The Challenges of Peripheral Industrialization and the Fourth Industrial Revolution: Case Study of Sub-Saharan Africa (SSA)

Professor Samuel Igbatayo

Professor, Department of Economics, Afe Babalola University, Nigeria

Abstract

Africa's industrial profile features a poor industrial economy, which underscores the region's state of under development. After political independence across the region, attempts at industrialization were largely grounded in Import-Substitution Industrialization (ISI), which was embraced by many countries from the late 1950s into the 1980s. The failure of ISI was a major reason that spurred economic reform agenda by the early 1980s, culminating into the Structural Adjustment Programme (SAP). Indeed, between 1980 and 1990, SSA's manufacturing share of GDP rose to its peak, estimated at about 12-13%. An examination of manufacturing value-added (MVA) in Africa by Sekkat and Varoudakis (1994) reveals a diversity of performance in SSA. In 1994, the weighted share of manufacturing in the region's GDP was estimated at 15%, against 13% in 1980, but much lower than the corresponding shares of 21 and 30% in Latin America and East Asia, respectively. The authors reveal that the average share of MVA over the period 1970-95 for selected SSA countries shows no clearly discernible pattern. Some countries have successfully established manufacturing industries, with a rise in the share of MVA in GDP. This was particularly evident with Cote D'Ivoire, Malawi, Mauritius and Zimbabwe, while most other countries have witnessed a stationary trend in manufacturing production as a share of GDP. However, manufacturing production rose considerably across several countries, more than doubling from US$73 billion in 2005 to US%157 billion in 2014. This was complemented by a rise in manufacturing activity, estimated at an annual growth of 3.5% between 2005 and 2015, a trend that was faster than the global growth in manufacturing production. A major objective of policy makers in the region is to leverage upon the fourth industrial revolution for the transformation of its industrial economy from the periphery to the mainstream of global markets.

1.0 Introduction

The industrial revolution was a watershed in the annals of the global economy, characterized by the invention of critical technologies as the steam engine, the cotton gin, electricity, telephone and telegraph, railway system, and automobiles. This outcome was also complemented by the development of the iron and steel industry that transformed the global manufacturing process by the mid-19th century, when Britain emerged as the core of the global industrial economy, which spread with some lag to continental Europe and North America. The initial impact was a Great Divergence in the living standards between Western nations and the rest of the world. The peripheral regions of the world supplied raw materials to industrialized countries in exchange for manufactured products. However, by the middle of the 20th century, several peripheral regions, particularly in Asia and Latin America, began to transform their economies, accompanied by peripheral industrialization on a pathway to the global marketplace. This development is

reversing the divergence in living standards between developed and emerging market economies. The transformation of emerging market economies in recent times, led by China and India, has been driven in large part by globalization and international economic integration. The transformation was accompanied in many countries by peripheral industrialization, which is increasingly becoming a model for several developing economies. It is noteworthy that peripheral industrialization features several challenges in the developing world, including technology transfer, capital mobility, enabling environment, and human capital, among others. Sub-Saharan Africa faces challenges associated with peripheral industrialization as the world's least industrialized region, while the Fourth Industrial Revolution offers prospects for a pathway to rapid industrialization and access to global markets.

2.0 The Transformative Impact of the Industrial Revolution

The industrial revolution was a critical force for the transformation of the global economy. The phenomenon was accompanied by an exponential increase in global economic output, explosion of technologies, increased international trade and investment, as well as human migration. In view of the multi-dimensional contexts of the industrial revolution and its far-reaching implications for the global economy, scholars have acknowledged four phases associated with the phenomenon since its inception around 1760. Indeed, the current world manufacturing landscape, driven by the global value chains, is the outcome of successive waves of innovation and economic development associated with the industrial revolution. While the industrial revolution is often considered as a single ongoing event that emerged in the 18th century, it features four paradigm shifts, or four phases. Each phase is built upon the innovations of the prior revolution, leading to more advanced models of manufacturing, as well as more complex networks of commercial relations (Rodrigue, 2022). Figure 1 illustrates the four phases of the industrial revolution.

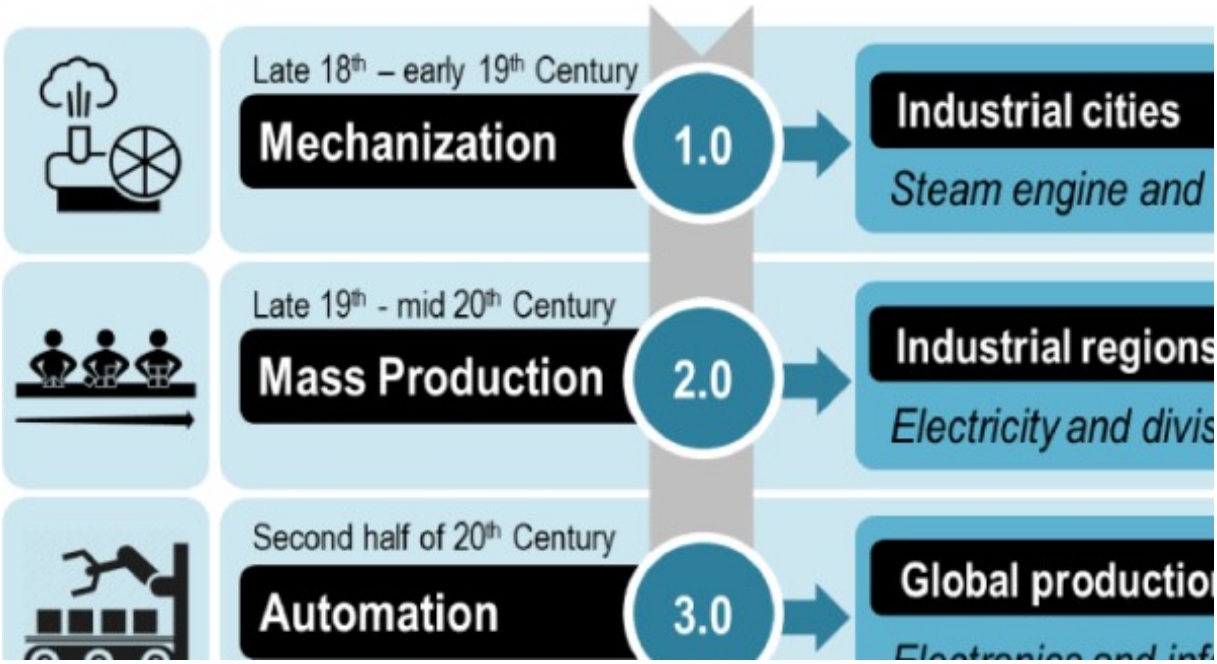

Figure 1: The Four Phases of the Industrial Revolution
Source: Rodrigue, 2022

Figure 1 shows the four phases of the industrial revolution: Phase 1, or the mechanization stage, features the emergence of industrial cities between the late 18th and early 19th century; phase 2, or the mass production stage, features industrial regions between the late 19th and mid-20th century; while phase 3, or the automation stage, features global production networks by the second half of the 20th century, and phase 4, or the robotization stage, features global value chains by the early 21st century.

The first industrial revolution lasted between the 18th and early 19th century, focused on the benefits of mechanization. For the first time in history, some animal or human labour could be substituted by mechanical labour. However, the new machines required a large amount of labour or energy to operate, but expanded the outputs of production, while the majority of labour tasks were performed manually. Also, new forms of industrial activities were unveiled, creating industrial cities associated with different functions and specialization, such as steel, textiles, tools, etc. These cities were often located close to sources of energy, particularly coal fields and waterfalls, or locations well connected to regional transportation hubs. Mechanization allowed the first industrial revolution to trigger economic growth and development, creating a growing divergence between industrializing and non-industrial economies.

The second industrial revolution spanned the period from the late 19th to the early 20th century, focused on the principle of mass production along assembly lines, scaling up manufacturing output and reinforced by higher coordination between labour, tasks, processes, and machines. This development led to increased specialization and interdependence in manufacturing, accompanied by the emergence of industrial regions (or manufacturing belts). Electricity

generation also supported the growth of modern telecommunication systems, including telegraphs, radios, telephone, and later on, television. The development created long-distance, mass transport systems, particularly rail and steamship, allowing even more expansion of manufacturing industry.

The third industrial revolution emerged in the latter part of the 20th century, with enhanced benefits of automation associated with numerous manufacturing processes. This is particularly evident in the application of machines with capability to repeat a series of tasks under relatively defined parameters and accompanied by minimal supervision. The process was also complemented by the development of information and communication technologies and, together with the computer system, the stage was set for the emergence of information "super highway", with the transmission of data, voice and video in communication systems by the end of the 20th century. The innovation in information technology paved the way for the internet. Furthermore, globalization became more robust, with the integration of national economies through trade liberalization, as well as lower transport cost achieved largely by containerization. The process featured a disruptive global manufacturing value chains, reversing the flow of manufactured goods around the world. With low labour cost and improved industrial infrastructure, East Asia, led by China and South Korea emerged as global manufacturing hotspots, attracting foreign direct investments that triggered an explosion of economic growth and development across the region.

The fourth industrial revolution unfolded in the early 21st century, featuring artificial intelligence, robotics, Internet-of-Things and 3D printing, among other things. These innovations enabled higher level of flexibility, particularly with the location of manufacturing processes, the scale and scope of output, as well as the customization of products. The array of emergent technologies associated with the fourth industrial revolution has transformed human-machine relationship, allowing the latter to perform more complex tasks and programmed to adapt to a redefinition of these tasks. Consequently, machines are assuming greater dimensions to the flexibility of human labour. These embrace not only simple and repetitive tasks, but also increasingly average skilled and routine tasks. This development holds considerable implications for the global value chains, which largely entail a circular process to harness resources, transform them in parts and products, and distribute finished goods across domestic and global markets. Indeed, global manufacturing and supply chain management are key elements in the agenda of multinational corporations' survival strategy against the backdrop of ever-increasing competition.

3.0 The Elements of the Fourth Industrial Revolution

Technological change is driving global productivity and economic growth. Advances in digital technology hold considerable potential to lift productivity and economic growth even higher, create new and better jobs, while reinforcing global competitiveness (Qureshi, 2020). At the heart of technological change is digital transformation, which has spawned novel technologies since the late 20th century. Digital transformation has ushered in the fourth industrial revolution, or 4IR for short. The fourth industrial revolution is characterized by an explosion of novel technologies, including artificial intelligence, cloud computing, robotics, autonomous means of

transport, the Intent-of-Things, 3D Printing, nanotechnology, materials science, and big data, among others (Goncharov, 2020). While the steam engine and steam power reinforced the first industrial revolution; the second was sustained by mass production underpinned by electric power; the third was driven by electronics, computers and digital information technology. The fourth industrial revolution expands on the previous revolutions and deepened their scale, scope and complexity (ASU, 2022). It is marked by a fusion of technologies that is blurring the lines between the physical, digital and biological spheres. The 4IR is a phenomenon, which is unique from the preceding revolutions. Its velocity, scope and impact are extra-ordinary. The speed of innovation that is driving the novel technologies has no historical precedent. Its evolution is accompanied by an exponential rather than a linear growth. It also features disruptive dynamics in almost every industry around the world, heralding the transformation of entire systems of production, management and governance in industries (Schwab, 2016).

The emergence of the Fourth Industrial Revolution is characterized by an explosion of digital technologies that are transforming national economies, multinational corporations, as well as business transactions and personal activities. The phenomenon is defined by its velocity, scope and systems impact, allowing firms to radically overhaul entire systems of production, management, distribution and marketing of tradable goods and services. The novel technologies associated with the fourth industrial revolution are accompanied by unprecedented processing power, storage capacity, and access to a wide array of knowledge. These include such emergent technologies as artificial intelligence, robotics, 3D printing, nanotechnology, biotechnology, material science, as well as quantum computing, among others (Hobcraft, 2018). Figure 2 illustrates the dynamic structure of novel technologies associated with the fourth industrial revolution.

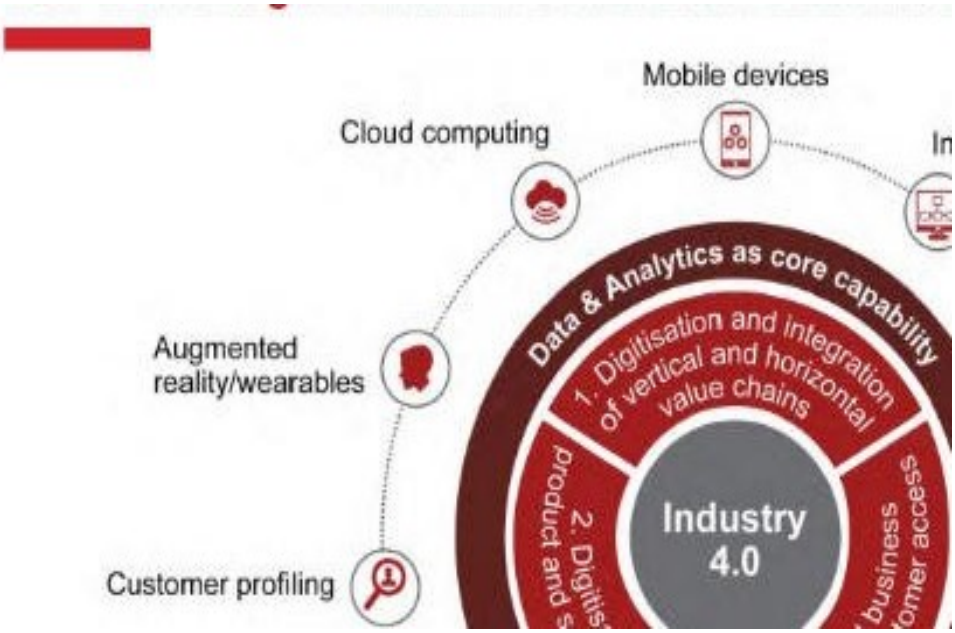

Figure 2: Elements of Novel Technologies associated with the Fourth Industrial Revolution
Source: Hobcraft, 2018

Figure 2 reveals a gamut of novel technologies associated with the fourth industrial revolution, ranging from mobile devices, Internet-of-Things and 3D printing to Big Data Analytics and Cloud computing, among others. Marr (2020) identifies a variety of novel technology trends that define the fourth industrial revolution, which are examined in turn.

i. **Artificial Intelligence and Machine Learning:** These refer to the ability of machines to learn and act intelligently, making decisions independently, carrying out tasks and even predicting future outcomes, driven by what they learn from the data input. Artificial Intelligence (AI) is already transforming human and business activities, ranging from Google searches to powering Amazon's product recommendations, as well as personalized suggestions from Netflix and Spotify, which are frontline social platforms accessible to billions of subscribers around the world. AI provides machines with the capability to initiate a wide array of human-like activities, including seeing (facial recognition), writing (Chat bots), as well as speaking (Alexa).
ii. **The Internet-of-Things (IoT)**: This refers to a wide array of everyday devices and objects that are connected to the internet, gathering and transmitting data. While one of the earliest "smart" devices associated with the digital technology was the Smartphone; there are now smart-watches, TVs, refrigerators, among other things. Indications are that the world is awash with more than 20 billion smart devices, which are even expected to increase further, as the digital revolution is embraced by more countries. The ability of machines to connect to and share information with each other is a key element of IoT.
iii. **Big Data**: The term refers to the exponential increase in the quantity and quality of data generated, and driven by digital technology. Data is increasingly analysed with intelligent algorithms to unlock complex industrial and administrative processes. It enables understanding of the relationship between data points in order to predict future outcomes of complex processes, among other things. Big data enables augmented insights to assist organizations with gaining analytical perspectives from their data.
iv. **Block Chains**: A block chain, otherwise known as distributed ledger, refers to a highly secure database, enabling the storage of information. In the digital age, storing, authenticating, and protecting data presents particularly challenging dimensions. Block chain technology presents an open, secure and seamless solution to the challenges. Consequently, the technology is increasingly embraced by banking and insurance firms, which need to protect sensitive information about their customers.
v. **Cloud and Edge Computing**: This is a process involving the storing and processing of data on other people's computer in a data centre via a network. This gives firms the capability to store massive amounts of data and process them in real-time. On the other hand, edge computing refers to the processing of data on such devices as Smart Phones. Cloud service providers, including Amazon, Google and Microsoft, allowing firms to host all vital Information Technology (IT) infrastructure in their cloud, rather than within an organization's digital walls, reducing overhead costs to maintain and operate a wide array of systems, software and data.
vi. **Robots and Cobolts**: Robots are intelligent machines with the capability to understand their environment and respond to commands, while performing routine or complex tasks autonomously. Robots are driven by the intelligence and ability to act autonomously,

which separate them from other machines. The rise of collaborative robots, otherwise acknowledged as Cobolts, has emerged as the latest generation of robotic systems, designed to operate alongside humans, as well as other robots. Indeed, Cobolts are designed with the capability to operate like humans and interact safely and autonomously with the human workforce.

vii. **Autonomous Vehicles**: This refers to a wide variety of transport systems, ranging from a car, truck, ship, drone or other vehicles that can react to commands and operate without human control, with a sense of awareness about their environment. In recent times, vehicle manufacturers have invested billions of dollars to produce self-driving technology that culminates into autonomous vehicles, transforming mobility across the world. The novel technology is environmentally friendly, reducing pollution that fuels global climate change.

viii. The 5G Network: This refers to the fifth-generation cellular network, which interacts with other innovations to propel faster, and stable wireless network systems. This is in addition to connecting with more devices, enabling rich and more varied streams of data. Networking technology has emerged as the backbone of online systems that drive a smarter world. With increasing bandwidth and coverage, the 5G Network has widened various activities available on the Web, ranging from e-mails to browsing, location-based services, as well as streaming videos and games. All these activities are generated with unprecedented speed around the world.

ix. Genomics and Gene Editing: Genomics is an interdisciplinary field of biology, focusing on the understanding and manipulating of Dyoxiroboneucleic Acid (DNA), and genomes of living organisms. Gene editing refers to the manipulation by a group of technologies, enabling genetic engineering to alter the DNA and the genetic structure of living organisms. In recent times, powerful computers, complemented by sophisticated software tools have emerged, allowing better comprehension of human genome since it was successfully sequenced in 2003. These technologies have brought about medical breakthroughs in human medicine.

x. Quantum Computing: This is a process that harnesses the peculiar phenomenon that takes place while operating at a sub atomic level, including quantum entanglement, quantum tunnelling, as well as the ability of quantum particles to simultaneously exist in more than one state. Quantum computing is set to transform computing science, with capacity to generate billions or even trillions more processes than current computer systems. Quantum computing is particularly set to revolutionize such novel technologies as artificial intelligence, as well as decoding such complex structures as genomic information.

The fourth industrial revolution is rapidly transforming the global economy through a myriad of novel technologies, which are disrupting income generation patterns, labour force participation and Gross Domestic Product measures (Roy, 2019). A major feature of the global economy is the rising number of the middle class and its increasing role in the digital economy. More than 50% of the world's total population of 7.6 billion, in 2019, lived in middle-class households. However, the profile of the middle-class varies from one region to another. Advanced market economies in Europe and Japan, for example, feature a growing middle-class, rising by 0.5% per annum. On the other hand, such emerging market economies as China and India are expanding

their middle-class profiles by 6% per year. With rising incomes in Asia, its middle-class population is set to constitute 88% of the world's entire middle-class. Figure 3 illustrates the economic profile of the global population.

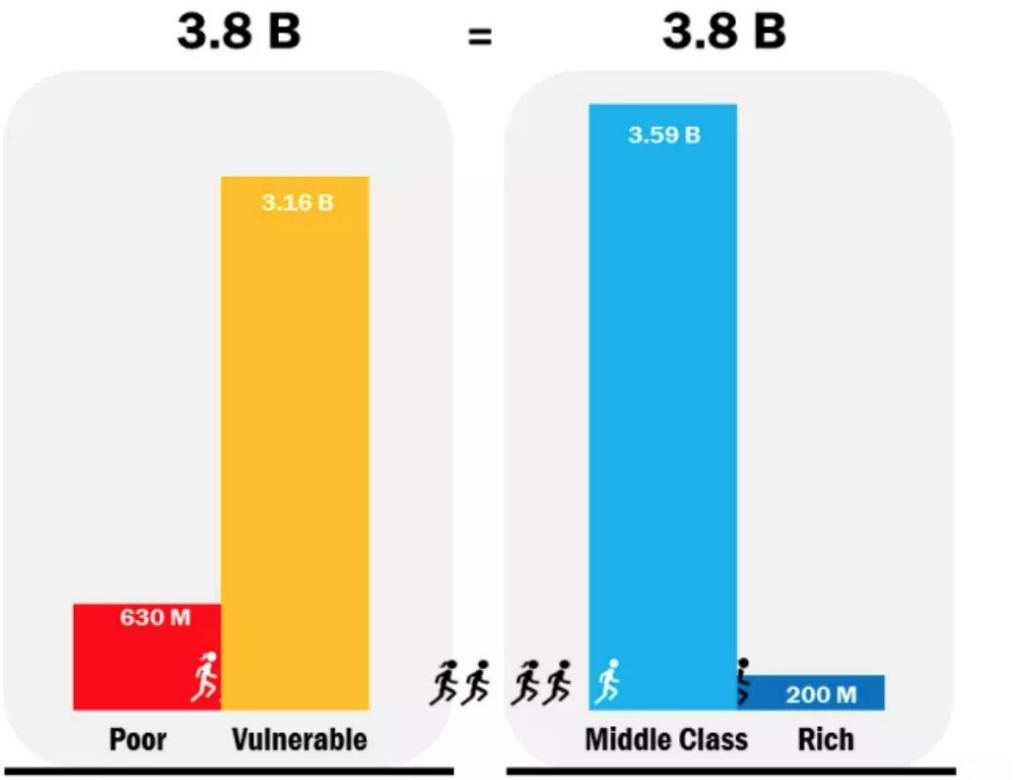

Figure 3: The Economic Profile of the Global Population
Source: Roy, 2019

Figure 3 shows the economic profile of the global population at 7.6 billion in 2019, evenly split at 3.8 billion comprising poor (630 million) and vulnerable (3.16 billion) on the one hand, as well as middle class (3.59 billion) and the rich (200 million), on the other.

4.0 The Challenges of Industrial Development in Sub-Saharan Africa (SSA)

Industrialization is a key element of the modern economy, critical for employment generation, economic growth, foreign exchange earnings and structural transformation. SSA has witnessed a long struggle with industrial development, and remains the region with the least manufacturing capacity in the world. The region's historical efforts in industrialization are traceable to the colonial era, particularly in the 1920s. The process emerged in two phases: the initial stage was driven by colonialists, as an element of urbanization and ended in the late 1940s; the second stage began in the late 1950s and proceeded into the 1960s, with the embrace of Import-Substitution Industrialization (ISI) strategy, adopted by the newly independent countries in SSA. The second stage was a conscious attempt by policy makers to tackle underdevelopment through the domestic production of manufactured products, as well as the protection of nascent

industries. The share of manufacturing activity as a proportion of GDP varied across SSA in the early 1960s, ranging from a paltry 3% in Tanganyika (now Tanzania) to between 9 and 10% in Kenya and Senegal, 14% in the Belgian Congo (Now Congo DR) and 16% in Southern Rhodesia (Now Zimbabwe). On the other hand, South Africa featured a much larger manufacturing capacity, estimated at 20% of GDP. It is noteworthy that most SSA countries in the early 1960s featured very low manufacturing capacity, constrained by the dearth of entrepreneurship, capital, as well as the small domestic markets. For example, Dahomey (Now Benin Republic), as late as 1965, featured a population of 2.4 million, with 2.6% share of manufacturing as a component of GDP, while Gabon, with a population of 400,000, had 6.1% manufacturing capacity as a component of GDP (Austin, Frankema and Jerven, 2017). Table 1 shows the manufacturing output of selected countries in SSA in 1960, revealing a low manufacturing capacity in all the selected countries.

Table 1: Manufacturing Output in the Context for Selected African Countries in 1960 (US 1964 dollars)

Country	Manufacturing GDP (%)	Population (Millions)	GDP (M.$)	Per capita income ($)	Manufacturing Output (M. $).
Southern Rhodesia	16.0	36.	751	206	120.2
(Zimbabwe)	14.0	14.1	910	58	127.4
Belgian Congo	9.5	3.1	678	218	64.4
Senegal	9.5	8.1	641	79	60.9
Kenya	6.5	6.7	583	87	37.9
Uganda	6.3	6.8	1,503	222	94.7
Ghana	6.0	4.7	511	109	30.6
Cameroon	6.0	20.7	1,021	49	61.3
Ethiopia	5.5	3.2	511	155	28.1
Northern Rhodesia	5.3	3.2	584	181	31.0
(Zambia)	4.8	11.8	909	77	43.6
Cote D'Ivoire	4.5	40.0	3,500	88	157.5
Sudan	4.3	4.8	726	151	31.2
Nigeria	3.0	9.6	671	67	20.1
Angola					
Tanganyika					

Source: Kilby, 1975

Import-Substitution Industrialization strategy was embraced as a popular tool for industrialization in SSA until the late 1980s, when it became incompatible with SAP (Mendes, Bertella, and Teixeira, 2014). Policy makers in the 1960s embraced industrialization as a long-term development objective to facilitate a higher standard of living in SSA countries. Therefore, the ISI concept was embraced as a mechanism to utilize agricultural output for industrial development. Indeed, post-independence plans across the region emphasized agricultural growth, accompanied by investment in rural infrastructure as a foundation for industrial development. Industrial development planning during the 1960s was also tailored at fostering manufacturing capacity in urban areas to absorb the rapidly-expanding urban labor, as well as providing wage-earning livelihoods in rural areas. Thus, planners across the region acknowledged the imperatives of greater utilization of raw materials, particularly in agriculture by the nascent industries. It is noteworthy that many of the early import-substitution industries were owned by large trading houses, with roots to the colonial era, and focused largely on

consumers with high disposable income. This development later became a binding constraint, compounded by the dearth of funds to finance importation of raw materials, critical to maintain capacity utilization in manufacturing industry (Steel and Evans, 1984).

5.0 Failure of Import-Substitution Industrialization (ISI)

With the passage of time, it became persistently clear that ISI was no longer sustainable, as countries in SSA continued to depend on former colonial powers for the importation of manufactured goods at considerable cost to hard-earned foreign exchange resources. By the late 1970s, capacity utilization in manufacturing industries had collapsed in many countries across the region. Heike (1994) identified the causes of ISI failure in SSA as follows:

i. absence or poor performance of intermediate goods, as well as capital goods industries, the rise in the importation of these goods and increasing dependence on foreign countries and the dearth of foreign exchange.
ii. dearth or poor performance of agro-based industries.
iii. marginalization of small enterprises.
iv. prevalence of low capacity utilization in the large, capital-intensive, import-substituting manufacturing facilities, which existed without sufficient downstream and upstream link.
v. small domestic market, accompanied by low purchasing power.
vi. high production costs, attributed to inefficient, mis-allocation of resources and the dearth of foreign exchange.
vii. over-bloated size of the public sector, together with widespread corruption.

In the light of the afore-mentioned constraints, ISI strategy was largely abandoned in SSA in the wake of SAP. The economic reform, among other things, promoted export-oriented industrialization instead. The macro-economic reforms under SAP, together with increased aid flows, spurred industrial production and reversed under-utilization of manufacturing capacity in some countries. Indeed, between 1980 and 1990, SSA's manufacturing share of GDP rose to its peak, estimated at about 12-13% (Ansu, McMillan, Page, and Velde, 2016). However, the resurgence in manufacturing activity in the region was short-lived, undermined by increasing competition from imports, as well as rising costs in local currencies, attributable to reforms in foreign exchange markets. Consequently, the share of manufacturing in GDP reduced from 1990 to 2006, stabilizing at 10%, the same level as in 1965. There were, however, exceptions: Ethiopia, Kenya, Nigeria and Tanzania featured much higher rates of manufacturing activities, while many others were associated with manufacturing growth, which remained at or below the growth rate of GDP.

An examination of manufacturing value-added (MVA) in Africa by Sekkat and Varoudakis (1994) reveals a diversity of performance in SSA. In 1994, the weighted share of manufacturing in GDP in the region was estimated at 15%, against 13% in 1980, but much lower than the corresponding shares of 21 and 30% in Latin America and East Asia, respectively. According to the authors, the average share of MVA over the period 1970-95 for selected SSA countries reveals no clearly discernible pattern. Some countries have successfully established manufacturing industries, with a rise in the share of MVA in GDP. This was particularly evident

in Cote D'Ivoire, Malawi, Mauritius and Zimbabwe, while most other countries have witnessed a stationary trend in manufacturing production as a share of GDP. Yet, other countries in the region have experienced a downward trend in MVA, particularly in the 1980s, resulting in de-industrialization, according to Sekkat and Varoudakis (1994). These included Senegal and Tanzania. A key element associated with de-industrialization in several countries in SSA was import compression, which undermined industrial production. The failed ISI strategy fueled a decline in export capacity and together with deteriorating terms of trade in the region; the limited export capacity triggered a precipitous fall in import capacity of intermediate inputs critical for maintaining manufacturing capacity utilization. Table 2 shows the trend in the average share of manufacturing value added in GDP for selected SSA countries from 1970 to 1995, featuring mostly low levels of MVA in most countries over the period in view.

Table 2: Average Share of Manufacturing Value Added in GDP for Selected SSA countries, 1970 – 1995 (in Percentages)

	Country	**1970 – 79**	**1980 – 84**	**1985 – 89**	**1990 – 95**
CFA Zone	Burkina Faso	18.91	15.97	16.28	16.41
	Cameroon	9.71	7.42	12.59	12.54
	Central African Rep.	7.33	7.87	7.00	n.a
	Congo, DR	8.91	5.79	7.86	7.67
	Cote D'Ivoire	12.15	14.16	18.37	19.34
	Mali	6.99	5.55	8.37	7.53
	Niger	5.13	4.33	7.02	n.a
	Senegal	16.85	11.93	12.97	12.39
	Togo	7.49	7.08	7.78	9.58
		11.09	5.53		7.45
Non CFA Countries		11.95	12.21	10.43	10.96
		7.40	10.91	11.67	12.14
	Ghana	11.94	12.63	11.80	18.35
	Kenya	15.12	16.09	16.06	23.32
	Madagascar	4.83	9.66	23.27	6.82
	Malawi	10.17	9.12	10.01	8.22
	Mauritius	14.69	19.81	7.73	29.86
	Nigeria	22.69	25.34	26.60	28.64
	Tanzania			25.58	
	Zambia				
	Zimbabwe				

Note: n.a. = not available

Source: World Bank data, 1970-1995

6.0 Economic Reforms and Industrialization in Sub-Saharan Africa

It is noteworthy that following economic reforms associated with the Structural Adjustment Program (SAP) in SSA, manufacturing capacity expanded in some countries across the region. For example, Ghana's economic liberalization program induced increased capital inflows, triggering a positive response to the industrial sector, with a share in GDP almost doubled in the latter half of the 1980s. Indeed, manufacturing value added outcomes have a considerable impact on export performance in SSA. While the share of manufacturing in total exports remains extremely low in most countries, some witnessed considerable progress in the aftermath of economic reforms, including Cote D'Ivoire and Mali in the CFA zone; as well as Ghana, Madagascar and Tanzania in the non-CFA Zone. Mauritius demonstrated exemplary performance with manufactured exports, triggered by its policy of Export Processing Zones (EPZs). The nation's export share of manufacturing was lower than Kenya's in 1970, while its share of MVA in GDP was also lower than Senegal's; however; Mauritius' share of manufactured exports climbed to more than two-thirds of total exports in the first half of the 1990s. On the other hand, other countries, including Kenya and Zimbabwe, which were associated with a comparatively good performance earlier, were unable to sustain a rise in the proportion of manufactured export in the 1990s.

It should be noted that agricultural products are probably the most dynamic elements in manufacturing export expansion in SSA, particularly in the 1990s. This is hardly surprising, as the products are associated with low-skill, labor-intensive manufacturing industries. This development is also acknowledged as the first-stage in international specialization for unskilled, labor-abundant developing countries. Mauritius was particularly successful with its robust share of textile exports in total exports, estimated as high as 84% in the first half of the 1990s; and provided an exemplary performance that could be replicated in such other countries as Kenya and Malawi. Table 3 shows the average share of manufactured exports in total exports for selected countries in SSA over the period, 1970 – 1994, featuring considerable divergence in the selected countries over the period in view.

Table 3: Average Share of Manufacturing Exports in Total Exports for Selected SSA Countries, 1970 – 1994 (in percentages)

	Country	**1970 – 79**	**1980 – 84**	**1985 – 89**	**1990 – 94**
CFA Zone	Burkina Faso	5.81	5.73	5.22	6.22
	CAR*	26.67	35.36	42.95	65.33
	Cameroon	3.45	2.75	2.76	2.64
	Congo	12.94	5.97	8.58	20.89
	Cote D'Ivoire	4.35	6.11	7.63	10.43
		7.14	10.45	12.39	22.84
		14.90	79.41	90.33	86.73

	Mali	9.69	12.63	14.19	12.52
	Niger	4.85	10.53	4.67	7.86
	Senegal				
	Togo				
		3.87	5.65	10.43	18.24
	Non CFA	16.15	17.17	11.67	18.57
	Countries	6.54	7.14	11.80	18.04
	Ghana	4.02	7.98	16.06	7.01
	Kenya	13.83	32.36	23.27	67.61
	Madagascar	0.92	0.42	10.01	2.00
	Malawi	10.18	11.39	7.73	13.74
	Mauritius	2.16	3.23	26.60	4.47
	Nigeria	33.08	30.42	25.58	31.29
	Tanzania				
	Zambia				
	Zimbabwe				

Note*: CAR= Central African Republic
Source: World Bank data, 1970-1994

Following economic reforms in the 1980s, more countries in SSA succeeded in diversifying their exports, while most countries exhibited considerable export concentration. Apart from Mauritius, which featured robust export diversification in the 1990s, other countries that followed the trend included Cote D'Ivoire, Senegal, Kenya, Madagascar, Tanzania and Zimbabwe.

In a reversal of trends, indications are that the manufacturing sub-sector in SSA is growing, particularly in recent times. While several countries may have witnessed de-industrialization phenomenon in the 1980s, more countries have recovered and are featuring a more robust manufacturing sub-sector around the region. On the one hand, the share of manufacturing in GDP (at factor prices) declined from 18% in 1975 to 11% in 2014; on the other, manufacturing production rose considerably, more than doubling from US$73 billion in 2005 to US%157 billion in 2014. This is complemented by a rise in manufacturing activity, estimated at an annual growth rate of 3.5% between 2005 and 2015, a trend that is faster than the global growth in manufacturing production (Balchin, Gelb, Kennan, Martin, Velde, and Williams, 2016). The authors reveal four of nine selected SSA countries for which data are available showed that food and beverages, usually a domestically oriented industry, was the dominant manufacturing sector, with 40 – 70%, followed by textiles and clothing, which are more prone to export orientation. The 'other' category, according to the authors, is a mix bag, associated with cement production in Nigeria (6%), machinery and transport equipment in Kenya (12%) and non-metallic mineral products in Rwanda (5%). It is noteworthy that recent national data in Tanzania, Uganda and Zambia suggest a strong manufacturing growth; albeit, with mixed performances across sub-sectors. For example, real growth in Tanzanian manufacturing was estimated at 6% per year from the period 2008-2012, but basic metal industries rose by 14%, while the textile and leather sub-sectors declined by 10%. In Uganda, total manufacturing real output growth was estimated

at 5% over the period 2010-2014; however, food processing, drinks and tobacco rose by 8%, while chemicals declined by 3% and textiles, clothing and footwear dropped by 11%. Zambian manufacturing rose by 3% per year over the period 2006-2010, while the paper industries increased by 14%, but the textiles and leather industry declined by 32%.

Despite policy makers' embrace of export-oriented Industrialization associated with structural adjustment in SSA since the 1980s; Balchin et al., 2016; reveal that Africa's share of total world manufacturing exports remained paltry, at less than 1% and had fallen marginally since 2010. However, the performance masked considerable variation across manufacturing sub-sectors. For example, the region's shares in global exports of fertilizers and inorganic chemicals both exceeded 5%, while it also accounted for more than 4% of global exports of leather, leather manufactures and dressed foreskins, together with about 2% of world's exports of articles associated with apparel and clothing accessories. Indeed, Africa had increased its share of world export in several other manufacturing sub-sectors since 2005. Africa's export orientation with many manufacturing product groups has witnessed strong growth in recent times. Available data reveal that between 2005 and 2014, exports from Africa as a whole grew at an annual average of 10% or more in 14 of 34 product groups, with the fastest growth witnessed in exports of plastics in non-primary forms (17.9%), telecommunication and sound recording equipment (15.9%), chemical materials and products (14.5%) and specialized machinery (13.3%).

Also, Intra-African trade in export manufactures is increasing. Indeed, between 2005 and 2014, the share of intra-African manufacturing exports as a share of total value of African manufacturing exports rose by about 15% to reach 34%. Regarding performance with product groups, export of road vehicles, iron and steel, essential oils for perfume materials, as well as cleaning preparations, non-metallic mineral manufactures and manufacturers of metals contributed the largest proportion of intra-African manufacturing exports.

A comparative analysis of manufacturing export performance in the nine selected SSA countries revealed considerable variation across countries. For example, the value of Ethiopia's and Rwanda's manufacturing exports was considerably smaller, compared to those of Ghana, Kenya and Nigeria, reflecting in part the relative sizes of the various economies. Measured in average annual terms, growth in manufacturing exports to global markets during the period 2005 – 2014 was fastest in Rwanda, followed by Nigeria, Tanzania and Ethiopia. During this period, Mozambique and Zambia also improved export performance on manufactures considerably. Figure 4 shows the product groups among the top five manufacturing exports to global markets in 2014 in more than one of the selected African countries, revealing the diversity of manufactured exports in the selected countries.

Manufactured Product Group	**Countries**
Leather manufactures	Ethiopia, Nigeria, Uganda
Textile yarn and fabric	Ethiopia, Nigeria, Tanzania
Apparel, clothing & accessories	Ethiopia, Kenya
Lime, cement, construction material	Ethiopia, Rwanda, Uganda, Zambia
Perfume, cosmetics & cleansers	Ghana, Kenya, Uganda
Industry special machinery	Ghana, Mozambique, Nigeria, Tanzania, Zambia
Miscellaneous manufactures	Kenya, Mozambique, Nigeria, Tanzania
Iron and steel	Kenya, Mozambique, Rwanda, Uganda, Zambia
Inorganic chemicals	Kenya, Zambia
Railway/tramway equipment	Mozambique, Nigeria, Rwanda.

Figure 4: Product groups among the top five manufacturing exports to the world in 2014 (by $ value) in more than one of the selected African countries
Source: Adapted from Balchin et al., 2016

It is interesting to note that several of the manufactured goods in figure 4 are ranked alongside the top five fastest growing exports in the world over the period, 2005 – 2014.

While several countries have experienced growth of the manufacturing sub-sector in recent times, it continues to task the efforts of policy makers in SSA. For example, the annual MVA in SSA over the period 2001 – 2005 was estimated at 12.11%, reducing to 10.19% between 2006 and 2010, and dipping even further to 9.88% between 2011 and 2015. A most critical factor undermining the growth of the manufacturing sub-sector in SSA is the dearth of physical and social infrastructure. In a study on infrastructure and manufacturing value added in SSA, Nnadozie and Raifu (2020) relied on panel data for 34 SSA countries for the period 2003-2018. The data were sourced from the African Development Bank (2019), World Development Indicators (2018) the KOF Globalization Index (2019), the World Bank Worldwide Governance Indicators (2019), as well as International Labor Statistics Database (2018). Data on infrastructure included those on electricity, transportation, water and sanitation, telephone subscriptions, internet users and international bandwidth, among others.

Empirical findings reveal that infrastructure exerts mostly positive outcomes on manufacturing value added in SSA, irrespective of the nature of infrastructure. The study assessed the effect of infrastructure on manufacturing value added across SSA's four major sub-regions: East, West, Central and Southern Africa. However, findings also reveal mixed performance across each sub-region. For example, the West African aggregate infrastructure index had a positive and significant impact on MVA, while results from different components are mixed. On the one hand, electricity index had an insignificant effect on MVA; on the other, transport infrastructure index had a significantly positive influence on MVA. ICT, water and sanitation also had

insignificant effects on MVA. In East Africa, the study reveals the effect of infrastructure on MVA was generally poor. Indeed, the aggregate infrastructure index featured a significantly negative effect on MVA.

Regarding various infrastructure types, the study also reveals that electricity and water sanitation have positive effects on MVA, with water and sanitation featuring statistically significant levels at 10%. On the other hand, transport and ICT have negative effects on MVA. Infrastructure also had a significant effect on MVA in Southern Africa. In a similar development with East Africa, the study reveals that the effects of each infrastructure component on MVA were mixed. While electricity had a positive and significant effect on MVA; transportation and ICT had negative effects. However, the positive effect of water and sanitation was statistically insignificant. In the case of Central Africa, the study reveals all measures of infrastructure had a positive impact on MVA. While aggregate infrastructure index, electricity and transport were statistically significant, ICT, water and sanitation were statistically insignificant.

Apart from infrastructure imperatives, acquisition of novel technologies is critical to the performance of manufacturing value added in SSA. In an empirical study, Ojo and Ogunleye (2019) examined the impact of technological leapfrogging on manufacturing value added in SSA. Relying on panel data spanning 1990 to 2018, findings reveal that technological leapfrogging was a positive driver of manufacturing value added across the region. This is critical for the productive activities of domestic firms with good prospects for innovation and creativity that can translate into the emergence of indigenous technology, according to the study.

7.0 Africa and the Fourth Industrial Revolution

The latest trend in global industrialization is the emergence of the fourth industrial revolution. This development is pertinent to the transformation of the economy in SSA. The 4IR holds considerable prospects for the transformation of the region's economy. While the region lags behind in several indicators critical for the realization of the 4IR, indications are that the emergent digital revolution in several African countries holds the key for the desired transformation. Improvements in Africa's ICT infrastructure are reinforcing the digital revolution in the region. For example, the region accounted for about one-half of global money accounts in 2018 and is projected with the fastest growth in mobile money through 2025 (Ndung'u and Signé, 2020). Africa's ICT sector is growing, with mobile technologies and services generating 1.7 million direct jobs (both formal and informal), and contributing US$144 billion in economic value, or 8.5% of GDP in sub-Saharan Africa. It has also contributed US$15.6billion to the public sector through tax revenue, according to Ndung'u and Signe (2020). A major objective of policy makers in the region is to leverage upon the fourth industrial revolution for the transformation of its industrial economy from the periphery to the mainstream of global markets (UNECA, 2017). This is a pathway traversed by the 'Asian Tigers' in East Asia, comprising Singapore, Taiwan, South Korea and Hong Kong by the 1980s. The transformation of the Asian Tigers transformed their economic status to become 'Newly Industrialized Economies'.

Digital technologies are transforming Africa's economic growth and development, particularly in the past couple of decades. The transformation is driven by the digital revolution, reinforced by increasing access to such critical tools as the Smartphone, internet, ICT infrastructure, as well as the emergence of Finetechs that provide a variety of services with novel technologies. Since the turn of the Millennium, digital technologies have been rapidly impacting Africa's economy and society, with innovations creating disruptions in several countries. The fourth Industrial Revolution (4IR), for example, has emerged as a major force for Africa's digital transformation, which is gradually integrating such novel technologies as artificial intelligence, robotics, internet-of-things, 3D printing and gene editing. This development is shrinking the boundaries between the digital and physical worlds, with profound impacts for structural transformation across the African continent.

The digital economy holds considerable prospects for Africa, projected to reach US$180 billion by 2030 (ECDPM, 2022). Indeed, digital revolution, driven by smart devices and the internet, are increasingly spurring innovation and social change across the region. It facilitates entrepreneurship and enables socio-political mobilization, accompanied by changing social interactions and economic organizations in several countries. In order to fast track the digital revolution in Africa, the African Union (AU) has established the Digital Transformation Strategy (DTS), critical to operationalizing the DTS in several sectors: Digital Industry, Digital Trade and Financial Services, Digital Government, Digital Education, Digital Health, Digital Agriculture, etc. In addition, a framework for Digital ID was adopted by the AU Executive Committee in February 2022, while African Education ministers also embraced the AU Digital Education Strategy (DES) in September, 2022. The DTS framework provides an elaborate strategy for Africa's digital transformation. It is accompanied by a developmental vision associated with digital transformation, with an emphasis on African ownership of the emerging technologies. It envisions the imperatives for Africa to emerge as "a producer and not only a consumer in the global economy". The strategy is particularly focussed on industrialization, which is critical to driving the region's path towards structural transformation. A major component of the DTS is the building of a Digital Single Market (DSM) in Africa by 2030, as a digital dimension of the African Continental Free Trade Area (AfCFTA). It embraces the creation of harmonized rules and regulations aimed at building a common African space for innovation and e-trade. In order to achieve this goal, regulations and standards are to be harmonized across the sub-regions and eventually the entire continent, reinforced by safe, secure and accessible internet connectivity to large segments of the population.

While Africa still lags behind most other regions of the world in the emergent digital economy, indications are that the region is closing the gap rapidly. Improvements in Africa's ICT sector have reinforced innovations and expanded mobile digital financial services across the region, accounting for about half of global mobile money accounts in 2018 and projected to witness the fastest growth in mobile money through 2025 (Ndung'u and Signé, 2020). Figure 5 illustrates Africa's ICT development indicators.

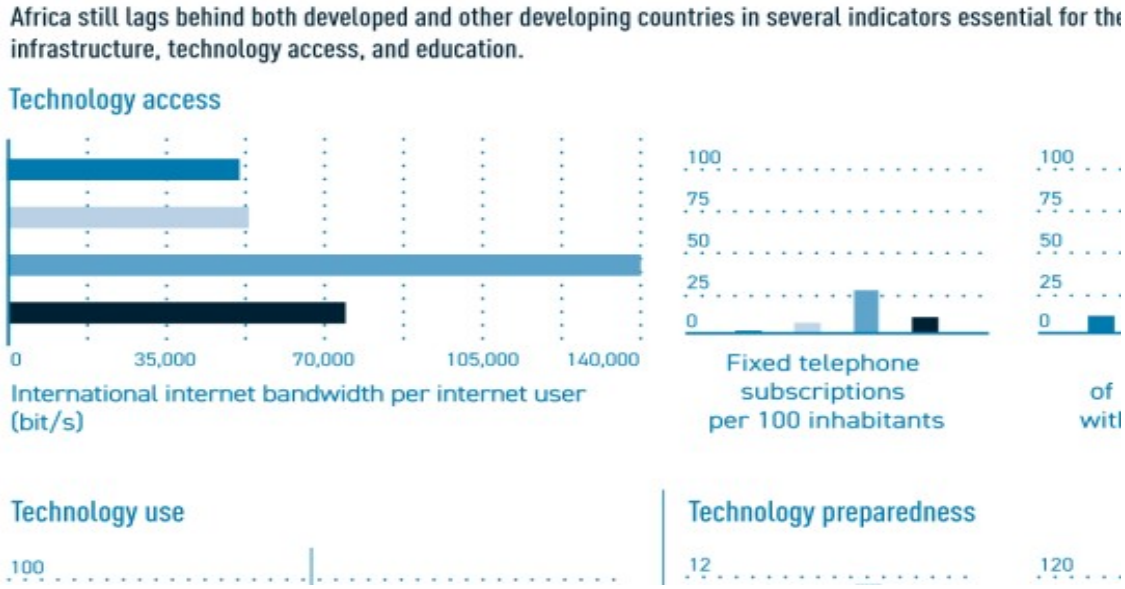

Figure 5: Africa's ICT Development Indicators
Source: Ndung'u and Signé (2020)

Figure 5 reveals Africa lagging behind both developed and several developing countries in several indicators driving the fourth industrial revolution, particularly in infrastructure, technology access, and education.

In a manifestation of globalization, Africa's ICT sector has witnessed rapid growth in recent years, with mobile technologies and services generating 1.7 million direct jobs (both formal and informal), and accounting for US$144billion in economic value, or 8.5% of GDP in Sub-Saharan Africa. The sector has also contributed US$15.6billion to the public sector through taxation. Indeed, Africa's working population is acquiring more education skills and embracing automation more broadly. This is critical for opportunities associated with the 4IR. It is projected that by 2030, Africa's growing labour force will emerge as the world's largest, making infrastructure and skills for innovation and technology use critical for participating in the 4IR.

The digital revolution provides an opportunity for the transformation of the agricultural economy in Africa, which accounts for 60% of total employment in Sub-Saharan Africa. The food system is projected to create more jobs than the rest of the economy between 2010 and 2025. Farm activities in the sub-region account for about 50% of all rural income in such countries like Ethiopia, Malawi, Nigeria and Tanzania, where information on competitive pricing, monitored crops information, disease prevention tips, as well as disaster mitigation management, has the potential to transform the agricultural economy for improved income, production and demand. Also, mobile technology has emerged as a platform driving activities in other sectors of the African economy. For example, about 27,000 public health workers in Uganda embraced a mobile system known as mTrac to report medicinal stocks. Also, the SMS for life program, a public-private partnership framework, reduces medical shortages in primary healthcare services through mobile phones to track and manage stock levels of malaria treatments, as well as other

critical drugs. Rwanda has emerged as the first country in Africa to incorporate drones into its healthcare infrastructure, with the application of autonomous air vehicles to deliver critical blood transfusions to remote areas. Digital technology has also emerged as a key instrument for improved disaster management. During the West African Ebola outbreak in 2014, the WhatsApp platform became a tool for disseminating information, assessing symptoms, as well as communicating under quarantine. In Ethiopia, Artificial Intelligence (AI) is gradually being employed to assist medical professionals to correctly diagnose cervical cancer and other ailments, while IBM Research Africa is also driving AI to determine the optimal methods for eliminating malaria in specific locations with application of the game theory and deep learning data analytics to diagnose pathological diseases, as well as birth asphyxia.

The digital economy in Africa has assumed a revolutionary dimensions in the past few years. Between 2020 and 2021, the number of technology start-ups has tripled to about 5,200 companies, with just under half emerging as Finetechs, which are unleashing business activities that disrupt but augment traditional financial services (McKinsey & Company, 2020). Indeed, African Finetechs are acknowledged with significant inroads into the market, with estimated revenues of about US$4 to 6 billion in 2020, accompanied by an average penetration of between 3 and 5% (excluding South Africa), in a development that compares with global market leaders. McKinsey analysis reveals that Africa's financial services market has the potential to grow at about 10% annually, climbing to about US$230 billion by 2025 ($150 billion, excluding South Africa, which has emerged as the largest and most mature market in the region). Finetechs players across the continent are delivering significant value to their customers, with transactional solutions becoming 80% cheaper, while interest rate on savings rising up to three times than those provided by traditional players. At the same time, the cost of remittances may be six-fold cheaper.

However, growth in financial services across the African continent is far from uniform. Currently, South Africa is acknowledged with the lion's share of the market, estimated at 40% of revenues. Ghana and Francophone West Africa are projected to witness the fastest growth, at 15% and 13% per year, respectively, until 2025. This is followed by Nigeria and Egypt, with each expected to grow at the rate of 12% per year over the same period. Overall, McKinsey Analysis projects that growth opportunities in Africa's Finetechs are likely to be concentrated in 11 key markets: Cameroon, Cote D'Ivoire, Egypt, Ghana, Kenya, Morocco, Nigeria, Senegal, South Africa, Tanzania and Uganda, all together accounting for 70% of Africa's GDP and half of its population. The emergence of Finetechs across the continent presents considerable opportunities. This is against the backdrop of the fact that the majority of all transactions, estimated at 90%, are still cash based. Consequently, successful Finetechs are mobilizing to engage with clients offline by building agent networks or leveraging pre-existing infrastructure, including physical shops for delivery of financial services. For example, South Africa's first digital bank, TymeBank, relied on a strategic alliance with major retailers, allowing the bank to place account-opening kiosks in retail outlets across the country, bypassing the need for physical branch networks.

In a significant development, Africa is witnessing an accelerating shift to digital payments across the region, driven by a global electronic payment industry. In 2020, Africa's e-payments

industry, both domestic and cross-border payments, generated about US$24billion in revenues, of which about US$15billion is associated with domestic electronic payments. This revenue was generated from 47 billion individual transactions, with a total of just over US$800 billion of transaction values. On average, only 5 to 7% of all payment transactions across Africa were effected via electronic or digital platform, compared to 50% or more in Turkey, for example. This is evident that e-payments are a major growth opportunity in Africa, particularly with improved and supporting infrastructure (McKinsey & Company, 2022). Electronic payments are benefiting from rising productivity and falling data costs in Africa. Across the region, policy makers are mobilizing resources to spur internet and mobile phone penetration amid declining costs. In 2017, Sub-Saharan Africa had more than 300 million mobile connections, 40% of which were Smartphones and subscription is projected to double to more than 600 million in 2022, accompanied by mobile-data traffic, which is expected to climb seven-fold.

Domestic payments infrastructure is accelerating in several African countries, spurring an increase in real-time payments. This development is enabling instant account-to-account transactions. Indeed, a few African countries are engaged in new rails or upgrading existing infrastructure with modern technology; however, only six countries have transformed into real-time payments at the end of 2021. Nigeria is ranked alongside the top-ten countries in the world, with real-time transactions in absolute terms, ahead of the US, Japan, and Brazil, while Kenya is projected to witness the fastest growth in real-time payments, according to McKinsey & Company (2022) report. Egypt has recently approved regulations enabling instant payments, while Ghana has also introduced instant payments, with Tanzania and other countries embracing the trend.

8.0 Conclusion

Sub-Saharan Africa has engaged in a long struggle to industrialize its economy over the past several decades. Policy makers in several countries across the region embraced Import-Substitution Industrialization (ISI) as a framework to fast track industrial development in the late 1950s into the 1980s. However, the attempt under the framework collapsed due to its poor management, lack of competition, and inefficient allocation of resources, foreign exchange scarcity, among others. Consequently, many African countries embraced economic reforms, culminating into the Structural Adjustment Programme (SAP). Beginning from the mid-1990s the manufacturing economy in Sub-Saharan Africa witnessed a gradual transformation, with rising Manufacturing Value Added (MVA) as a component of GDP. The process has accelerated into the early 21st century. While the region's industrial profile continues to lag behind that of other major regions of the world, the emergence of the fourth Industrial Revolution provides opportunities to bridge this gap and transform industrialization in the region from the periphery to the mainstream of global markets. The digital revolution is rapidly manifesting across Sub-Saharan Africa, transforming the industrial and service sectors for higher productivity and a more competitive position to participate effectively in global markets.

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