

AGRICULTURE, MANUFACTURING AND THE FOURTH INDUSTRIAL REVOLUTION IN NIGERIA- MATTERS ARISING.

SUB - THEME 2: DIGITAL REVOLUTION IN AGRICULTURE AND
MANUFACTURING FOR SELF SUFFICIENCY AND
EXPORT

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INTRODUCTION

- ❑ Nigeria has not really benefited from the boom created by technology in the past tens of decades, including the 1st, 2nd and 3rd industrial revolutions.
- ❑ Nigeria did not benefit during the era of the personal computer (PC) era ushered in by Microsoft, IBM, and Apple; as the country was not ready for it.
- ❑ Microsoft and co. envisioned a world in which every human being had a Personal Computer; in Nigeria, it was few and far between, and could not lead to the massive productivity that it promised.
- ❑ It took the evolution of mobile technology, and the advent of the smart phones to allow Nigeria to finally get access to the Internet, and attendant benefits.

- ❑ Although there are patches of benefits here and there, but overall, Nigeria seems to have lost in the race to use technology to advance its civilization, and build wealth for her citizens.
- ❑ The prevailing Covid-19 pandemic crisis has sped up the arrival of the future and has thrown the technological shortcomings of our societies and governments into the spotlight, especially in the education, health, industrialization, food security and employment (job creation) sectors.
- ❑ This 4IR is beginning to emerge at the same time that the third digital revolution is spreading and maturing across countries and organizations.
- ❑ The question remains how we can collectively and individually, ensure that it creates benefits for the many, rather than the few, especially in the agricultural and manufacturing subsectors of the Nigerian economy.

Industrial Revolutions

Table 1: Main Characteristics of Industrial Revolutions

Period	Transition Period	Energy Resource	Main Technical Achievement	Main Developed Industries	Transport Means
I: 1760-1900	1860-1900	Coal	Steam Engine	Textile, Steel	Train
II: 1900-1960	1940-1960	Oil Electricity	Internal Combustion Engine	Metallurgy, Auto, Machine Building	Train, Car
III: 1960-2000	1980-2000	Nuclear Energy Natural Gas	Computers, Robots	Auto, Chemistry	Car, Plane
IV: 2000-	2000-2010	Green Energies	Internet, 3D Printer, Genetic Engineering	High Tech Industries	Electric Car, Ultra-Fast Train

Source: Prisecaru, P. (2016)

- ❑ The fourth industrial revolution (4IR) is Also known as the 'digital revolution'.
- ❑ It combines technological and human capacities in an unprecedented way. It is an era of technology development marked by a fusion of digital, biological, and physical systems, in a way that will affect all sectors of life.
- It talks about self-driving and electric cars, robotics, 3D printing, ambient computing, wearable technologies and automation; among others.

- In practical terms, 4IR will invade, and disrupt all sectors of the economy, transform, merge and connect most sectors together, and finally infuse them in an intimate level with humans.
- Thus, the real platform is to look beyond technology, and find ways to give the greatest number of people the ability to positively impact their families, organizations and communities.
- A major distinction between the 4IR and other revolutions is the speed of current breakthroughs which is evolving at an exponential rather than a linear pace.

Relationship between Earlier Revolutions and 4IR

- ❑ First, the productivity of each subsequent age goes up fifty times over the preceding age. Consider for example, the increase in productivity of the industrial age over the agricultural age.
- ❑ Second, each subsequent age destroys many of the jobs of the preceding age. The information age is replacing the jobs created by the industrial age.

- Third, in the first three ages of civilization manual workers produced most goods and services with their body, but in the last two ages, knowledge workers produce most goods and services with their mind.
- The main assets and primary drivers of the industrial age were machines and capital. People were necessary but replaceable.
- The management style of the industrial age focused on motivating employees to perform the physical labor needed to produce the products and services.
- In the 4IR age, the challenge now is how companies can motivate their knowledge workers to release their human potential.

Key Emerging Technologies Linked to 4IR

- a) Big data: Voluminous machine-readable data
- b) Big Data analytics: Refers to techniques and technologies that allow big data to be generated, stored, accessed,
- c) Cloud computing: Cloud computing services are used over the internet to access software, computing power, storage capacity and the likes.

- d) Additive manufacturing: The use of special printers to create three dimensional (3D) physical objects by adding layer upon layer through various means. Additive manufacturing is contrasted with subtractive manufacturing methods, which use moulds or rotating milling cutters to remove material from a solid block of materials .
- e) Artificial intelligence: The branch of computer science which seeks to make computers intelligent and capable of mimicking and predicting human behaviour and solving problems as well as or better than humans.

f) Blockchain: A network of computers that must all approve a transaction before it can be verified and recorded. Using cryptography to keep transactions secure with reliability and anonymity.

The record of events is shared between many parties and information once entered cannot be altered. Before blockchain, we relied on trusted institutions such as a bank to act as a middleman.

g) Machine-to-machine: Direct communication or data exchange between machines, or between machines and devices or components. The interconnection of more machines able to communicate is known as Internet of Things.

h) The Internet of Things (IoT): Is the Internetworking of physical devices. System of interrelated computing devices with the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Drones: Unmanned flying vehicles that are controlled remotely. Depending on their design, they may be used for surveillance, survey, sports, cinematography and delivery.

j) Robotics/ Robots: Machines programmed by a computer and designed to execute one or more complex tasks automatically with speed and precision. Robots can be industrial robots (carry out industrial tasks); service robots (cleaning, surveillance and transportation tasks) and collaborative robots (portable and physically interact with man).

k) Building Business around Social Platform (Network Building): Use of social network which include e-marketing, mobile marketing, mass customization and social marketing.

Business platforms tools and techniques include; websites, online public relations, email, blogs, social networks, podcasts and wikis.

l) Social commerce is a subset of e-commerce that utilizes the social interaction media and technologies to assist in the marketing of goods and services

These include;

Facebook, Twitter, Youtube, Amazon, Google+, Instagram, Pinterest, LinkedIn as well as personal ¹⁴websites; among others.

- m). **Advanced Digital Production Technologies (ADPs):** These are technologies that combine hardware (advanced robots and 3D printers), software (big data analytics, cloud computing and artificial intelligence) and connectivity (the Internet of Things). ADPs are the latest evolution of digital technologies. They give rise to smart production— also referred as the smart factory, or Industry 4.0.
- n). **Smart factory and Smart Manufacturing:** A smart factory is a plant applying smart manufacturing. It is used in general, to refer to the growing computerization and automation of manufacturing plants. Smart manufacturing is the application of ADPs to manufacturing production.
- o). **Wearable internet:** Implantable and wearable devices such as sports shirts that provide real-time workout data by measuring sweat output, heart rate and breathing intensity are available. These devices can provide immediate information about our health and about what we see, or help locate missing children.

AGRICULTURE

- ❑ A transformed agricultural sector is an important key to any developing economy's drive for economic development and inclusive economic growth.
- ❑ It ensures food security, promotes industrialization, provides jobs, stimulates strong resilience to external vulnerabilities and fosters shared prosperity.
- ❑ Hardly can a country industrialize without first modernizing its agricultural sector;
- ❑ It is a key driver of non-farm economic development.

- ❑ Each dollar of additional value added in agriculture generates another 30 – 80 cents in second – round income gains elsewhere in the economy.
- ❑ Growth in the agricultural sector will be at least 2 to 4 times (11 times in SSA) more effective in poverty reduction than in any other sector.
- ❑ Several countries that have achieved high-income status started with agriculture. China's rapid growth in GDP per capita from \$155 to \$8,123 between 1978 and 2016, was due to agricultural transformation.

- ❑ Brazil and Vietnam, at the least, doubled the value of their agriculture sector within 20 years of starting their transformation;
- ❑ Ethiopia and Rwanda reduced poverty by 33% since 2000, with an agricultural GDP growth of near 10% per year being the main driver.
- ❑ Nigeria accounts for 40.65% (5.0 million) of the people estimated to be in food crisis in West Africa, having more than the total number of hungry people from countries that rank next – Cameroon (1.4 million), the Niger (1.4 million) and Burkina Faso (1.2 million) (FSIN, GRFC 2020).

- ❑ The Hunger and Commitment Index for Africa (HANCI-AFRICA) has put Nigeria in 37th place out of 45 countries based on its political commitment to tackle hunger and under nutrition.
- ❑ South Africa, Malawi and Madagascar occupied the top three positions. Nigeria's low ranking stems from the fact that the country spends low on its agriculture and health sectors.
- ❑ Nigeria is conspicuously missing in the list of Africa's top 10 most advanced food-secure countries. According to The Africa Country Benchmark Report (ACBR, 2017) Tunisia, Morocco and Algeria as the most food-secure countries in Africa.

Reasons For High Level Food Security

- ❑ Democracies (pro-people governance - governments are more attentive to the needs of their populations);
- ❑ Peaceful coexistence (Absence of armed conflict-focused national spending and efforts on food security),
- ❑ Historic trade routes with foreign markets (export-driven trading economies (perennial food exporters- assured availability of food even when local crops are affected by natural disaster.
- ❑ and none is geographically landlocked
- ❑ All above lead to More Prosperous Economies, ^{to} Allowing Citizens to Purchase More and Better Quality Food.

- The Global Peace Index (GPI-2019) which measures peacefulness across three domains: safety and security, ongoing conflict, and militarisation has placed Nigeria (148 out of 163) among the 5 least peaceful countries in Sub-Saharan Africa; including Democratic Republic of Congo (155), Central African Republic (157), Somalia (158) and South Sudan (161).

Economic Actualizations/Potentials

- ❑ Largest employer of labor in the country, providing jobs for more than one – third (36.4%) of the labour force, the highest over the past 28 years (1991 – 2019).
- ❑ The Agro-sector has been growing steadily over the last three years at an average of 2.6%.
- ❑ As at Q1 2020, the sector accounted for about 22% of Nigeria's GDP compared to oil and gas (9.5%), manufacturing (9.7%), financial services (3.9%), and trade (16.1%).
- ❑ Contribution to GDP average (24.8%) over the five years from 2015 to 2019.
- ❑ The value of imported agricultural goods increased by 12.02% in Q1 2020 compared to Q4 2019 and 10.62% more than Q1 2019.

- ❑ The value of Agricultural goods exports grew 85.36% in Q1,2020 compared to Q4,2019
- ❑ Main agricultural exports; Sesame seeds, cashew nuts, fermented cocoa beans, ginger, frozen shrimps and cotton. (Sesame, cashew nuts and cocoa accounts for more than half of the nations agricultural exports)

The Top Agro Exports (first half of 2019):

However, the share of agriculture in Nigeria's total export earnings remains small compared to crude oil exports. In 2019, agriculture (less than 2% of total exports) Crude oil (76.5%).

Reasons for Slow Agro-Growth

- i. Nigeria's agricultural sector is primarily focused on meeting domestic demand and is less export oriented. Food production cannot keep-up with population expansion resulting in increase in importation, even with increased productivity.
- ii. Approximately 92% of activities in farming are informal, with little or no documentation.
- iii. There is a preponderance of smallholder farmers, cultivating low-yield staple food crops on small plots with minimal use of agricultural inputs, and heavily rainwater-dependent, (Production subjected to the vagaries of the weather).
- iv. Tax uptake from Agriculture is very low, owing partly to its informal nature
- v. Fiscal planning is relatively difficult.

Low Level of Technology Use

- vi. Engine powered technology (3%), Hand tools application (90%) and Animal drawn technology (7%)
- vii. Low Level of value addition and crop processing of agricultural commodities.
- viii. Post-harvest losses average 30-40 percent of total production.

Infractions and Inequities on the Agricultural Sector.

- Nigeria's agricultural sector has been described as one of the most underfunded in the world.
 - A. Nigeria's budgetary allocations to agricultural sector have not exceeded 2 per cent.
 - B. Neglected agricultural research system:

2010-2015 Nigeria spent approx. 1.5 percent of the budget on agricultural research activities [cf.]

Uganda (12.6%); Benin (17.0%); Côte d'Ivoire (20.0%)
 - C. Lending to the Agricultural Sector

2016 (3.26 %) and 2017 (3.36%)

(cf. Kenya -6%; Brazil, 18%).

- D. Foreign Direct Investment (FDI) in the agric sector have grown consistently at an annual average of 82percent within the last six years,
- Q1 of 2020- Total Capital Importation (inflows) \$5.85 billion
 - Banking sector - 51.08% (\$2.99bn) largest portion
 - Agriculture sector - 0.93% (\$54.2.m) 7th largest portion (out of 10 sectors)

i. Improved Seeds

- Less than 1% (8, 000 tonnes) of improved seed inputs made available
- Estimated requirement - 1, 000, 000 tonnes per annum.

ii. Fertilizer Use (Nigeria): 2019 (13 kg/ha)

African Average (8kg/ha)

Global Average (99kg/ha)

FAO Recommendation for SSA 200 kg/ha

iii. Mechanized Agriculture

- No. of Serviceable tractors in Nigeria (approx.45,000 units). Requires 750,000 extra tractors
- Nigeria - One of the least mechanized farming countries globally (132nd out of 188 countries),

Agricultural Re – Investment (Insurance)

Very low (Only 1% farmers can easily access insurance)

Out of 20 million commercial farmers in Nigeria, only 700,000 (3.5%) have accessed agricultural insurance as at 2014, implying over 19 million farmers are still unserved (OXFAM-2017).

- Low budgetary allocation and release to the Nigerian Agricultural Insurance Commission (NAIC).
- 2017, N917million was budgeted – N454million was released;
- 2018, N148million budgeted – N16million was released..

Infractions/Inequities on the Socio-economic Fabric of the Economy

- ❑ March 2017 - about 7.1 million people in Nigeria were facing acute food insecurity and in need of urgent life saving and livelihood protection (FAO, 2017).
- ❑ Nigeria accounts for 40.65% (5.0 million) of the people estimated to be in food crisis in West Africa.

ii. Food Inflation

- NBS shows that the composite food index rose by 15.48% in July 2020 compared to 15.18% in June 2020. This represents 0.34% increase compared to June figures.
- The Brookings Institution has rated Nigeria as the nation with the highest number of extremely poor people in the world.
- In May 2018, 87 million people lived in extreme poverty
- Number of Nigerians in extreme poverty increases by 6 people every minute

❑ iii. Inflation Rate

- ❑ Rose by 12.82% (year-on-year) in July, compared to 12.56% recorded in June 2020.
- ❑ On the prosperity Index, the Legatum Prosperity Index ranked Nigeria 128th out of 149 countries.
- ❑ Nigeria has the highest poverty rate in all OPEC countries.
- ❑ In May 2018, 87 million people lived in extreme poverty
- ❑ Nigerians spend over half (56.65%) of household income on food (the highest of all the 10 nations, world-wide that spend more than 40% of their income on food).
- ❑ USA citizens spend at least 6.4% household budget on food.

Unemployment Rate

- 2017 3rd Qtr - 18.8%.
- 2020 2nd Qtr - 27.1%
- Underemployed - 28.6%

Unemployment (Youth)

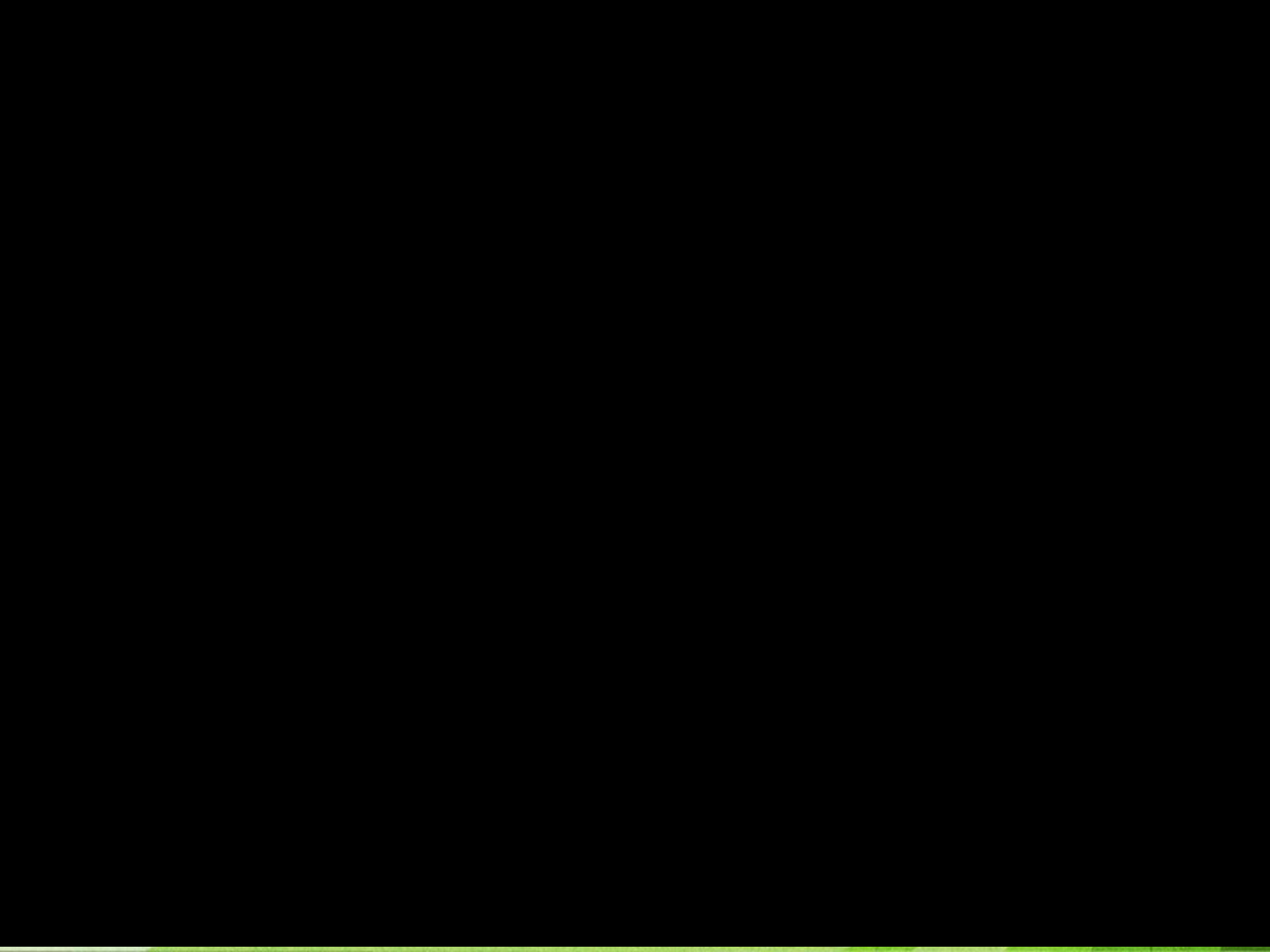
- 2017 3rd Qtr - 29.7%.
- 2020 2nd Qtr - 34.9%

13.9 million youth (15 - 34 years) are unemployed

Graduates and post graduates combined made up about 2.9 million of the total Nigerians that are unemployed.

Various Attempts to Revitalize the Agricultural Sector

- Major challenges were addressed in the **Nigerian Vision 20: 2020 (NV20: 2020)** which was prepared in 2009 (launched in 2010).
- The first implementation plan (2010-2013)
- Second Implementation Plan (2014-2017)
- Third Implementation Plan (2018-2020)
- The agricultural sector has witnessed remarkable policy changes since the launch of the vision document
- The first implementation plan (2010-2013) was ongoing when the **Agricultural Transformation Agenda (ATA)** came on stream in 2011 and lasted till 2015.
- In August 2016, the **Agriculture Promotion Policy (The Green Alternative)** was launched and it is now reshaping the direction of agricultural development in the country.



MANUFACTURING

Characteristics of Nigeria's Industrial Sector

- ❑ Every economy sees industrialization and the role of the manufacturing sub-sector as indispensable in harnessing the existing resources of the economy and repositioning the state to raise the living standard of her citizenry.
- ❑ Nigeria's industrial sector has been characterized by high import content of industrial inputs, dwindling capacity utilization, high cost of production, low value added, declining output growth, low employment generation and inadequate linkages with other sectors of the economy (Obioma and Ozughalu, 2005).
- ❑ (About 14 years later) the sector has remained largely import dependent (a factor of its weak competitiveness) because many manufacturing firms have low local value addition, weak backward integration, inadequate forward integration, and very low job creation potentials (LCCL, 2019).

Attempts to Develop Nigeria's Industrial Sector

- ❑ Some of the policies/strategies employed by Nigeria to industrialize her economy, include: Import Substitution Industrialization Strategy;
- ❑ Export Promotion Strategy;
- ❑ Small and Medium Industries Equity Investment Scheme;
- ❑ National Economic Empowerment and Development Strategy (NEEDS);
- ❑ National Integrated Industrial Development (NIID)
- ❑ Nigeria Industrial Revolution Plan (NIRP) - was designed to accelerate the build-up of industrial capacity within Nigeria.
- ❑ Nigeria Industrial Policy and Competitiveness Advisory Council - Appointed in May 2017, with terms of reference including:
 - ❑ - Driving an ambitious industrialization programme aimed at increasing the contribution of manufacturing to GDP by 250% over five years (albeit from a low base),
 - ❑ ³⁷ Making Nigeria a manufacturing hub in West Africa, and diversifying the economy from its overdependence on oil.

Contribution of Nigeria's Industrial Sector to National Development

- ❑ In 2018, the industrial sector contributed around 25.75 percent to Nigeria's GDP.
- ❑ For the manufacturing sector, for (2019), real contribution was 9.06% against 9.20% (2018) and 8.5% in(2017).

The largest manufacturing sub-sectors are:

- ❑ Agro processing (food, beverages and tobacco);
- ❑ Light manufacturing, including textile and wood products; and
- ❑ Resource processing (cement and basic metals).
- ❑ Traditionally, manufacturing has been dominated by Micro, Small and Medium Enterprises (MSMEs) that create jobs.

UNIDO Competitive Industrial Performance Index (2018).

- ❑ Nigeria ranked as 115th out of 150 countries.
- ❑ 11th out of 29 SSA countries,
- ❑ suggesting Nigeria's industrial potential remains somewhat underdeveloped.
- ❑ The ERGP is building on the Nigeria Industrial Revolution Plan (NIRP), which addresses the key challenges in manufacturing, such as limited access to credit and financial services, poor infrastructure and unreliable power supply, which force businesses to rely on generators, thus increasing their input costs and reducing their overall competitiveness and profitability.

Importance of the Manufacturing Sub-Sector

- ❑ A robust manufacturing sector is broadly understood as a fundamental path to economic growth and development.
- ❑ The most recent illustration is the launch of the African Continental Free Trade Area (AfCFTA) in March 2018, a single market for goods and services in Africa that aims to unlock manufacturing potential and facilitate industrialization, driving sustainable growth and jobs among other objectives.
- ❑ The key boon is that it absorbs a large proportion of workers and places them into productive and decent paying jobs. The African Union has put the sector front and centre in its Agenda 2063.
- ❑ It contributes significantly to the accumulation of physical and human capital, by providing good jobs for large numbers of unskilled or under-educated workers—particularly those who are not integrated in the formal economy, resulting in increases in household income, and hence; domestic demand.

- ❑ Industry generates substantial backward and forward linkages with other sectors, providing a wealth of opportunities for suppliers, distributors, retailers, and business services.
- ❑ A strong manufacturing sector improves a country's external account balance by decreasing imports and diversifying exports, thereby increasing resilience to external shocks as compared to reliance on primary commodities.
- ❑ Industrialization continues to be the main avenue for successful development. 4IR technologies applied to manufacturing production offer huge potential to advance economic growth and human wellbeing and to safeguard the environment, contributing to SDG 9—
Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Constraints to Industrialization/Manufacturing

Insufficient power supply (63.9) high interest rate (55.3 points), unfavourable economic climate (54.6 points), financial problems (51.8 points), unfavourable political climate (50.0 points), unclear economic laws (49.4 points), insufficient demand (42.8 points), and access to credit (41.8 points) (CBN- March, 2019) Business Expectation Survey (BES).

Regardless, with regard to Employment Outlook Index by sector, showed that the industrial sector (31.5 points), indicates the highest prospects for creating jobs, followed by services (23.8 points), wholesale/retail trade sector (23.6 points) and construction sector (16.7 points). The industrial sector is however unable to fully perform its expected functions.

- *Major challenges* Lack of the basic industries such as iron and steel and petrochemical;
- lack of skilled manpower;
- infrastructure issues, especially power and logistics;
- influx of substandard and fake products through the porous borders and
- weak domestic patronage both from the government and the private consumers.
-

Current challenges (LCCI, 2019):

- Weak infrastructural base – power, transportation,
- Apapa Port logjam issues and poor railway system;
- high cost of fund, absence of long-term funds, challenges of access to credit because of perception of manufacturing as very risky in the economy;
- weak institutions, resulting in ineffective regulation; end products of which include, faking and counterfeiting, smuggling and under invoicing etc.
- Research and Development does not attract sufficient investments needed to promote industrialization.
- low industrial space and absence of innovation;
- Lack of qualified labour for various businesses, because the curriculum of many tertiary institutions is not dynamic and most often, not aligned to the needs of industries, which is very dynamic.

Factors that Drive Successful Manufacturing

Five factors drive successful manufacturing economies (Moghalu (2020)).

a) **Innovation:** innovation is the secret of wealth of nations. The discovery of new inventions that improve the quality of life and new ways of doing things that are more efficient, coupled with the mass productions of inventions, is what has created the wealth of the industrialized world.

b) **Costs:** the efficiency of production or otherwise makes a fundamental difference to the profitability of manufacturing companies. A focus on a use of innovation and production-process efficiencies can help reduce costs.

c) **Workforce investments:** manufacturing companies in competitive economies invest heavily in the technical capabilities of their workforce. This creates a competitive edge because skilled workforces increase the productivity of labour for⁴⁵any organization. Constant training of the workforce is therefore imperative.

d) **Infrastructure:** infrastructure support contributes directly to efficient production. This is a major cost factor that affects the viability of manufacturing.

e) **Industrial financing:** industrialization in East Asia was boosted by favourable financing subsidies linked with appropriate control measures such as proof of valid export orders before companies could benefit from subsidized finance.

Summary: A strong manufacturing economy requires targeted, phased and well monitored competent government policy intervention.

RELATIONSHIP BETWEEN AGRICULTURE AND MANUFACTURING

- For any economy to drive to maturity and industrial revolution, structural transformation must occur. Structural transformation accompanies development, they are interrelated.
- Structural adjustment touches on how an economy transits from agriculture to industry and from industry to service. The initial stage of any economy is the agricultural phase, then gradually moves to industry and then to service.
- So it may be difficult to transit to industry if the agricultural stage is not well managed. Any country that desires development must experience each phase duly before any transformation can be achieved.
- It is confirmed that growth in agriculture is more effective in reducing poverty than growth in other sectors.

- But beyond a basic, subsistence level of development, industrialization determines agricultural efficiency and expansion, and even the development of high-value services.
- For any country to experience industrial revolution, labour in the agricultural sector must be moved to the agricultural sector; however, the sector's productivity must not decline as a result of the labour migration.
- The productivity level of agriculture can be maintained through technology, re-training of labour, investing in factors of production and investing in agriculture researches.
- The matters arising in Nigeria's Industrial revolution are that the country has not explored its comparative advantage.
- Agricultural producers have to move beyond the raw material stage and become more involved in value added activities.

- Countries grow wealthy and prosperous through the structural transformation of their economies – by moving capital, labour and technology from lower to higher-productivity sectors.
- Manufacturing is the most productive sector, the Asian experience shows; where growth-inducing structural transformation from low-productivity subsistence agriculture to high productivity manufacturing led to rapid income growth, unprecedented levels of poverty alleviation and improved livelihoods.
- For SSA – a shift has occurred from low productivity agriculture to slightly more productive employment in services, generally consisting of wholesale and retail trade in the informal sector (Bhorat et al, 2017).
- However, low-end services such as retail and trade were reported to be only two times more productive than agriculture, with the result that growth in services in Africa has contributed to no or slow growth in aggregate per capita income (Cervantes-Godoy and Dewbre, 2010)

- Manufacturing is however unique in its potential to transform productivity and induce rapid economic growth. This is more so in Africa, it has been reported that manufacturing is six times more productive than agriculture and that growth in manufacturing propels more rapid general economic productivity improvements (Cilliers, 2018).
- Rather than improving productivity, Africa's structural transformation from low-productivity agriculture to low productivity urban-based retail services has therefore been 'growth reducing'.
- This is because the share of workers employed in high-productivity sectors such as manufacturing is declining, offsetting positive 'within sector' productivity growth. The result is that the aggregate growth of output per worker is declining (Bhorat, 2017)

- The knowledge spillover from manufacturing eventually makes it profitable to invest in more productive agricultural machinery and systems.
- Growth in manufacturing thereby increases wages and productivity in the agricultural sector. Agriculture and other components of the primary sector can eventually be part of the 'high-tech' sector (given the potential for technological upgrading within the agricultural sector) when combined with IT or digital technologies.

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DIGITAL TECHNOLOGY

Development Policies

- ❑ The Nigerian Communications Commission (NCC) is the sector regulator for digital technology, with its mandate guided by the Nigerian Communications Act of 2003.
- ❑ In June 2012, first coherent National ICT policy in vision 20:2020,
- ❑ 2013 - National Broadband Plan covering the period 2013-2018 which aimed at promoting pervasive broadband deployment in Nigeria, to about 80 percent by 2018.
- ❑ 2017, the Nigeria ICT roadmap for the timeframe 2017-2020 was published.
- ❑ 2019- Nigerian ICT Innovation and Entrepreneurship vision.
- ❑ For now, there is no national strategy specifically addressing 4IR technologies. However, the Federal Government is looking at AI, Big Data, IoT and Blockchain.

Level of Readiness of the Country for the 4IR

- This parameter is assessed through four indicators, as detailed below (ADB, 2019).

ICT Development Index

- Nigeria was ranked in 143rd position in the ITU's ICT Development Index (IDI) in 2018, with an estimated 25.67% of their population using the internet. The ICT-IDI looks at:
- ICT readiness – reflecting the level of networked infrastructure and access to ICTs;
- ICT intensity – reflecting the level of use of ICTs in the society, and;
- ICT impact – reflecting the results/outcomes of more efficient and effective ICT use.

Global Innovation Index (GII):

- 2018 – Nigeria scored 22.4 (scale 0-100) and was ranked 118th out of 126 countries.
- ⁵⁴2019 – Nigeria scored 23.9, and was ranked 114th out of 129 countries.

General Indicators of Nigeria's Level of 4IR Readiness (ITU, 2018)

Table : Indicators of Nigeria's Level of Readiness for 4IR

Key indicators for Nigeria (2017)	Nigeria	Africa	World
Fixed-telephone sub. per 100 inhab.	0.1	0.9	13.0
Mobile-cellular sub. per 100 inhab.	75.9	74.4	103.6
Active mobile-broadband sub. per 100 inhab.	19.9	24.8	61.9
3G coverage (% of population)	54.0	62.7	87.9
LTE/WiMAX coverage (% of population)	50.8	28.4	76.3
Individuals using the Internet (%)	27.7	22.1	48.6
Households with a computer (%)	8.1	8.9	47.1
Households with Internet access (%)	17.8	19.4	54.7
International bandwidth per Internet user (kbit/s)	3.4	11.2	76.6
Fixed-broadband sub. per 100 inhab.	0.04	0.6	13.6
Fixed-broadband sub. by speed tiers, % distribution			
-256 kbit/s to 2 Mbit/s	1.5	38.7	4.2
-2 to 10 Mbit/s	61.6	37.2	13.2
-equal to or above 10 Mbit/s	36.9	24.1	82.6

□ **Readiness for the Future of Production:**
This indicator sheds light on Nigeria's strengths and weaknesses in terms of technology and innovation, human capital, trade and investment, institutional framework, sustainable resources and demand environment. The report shows that there is still a long way to go for Nigeria as regards creating an enabling environment for the 4IR.

Based on this report, Nigeria's ability to innovate is very low, with only two rates above 5.0 (on a scale of 10).

Table: Nigeria: Readiness for the Future of Production Assessment 2018 edition

Index	Component	Rank/100	Value/10
Structure	Complexity 0-10 (best)	100	0.0
Structure	Scale 0-10 (best)	49	4.2
Driver	Technology and Innovation 0-10	77	3.5
Driver	Human Capital 0-10 (best)	89	3.7
Driver	Global Trade & Investment 0-10 (best)	97	2.4
Driver	Institutional Framework 0-10 (best)	97	3.2
Driver	Sustainable Resources 0-10 (best)	32	6.8
Driver	Demand Environment 0-10 (best)	38	5.3

Preconditions for 4IR (Digitization) Take-off

There are three main preconditions for the take-up and take-off of 4IR technologies in Nigeria. They are **stable power supply**, **reliable and fast internet connectivity** (both through fibre mobile connections to the 'last mile') and **human capital**.

i. Power Supply

- Nigeria has power supply deficits.
- About 80% of the population still does not have access to on-grid electricity, while
- Four (4) out of 5 people that do have a grid connection have to rely on expensive, petrol and diesel back-up generators to complement the electricity coming from the weak and unreliable power grid.
- Power Africa (2019) reports that 20 million Nigerian households have no access to power and places current access rate at 45%; with rural and urban estimates placed at 36% and 55% respectively.

ii. Internet Connectivity

As regards internet connectivity, It is not possible to make the leap straight to mobile networks but rather a combination of investment in fibre broadband and 'last mile' mobile connectivity is required.

Below are a few indicators on the World Economic Forum's competitiveness index, placing Nigeria near the bottom of the rankings, as reported by ADB (2019):

- Mobile broadband subscriptions: 19.9% of the population (ranked 126th out of 140 countries);
- Fixed broadband internet subscriptions: 0.06% of the population (ranked 136th out of 140);
- Fibre internet subscriptions: 0% of the population (ranked 105th out of 140);
- Internet users: 25.7% of the population (ranked 107th out of 140).

Nevertheless, there have been some improvements. The country recently exceeded its own target of connecting 30% of the population to broadband, reaching 33% in early 2019, representing 65 million citizens. A new target of 70% has been set by the Federal Government for 2024.

iii. Human Capital

- Perhaps, most important precondition for rapid 4IR take-up and reaping the associated rewards is a well-educated and motivated workforce with the right skills.
- Nigeria has already made significant progress in this regard but more needs to be done. According to the World Economic Forum, Nigeria is ranked 3.3 on a scale of 1-7 (121st out of 140 countries) in terms of the existence of digital skills in the population.
- In rural areas, more basic issues trump the lack of digital skills as many people are illiterate.
- The take-up of the 4IR is made more difficult by a mismatch of skills and a 'brain drain' of highly-skilled people to other countries. Where in the past many medical staff left for Europe and the US, it is now the software developers and coders that are joining start-ups around the world.

Regulation & Government Support

A strong regulatory framework creates the legal certainty needed for investors to be confident enough in the Nigerian economy to invest in innovation. The WEF has two indicators positioning Nigeria in the lower ranks of countries with regard to its regulatory environment:

- Intellectual property protection: **3.1** on a scale of 1-7 (ranked 129th out of 140);
- E-participation index (use of online services to facilitate the provision of information by governments to citizens): **0.48** on a scale 0-1 (ranked 104th out of 140).

General Importance of 4IR

- ❑ 4IR technologies have the potential to connect billions on the web,
- ❑ dramatically improve business organizational efficiency, and improve the natural environment through improved asset management.
- ❑ It will become a fresh innovative division of life that will replace human intelligence and wisdom, combining artificial intelligence with robotic technology as a substitute for labour
- ❑ Encourage economic growth and structural transformation,
- ❑ Redress poverty and inequality;
- ❑ Reinvent labor, skills, and production;
- ❑ Increase financial services and investment;
- ❑ Modernize agriculture and agro-industries; and.
- ❑ ⁶² Improve health care and human capital.

- ❑ It will also lead to a supply-side miracle, with long-term gains in efficiency and productivity.
- ❑ Transportation and communication costs will drop, logistics and global supply chains will become more effective, and the cost of trade will diminish, all of which will open new markets and drive economic growth.
- ❑ 4IR technologies will support manufacturing and industrial development through
- ❑ Introduction of new and better goods into the market— smart TVs, smart watches, home control devices and so on— and;
- ❑ Increase production efficiency through the ⁴³digitalization and interconnectivity of production processes.

Challenges to 4IR Utilization

- ❑ Greater income and gender inequality,
- ❑ low investment in research.
- ❑ poor/lack of internet connectivity,
- ❑ lack of access to finance,
- ❑ low technological capabilities and
- ❑ technological divide which may increase the digital gap.
- ❑ greater inequality manifests through a potential to disrupt labor markets, as automation substitutes for labour.
- ❑ 4IR would also create relatively fewer positions, requiring higher educational levels and specialized skills that may discriminate against women (gender inequality) with likelihood of negative effect on developing economies.

Greater insecurity - through ransom-ware attack that would deprive millions of power, infiltrated crypto currency exchanges, proliferation of cyber-criminal gangs and hackers,

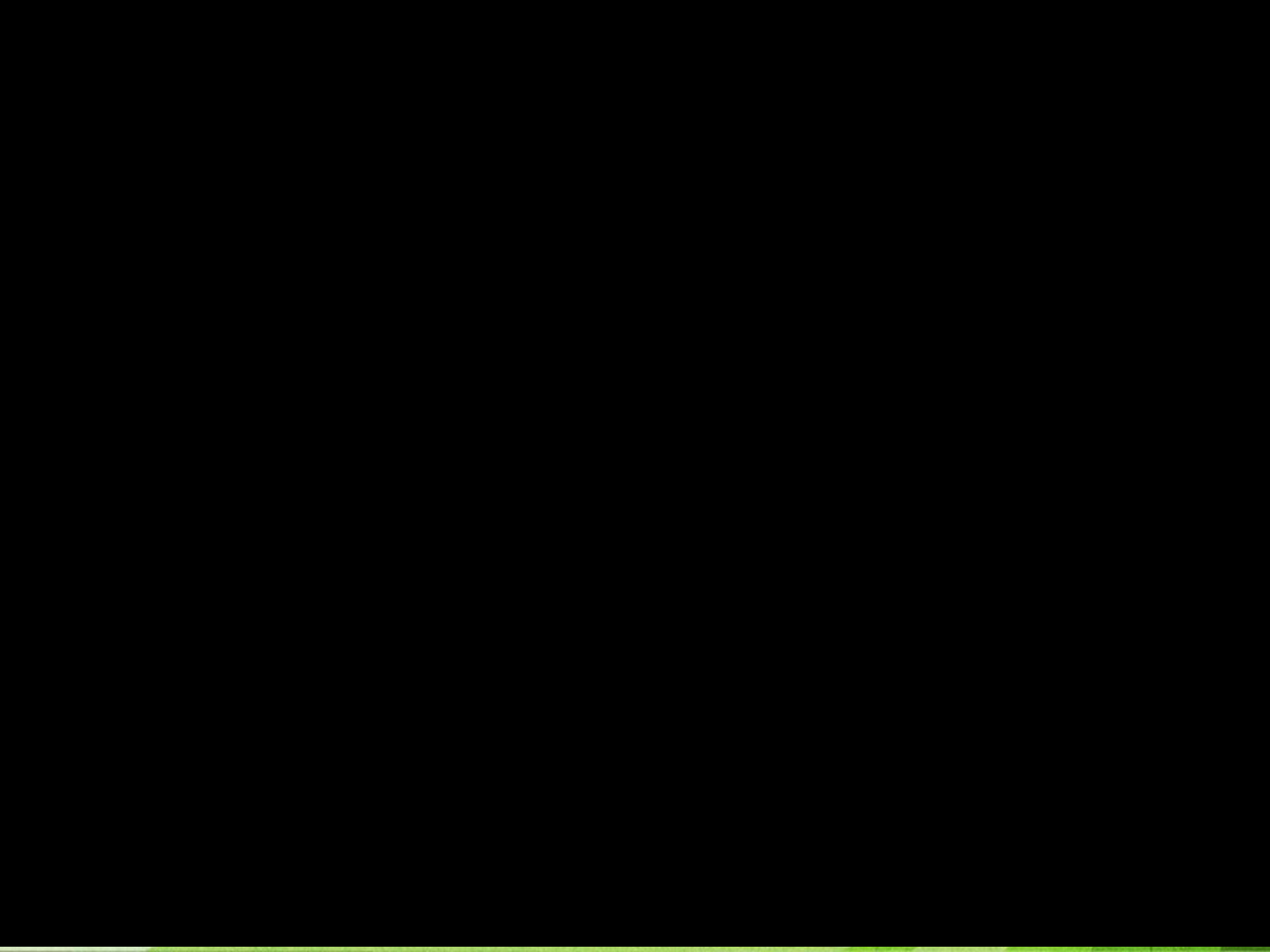
loss of identity- exhibited through a hyper-connected world which, through the dynamics of social media use can serve to narrow available news sources, restrict speech and harass citizens; and when combined with rising inequality could lead to fragmentation, segregation and social unrest

Financial globalization, digitization and monopolies on intellectual property rights, may mean that the profits of certain technologies may be captured by a few large companies.

In an era of automation, robots, and genetic engineering, there are new ethical concerns and debates, especially in genetic engineering. On one hand, preventing genetic disease by genetic engineering is desirable. On the other hand, what guidelines, regulations, or ethical boundaries should be established in order to prevent the over manipulation of genetics for desirable traits?

In essence, although robots have become smarter and more autonomous, but they still lack an essential feature - the capacity of moral reasoning.

It is important also to note that lack of knowledge and research evidence to back up relayed messages, results in poor adoption due to the transmission of inappropriate information, unsuited to local user-^{66.}environments.



POTENTIALITIES AND UTILIZATION OF 4IR FOR AGRICULTURAL DEVELOPMENT PURPOSES

4IR technology can combine traceability, digital finance and mobile-based information exchange and training, among many others; and also have the potential to makes farmers' lives better, by lifting yields, improving suitability and linking farms to markets (Dixie (2018)).

4IR technologies will also reduce environmental impact, by reducing use of chemicals through targeted on-leaf applications, and thereby enhance profitability of a farm enterprise.

However, it's only when these tools all work together in concert on a single farm that transformation is created.

Expected Improved Outcomes from the Use of 4IR Technologies

i) IoT devices—collect data that can help farmers efficiently manage their farms, eliminate the need for manual monitoring in greenhouses, monitor the health, reproductive cycle and location of livestock, and also to monitor levels and health of water tanks and track dairy cows, through the aid of smart collars.

ii) Big Data and AI— provide data to support farm management decisions, help in bovine facial recognition and herd behavior. AI start-ups also help to select good genetic breeds that address changing consumer demands in an accelerated and more precise manner

iii) Blockchain devices can improve traceability, increase transparency in agricultural supply chains, and can help secure contracts and transactions, namely in land registration and agricultural insurance. It can also provide better monitoring of farmers' inventory and simplify their food value chain, resulting in greater income for the farmers.

iv) **Drone technology** - Used to monitor crop volume and vigour and track changes in plants and indicate their health. It can also be used for **precision spraying**, inspection of farm infrastructure, generation of high-resolution mapping and surveying of individual fields, crop damage assessment and insurance claim forensics. Drones are also used for **precision planting**, which will increase yield, with lower costs, faster planting speeds, and a reduced impact on the environment.

v) **Robotics** allows farmers to monitor factors, e.g., soil properties and animal movement in almost real-time circumstances. Robots are also being used to milk cows, feed chickens and harvest fruit. They may also be used for soil compaction and indoor hydroponic farming.

vi) A combination of IoT sensors, 3D aerial imagery from **drones**, and AI-powered analytics can help pesticide and fertilizer companies to use precision farming to analyze the characteristics of soil and the behavior of crops down to the square inch, which may soon significantly reduce the need for fertilizers and pesticides altogether.

vii) Mobile-commerce platforms exist that help farmers purchase supplies and raw materials. There is also a mobile app that utilizes a "missed call" technique. (The customer dials a number but disconnects before the call is picked up, which alerts the recipient that the caller wants to order or communicate but enables the caller to avoid cell-phone usage charges.)

viii) GPS packages are available that can track and map an agricultural producer's mechanized equipment, and help farmers to monitor their machines on a tablet or smartphone and direct them to where they are needed — when, for example, a storm is coming — as well as to reroute support vehicles carrying fuel, seed, and fertilizer.

ix) Drones, multispectral and satellite imagery — provide valuable information at a glance — for instance, whether a particular area or crop is unrecoverable and not worth spending further money on (e.g. fertilizer, pesticides). Satellites can be used to predict crop yields and will soon be used to look at any cultivated field and know what crop is growing there, when it was planted, what kind of soil it's growing in, how well it's growing, what the protein content is, what the yields will be, and when harvest time will be.

x) **Satellite and Unmanned Aerial Vehicle (UAV) Imagery and Transportation:** Weather modeling can be done with the aid of weather satellites to transmit weather data, predict weather patterns and warn farmers about conditions and, predict how the next season will be so as to plan for the amount of irrigation that will be needed.

UAVs can also be used in precision farming, for close-up visual inspections, or to detect the height of trees or crop canopy. They can also be used for index-based insurance, to transport small goods to places that are not easily reachable and in case of an emergency, a drone can be used to transport emergency equipment to a remote location and provide fast action.

xi). **Global Navigation Satellite Systems (GNSS)** are satellite constellations that provide world-wide positioning, navigation, and timing information. They can be used for increased accuracy in farm management and agricultural planning, to ensure efficiency. It can also be used to determine the exact location where pesticide, fertilizer or irrigation needs to be applied.

Current Use of 4IR Technologies for Agricultural Development in Nigeria

- There are only a few companies leading the use of six prominent digital technologies (drones, blockchain, 3D printing, AI, big data analytics and IoT) in agriculture in Nigeria (ADB/ KOAFEC, 2019).
- **Drones** are hardly utilized because of legal barriers by the military, **blockchain** use is still at an exploratory stage, but it is the most frequently searched technology,
- There is limited scope for **3D- printing** due to the low level of mechanization in the country;. It may be obvious that take-up of these technologies in Nigeria is still fairly low; their potential for modernizing the sector is as summarized by ADB (2019).

Current Level of 4IR Utilization for Agricultural Purposes

<i>Technologies</i>	<i>Current Level of Use</i>	<i>Potentials for Application</i>
<i>Artificial Intelligence</i>	<i>Nascent/some examples</i>	<i>Good potential/numerous examples</i>
<i>Big Data Analytics</i>	<i>Nascent/some examples</i>	<i>Good potential/numerous examples</i>
<i>Blockchain</i>	<i>Nascent/some examples</i>	<i>Nascent/some examples</i>
<i>Drones</i>	<i>Nascent/some examples</i>	<i>Good potential/numerous examples</i>
<i>3D Printing</i>	<i>not many/few examples</i>	<i>Not many/few examples</i>
<i>IoT</i>	<i>Nascent/some examples</i>	<i>Good potential/numerous examples</i>

Specific Current Use Cases and Potentialities for Development

Privately-ran Agritech start-ups are the main proponents and sponsors of 4IR use in Nigerian agriculture.

They seek to solve the logistics of food waste in the country and how to get produce from the farm to the end consumer in the most efficient and effective manner.

Some also create solutions for farmers to access credit to grow crops, connecting urban citizens with some disposable income with rural farmers who need the cash injection to expand their production.

ADB (2019) details a set of use cases of start-ups working on applying 4IR technologies to disrupt and modernize the agricultural sector in Nigeria.

a. MTN, Nigeria has an IoT-based Animal Identification Management System. The chips provide real-time information on the location of animals to the farmer, and produces automatic alerts if a cow breaks out of a designated area; Plantheus is a plant diagnostic application that requires no internet access to run diagnostics on the condition of (cocoa) plants, which is available in local languages.

b. Zenvus seeks to improve decision-making for farmers by providing insights into crop status based on data collected from sensors and IoT. The data is stored in the cloud and can be accessed by the farmers regardless of their location. This allows farmers to use fertilizers and irrigation more precisely, for increased farm efficiency;

c. **Binkabi** is a Blockchain-enabled agriculture trading platform developed in cooperation with Sterling Bank which will allow farmers to deposit their crops in a warehouse as opposed to the current situation in which they are often forced to sell it right away after harvest. The crops are used as assets to borrow money. **XendBit** is a Blockchain start-up in collaboration with the Nigeria Stock Exchange. The platform will allow for alternative funding and crowd funding of infrastructure and equipment for farms, and should reduce the counterparty risks when it comes to payments

d. **Vetsark** analyses Big Data to protect crops and livestock from pests and disease and works as a mobile platform for veterinarians, crop extension officers and farmers.

e. **Orbital Solutions** uses Big Data and drone technology and AI to provide small scale farmers with technology driven advisory services. They monitor crop health, predict yield, combat pests, use local language to provide weather information prediction and advisory services, and teach young people in local communities how to use ICT and Smartphone to collect and interpret data to support smallholder farmers.

f. **Track Your Build**- uses drones, satellites, cloud computing and data analytics to collect vegetation data in order to predict yields and maximize field productivity whilst reducing environmental impact.

g. **Hello Tractor**- uses AI and IoT solutions to track tractors and monitor their condition.

h. **Farmcrowdy** - connects investors and smallholder farmers on a crowd funding platform.

Challenges Militating Against 4IR Use in Agriculture

Lack of quantity and quality of agricultural products in Nigeria. Digital solutions can provide answers to these issues, for instance, by using drones to monitor crop health.

Digital solutions require the necessary infrastructure: access to electricity, access to the internet, access to hardware (e.g. mobile phones, drones or other devices) and users who have sufficient knowledge as to how to use the applications that they are provided with.

Since literacy is an issue in Nigeria, especially in rural areas, digital solutions for agriculture need to take this into account.

Moreover, due to the different climate zones (ranging from tropical rain forest to the desert); advice for farmers needs to be adapted to these circumstances.

There are also sedentary and nomadic people in Nigeria and several languages are spoken, which highlight the need for custom-made solutions adapted to the cultural diversity of the country. Otherwise, there could be a risk of deepening inequality between those who are computer literate and those who are not.

These challenges notwithstanding, there are considerable rewards to be reaped from using the 4IR in agriculture in Nigeria, which should drive its take-up. The consequence of combining drones, IoT and AI would be more productive farms that increase food security and hence well-being, using fewer resources as inputs, which has a positive impact on the environment.

However, increased use of technology may also reduce the need for manual labour and hence the number of jobs in agriculture. This may not be a negative development, however, as it would mean that Nigeria's workforce would resemble more that of more advanced economies, with fewer people working in agriculture and more in industries and services and working in urban environments.

POTENTIALITIES AND UTILIZATION OF 4IR FOR THE MANUFACTURING SUB - SECTOR

Importance of Manufacturing to 4IR Adoption and Utilization

- ❑ Industrialization and the manufacturing sector are fundamental for embarking on a 4IR learning pathway and capturing its digital dividend, for at least three reasons (UNIDO, 2020).
- ❑ First, manufacturing companies remain the main learning centres of any industrial revolution, especially for the development of digital production technologies.
- ❑ Second, the 4IR ultimately stems from 3IR technologies— hardware, software and connectivity— and organizational principles. When non-manufacturing sectors capture the digital dividend, it is because 3IR and 4IR technologies are used to manufacture their transformation.
- ❑ Third, across developing countries, the application of ADP technologies to services has remained concentrated in activities that do not typically deliver the type of structural transformation countries need.

For example, the increasing use of ICT in mobile communications and financial transactions, especially in countries like Kenya and Nigeria, has provided important services to communities. But the use of these technologies in production remains limited.

Level of 4IR Utilization in Industrial Set-ups

- ❑ According to UNIDO (2020) on the global level, 4IR technologies are not found in all industries even in frontrunner economies. Indicators are that the computer and machinery industry and the transport equipment industry are most active in using those technologies.
- ❑ The computer and machinery industry has the highest use of cloud computing and 3D printing technologies, at 10–15 percentage points above the average for manufacturing,
- ❑ The transport equipment industry is ranked second and tops the use of industrial robots in manufacturing.

- ❑ Industries with low and medium low levels of digital intensity include; food products, beverages and tobacco, textiles, wearing apparel and leather, coke and refined petroleum products, rubber and plastics products and basic metals and fabricated metal products .
- ❑ On the Nigerian scene, ADB (2019) reports that on the supply side, 4IR technology producers are start-ups, local companies or multinationals.
- ❑ The demand is driven by businesses in some industries (financial sector and telecommunication companies mainly), end users and the government. The use cases in the manufacturing may not be too encouraging, as are presented on Table below (ADB, 2020).

Table : Current Level of 4IR Utilization for Manufacturing Purposes

<i>Technologies</i>	<i>Current Level of Use</i>	<i>Potentials for Application</i>
<i>Artificial Intelligence</i>	<i>nascent / some examples</i>	<i>good potential/numerous examples</i>
<i>Big Data Analytics</i>	<i>good potential /numerous</i>	<i>good potential /numerous examples</i>
<i>Blockchain</i>	<i>nascent / some examples</i>	<i>good potential /numerous examples</i>
<i>Drones</i>	<i>not many / few examples</i>	<i>nascent / some examples</i>
<i>3D Printing</i>	<i>nascent / some examples</i>	<i>good potential /numerous examples</i>
<i>IoT</i>	<i>good potential /numerous</i>	<i>good potential /numerous examples</i>

Some interesting AI/Big Data analytics use cases include:

a). Intelia and Kudi.ai use AI to facilitate financial transactions and payments on chat platforms such as Facebook, Messenger, Slack and Telegram. Versus.ng helps brands and companies to make intelligent decisions through a sentiment analysis product that enables objective reporting while measuring sentiment across different brands, companies and individuals. Lara.ng, a WhatsApp-styled chatbot offers turn-by turn directions and fare estimates for transportation within Lagos. Banks are exploring the use of AI too, including Chatbots like Diamond Bank's Ada, Stanbic IBTC's Sami, Access bank's Tamara and UBA's Leo; which allow customers to perform basic banking transactions. In telecommunications, the Glo AI platform, which will be the first in the telecoms sector, would enable conversation in English and Pidgin through voice and text;

b. **Blockchain:** The use cases of Blockchain are concentrated in financial services and are utilized to ease financial transactions. These include Nigeria's largest gaming company, Naijalottery, Nigeria's Customs service and the The Central Securities Clearing System (CSCS) Plc.,

c. **IoT:** NAFDAC in 2010 resorted to a product verification initiative using Radio Frequency Identification (RFID). The technology uses tags equipped with RFID to authenticate drugs throughout their supply chain starting from manufacturers, distributors, wholesalers, retailers and even consumers.

d. **3D printing** - Elephab refined the idea of the production of replacement parts using 3D printing in GE Lagos Garage's advanced manufacturing training programme. Its founders want Nigerians to be able to repair things when they break rather than waiting for new parts or products to be imported from overseas.

Drivers and Challenges Specific to Industrialization

- a) Nigeria can count on a young, adaptable and motivated workforce and entrepreneurs, as well as a strong entrepreneurial culture, to foster the integration of 4IR technologies in the industry;
- b) Some major players in emerging technologies (GAFAs) have installed hubs in Nigeria;
- c) Key challenges include a lack of experts and skills in the mastery of certain technologies, mainly 3D printing (prototyping);
- d) The manufacturing sector is not currently showing the drive needed to implement 4IR technologies. Most of the current use cases are concentrated in the financial sector and telecommunications.

CHALLENGES MILITATING AGAINST ADOPTION OF 4IR TECHNOLOGIES

(Andreoni and Anzolin, 2019).

- ❑ **Basic capabilities.** The production capabilities required for absorbing, deploying and diffusing ADP technologies along the supply chains are scarce and unevenly distributed. These technologies have also raised the “basic capability threshold,” not because they are entirely new but because they imply the fusion of new and existing technologies into complex integrated technology systems.
- ❑ **Retrofitting and integration.** Companies in developing countries that could make technology investments in this area have already committed resources to older technology, and they need to learn how to retrofit and integrate the new digital production technologies into their existing production plants. Setting up brand new plants is rarer because it requires significant long-term investment and access to markets.

- ❑ **Digital infrastructure.** These technologies demand substantial infrastructure for use in production. Some developing countries face significant challenges in providing affordable and high-quality electricity as well as reliable connectivity. These and other infrastructure bottlenecks might make technology investments by individual firms too risky and financially unviable.
- ❑ **Digital capability gap.** Only few companies in developing countries utilize 4IR technologies, a majority is still utilizing 3IR and 2IR technologies. In this context, it is extremely difficult for the leading companies to link backwards and nurture their supply chains. When this digital capability gap is extreme, the diffusion of ADP technologies remains very limited.
- ❑ **Access and affordability.** These technologies tend to be controlled by a limited number of countries and their leading firms. Developing countries rely dramatically on importing these technologies and in many cases, even when they can mobilize the resources to access them; they remain dependent on providers for hardware and software components.

STRATEGIES TO OVERCOME 4IR ADOPTION CHALLENGES.

a). The African Union (supported by the World Bank) is reported to have taken the first steps. Ghanem (2020) discloses that the African Union (supported by the World Bank) is pursuing a **Digital Moonshot Initiative** targeted at digitally transforming the rate of internet use to catch up and even surpass the rest of the world in a decade or less. This has five key elements, as stated below.

- The first element is investing in digital infrastructure to improve access and quality, which includes investing in connectivity (e.g., high speed internet, internet exchange points), the Internet of Things (e.g., mobile devices, computers) and data repositories (e.g., data centers, clouds). These upgrades will require some public investments, but most investment will need to come from the private sector, hence the need for legal and regulatory reforms to encourage private investment.
- The second element is investing in a digitally savvy workforce to build robust digital economies and competitive markets.

- Third is investment in digital platforms that offer products and services through digital channels.
- Fourth is the development of digital financial services to enhance financial inclusion; this requires reforms of monetary and financial regulations and supervision systems to allow mobile phone operators to provide financial services.
- The fifth element is to create an ecosystem to encourage digital entrepreneurship and innovation.

Other requisite important elements include;

The need to put in place policies and institutions that encourage the private sector to invest; and to ensure that the needs of the digital economy do not distract from work to deal with other equally important needs, especially investment in human capital, energy, and transport.

b). Other strategies to ameliorate constraints deterring adoption of 4IR technologies are listed below, to include:

i) **Fixing the labor-skills mismatch** - through Investments in education and skills re-training programs. The focus here is the development of appropriate skills to identify and use technologies by updating existing curricula and developing new vocational education programs.

ii) **Develop policies that create conducive environment** for the development and adoption of new technologies, and ensure that wealth generated by new technologies is not accumulated by only some.

Invest in and promote the development of technologies that address the needs of low-income and vulnerable groups, including women

iii) **Enhancing agile governance** for secure, effective management of the 4IR and integration into global value chains.

iv) **Enactment of a comprehensive legal framework and institutional capacity** to address cybercrime.

Nigeria must improve on its global e-Readiness Index status –

- Improved access to broadband and developing technical skills and technology hubs.
- Policies should address frameworks for increased digitalization and investment, including better and more affordable access to internet and other information and communications technologies (ICT) and ICT infrastructure and participation in global value chains.
- Necessary to facilitate collaboration that will lead to innovation through local content development.
- v) Public – private collaboration should contribute to investments in education and complementary skills through revising and reorienting the curriculum around science, technology, engineering and mathematics and providing better technical and vocational education and training.

• In the process, it will build a nation whose citizens can aspire to be the best in world and join a future that will be led by educated humans, supported by intelligent machines.

Vi) Universities would play a crucial role. They would carry over the fruits of pure science to applied science and they would also provide laboratories and workspaces with the aim of developing entrepreneurial skills and fostering the demand for new products, services and applications. Their role in the digital cyber space cannot be overemphasized.

vii). The lack of adequate investments in research and development is an important obstacle. Nigeria must develop innovative financial instruments and public-private partnerships to fund human capital development, including a focus on industrial research and innovation hubs that bridge the gap between higher education institutions and the private sector to ensure the transition of 4IR products from the laboratory to the market.

viii). Nigeria should Strengthen the capacity of the Private Sector to improve the potential for innovation in the private sector.

The belief is that the private sector creates technologies that serve the needs of customers efficiently and effectively.

The role for governments would therefore be to de-emphasize focus on technologies in which investments can be made more appropriately by companies, while supporting a broad range of technological applications in different industries.

CONCLUSION

It may be concluded that technology and advancements in science drive transformation around the world.

They create ripple effects on societies, institutions, and economies.

They will transform the ways in which we live, work, and interact with one another.

Understanding these new technologies and their disruption potential is critical for all nations and especially developing countries.

Every period of upheaval has winners and losers, and the technologies and systems involved in this latest revolution means that individuals and groups could win – or lose.

There have been positive strides in ensuring smallholders become involved in digital agriculture.

An estimated 33 million people – about 13 percent of all sub-Saharan African smallholders and pastoralists—are already registered for services such as weather updates and market linkages.

Ethiopia's "80-28" hotline—a farmer advisory service – has about 4 million users, and because of its free service and local language delivery, has the highest subscription on the continent.

On the other hand, Kenya leads the way in digitization in Africa, mainly, because of its collaborations between agriculture and telecommunication.

One additional strategy is to blur the boundaries between different sectors. Digitization is not just an agricultural nor manufacturing issue, or a technological one. It involves many parts of the economy. Hence, digitization must be situated within a broader development and poverty reduction agenda

For instance, education is critical to farmers' ability to use and benefit from digital technologies. It is also crucial to place smallholders' front and center when designing policies and specific digital products meant to help them. In this way, digital transformation will reflect the users' needs.

It is a desideratum to move the digital sector forward. Experts assert that it would be a tragedy for Nigeria to miss the 4IR, because this presents a huge opportunity for Nigeria and other African countries to leapfrog into the global technology ecosystem

THANK YOU