, fragmented markets and rising barriers to cross-border e-payments. Thus, as a future policy direction, African government should support the creation of national or regional e-commerce multistakeholder

associations to champion policies; develop the African Digital trade and digital economy strategy; and support an inclusive pan-African perspective for e-commerce growth with entrepreneurs need connectivity. Again, digital policies should improve interoperability between international payment service providers, local banks and regional payment ecosystems.

8.0 CONCLUSION

Indeed, the promise of digital technology adoption will not be realized without government attention to support essential analog complements. Among other things, Africa's digital transformation needs competition, capital and capacity. Specifically, the African government should close the current gap in digital infrastructure and enhance affordable broadband access with improved regulatory frameworks. Public-private investments are also required in electricity and transport (logistics) infrastructure while favorable trade-policies and broader business environment reforms remain crucial to enhance African firms' participation in global value chain as well as foreign direct investment attraction. Furthermore, the African policy makers should create the enabling environment to establish effective early warning systems (including insurance markets) to identify risks in time for effective mitigation. They should also coordinate regional organizations, financial regulators and development partners toward common objectives on tax policy, reducing remittances costs and providing development assistance to enhance social protection coverage. For the sake of boosting human capital, African governments should use targeted measures to train a critical mass of investors and entrepreneurs to develop and scale digital technologies to boost the productivity of all workers (especially low-skilled workers in current and new occupations) and to strengthen the delivery of education and health services.

However, additional knowledge may be needed on several matters to help guide future policies. Critically, there is a need for better understanding of how to identify, empower and train transformational inventors and entrepreneurs (such as those with high talents and low incomes). Although digital technologies can promote access to human capital services, a better understanding is needed of the extent of the digital technologies on the quality of human capital service delivery. In other words, would digital technologies mainly complement already high-performing human capital workers to perform better or can they improve the performance of the low-performing workers using country-specific sectoral cases. Statistically, adequate measurements are needed on many fronts including better

measures of the quality of education, innovator and entrepreneurial skills as well as worker skills (especially soft skills and adaptation skills).

In conclusion, while the digital revolution is inevitable, the outcome will depend on good policies. However, policy responses should strike the right balance between enabling digital progress and addressing risks. Yet, considering the inherent global reach of these technologies, regional and international cooperation will be the key to developing effective policy responses. In fact, the more willing the society is to support those who are left behind; the faster the pace of innovation that it can accommodate and still ensure that all citizens ends up better-off. And with the right inclusive policies and legislation, the digital revolution could be a new engine of growth and prosperity for African economies in the twenty-first century.

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