



Building the Human Capital for Nigeria Data Centre sector

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Table of Contents

TABLE OF CONTENTS.....	2
1. INTRODUCTION	4
1.1.1. <i>Nigeria population density</i>	5
1.1.2. <i>Nigeria population growth curve</i>	5
1.1.3. <i>Nigeria Japa statistics.....</i>	6
1.2. RESEARCH PROBLEM.....	6
1.3. THEORETICAL FRAMEWORK	7
1.4. AIM AND OBJECTIVES	7
1.4.1. <i>Aim</i>	7
1.4.2. <i>Objectives</i>	8
2. LITERATURE REVIEW	8
2.1. ICT SKILLS SHORTAGES	9
2.2. NET MIGRATION	9
2.3. DIVERSITY AND INCLUSION (D&I)	10
2.3.1. <i>Nigerian workforce gender distribution</i>	10
2.3.2. <i>Total Employment in Nigeria by Gender</i>	11
2.4. HUMAN CAPITAL	11
2.4.1. <i>Human Capital Theory</i>	12
2.5. HUMAN CAPITAL INDEX, NIGERIA	12
2.5.1. <i>Human Capital Index, Nigeria.....</i>	13
2.5.2. <i>Literature review summary.....</i>	13
3. RESEARCH METHODOLOGY	14
4. FINDINGS.....	15
4.1. EVOLUTION OF DATA CENTRE ROLES	15
4.2. DC CERTIFICATION FRAMEWORK, IMASONS	16
4.3. NIGERIA DATA CENTRE PROFILE.....	17
4.3.1. <i>Nigeria Data Centre growth</i>	17
4.4. DEMAND SIDE SURVEY.....	18
4.4.1. <i>Key findings.....</i>	19
4.5. SUPPLY SIDE SURVEY.....	20
4.5.1. <i>Key findings.....</i>	22
4.6. DEMAND AND SUPPLY MATCHING	23
4.7. DIVERSITY AND INCLUSION (D&I)	24
4.8. GOVERNMENTAL RESPONSE TO DC HC DEVELOPMENTS	25
5. IMPETUS FOR A SUSTAINABLE DC HC FRAMEWORK	28
6. RECOMMENDATIONS FOR DC HC DEVELOPMENT	29
7. CONCLUSIONS.....	35
8. REFERENCES.....	37
9. APPENDICES	44
9.1. APPENDIX A: GDP PER CAPITA	44
9.2. APPENDIX B1 - DEMAND-SIDE QUESTIONNAIRE AND RESULTS COMPILATION ERROR! BOOKMARK NOT DEFINED.	
9.3. APPENDIX B2 - SUPPLY-SIDE QUESTIONNAIRE AND RESULTS COMPILATION .. ERROR! BOOKMARK NOT DEFINED.	
9.4. APPENDIX E: NIGERIA DC LOCATIONS	45
9.5. APPENDIX J: GLOSSARY	46

Abstract

As digital infrastructure investments proliferate in Africa, the continent is rapidly adopting the 4IR with a plethora of digital transformations in businesses and communities.

The largest country in Africa, Nigeria is leading several African greenfield DC projects and expansions, putting it at the cusp of a major uplift in the digital ecosystem, positioning the country as a global digital hub. As Nigeria is on the verge of forming an international hub in sub-Saharan Africa where Data Centre (DC) establishments are key, the Human Capital element is a frontier to be explored and built, with strategies formulated to drive the ensuing digital revolution.

The ICT space is undergoing phenomenal growth with connected digital infrastructures in the form of subsea optical fibre connectivity, countrywide DC developments, peer networks - pan-African DCs linking major cities and regions with internet exchanges, and the emergence of the Internet of Things (IoT), edge computing, 5G mobile networks and Artificial Intelligence (AI). This is principally driven by increased internet penetration, the digital transformation of businesses, and the rising demand for cloud services.

Nigeria's ICT sector recorded a 10.32% growth in Q1 2023. In the fourth quarter of 2023, Nigeria's Information and Communications Technology (ICT) sector played a pivotal role in the nation's economic landscape, contributing 16.66% to the real Gross Domestic Product (GDP), as revealed by the National Bureau of Statistics (NBS) in its Q4 GDP statistics.

As with major factors in the digital infrastructure ecosystem, a solid Human Capital model is crucial in developing the skills and talent which will grow and sustain the digital economy. DCs are at the forefront of digital infrastructure alongside telecoms masts and fibre optic rings whilst DCs enable the complex amalgamation of IT, Telecoms, and facilities like power and cooling technologies that maintain the DC environment for efficient data transmissions, processing, and storage.

This paper adopts an exploratory approach to determine the current state of Human Capital in the Nigeria DC environment focused on skill shortages and talent development, stimulating young talent entry into the sector, outlining of non-technical talent relevant to the sector and promoting diversity and inclusion whilst offering recommendations as necessary to stimulate growth.

1. Introduction

Industry 4.0 and the knowledge age are taking giant strides in Africa, where the continent is considered an emerging economy and is set to be the new hub for global digital transformations.

The ICT space is undergoing phenomenal growth with connected digital infrastructures in the form of subsea optical fibre connectivity, countrywide Data Centre (DC) developments, peer networks - pan-African DCs linking major cities and regions with internet exchanges, and the emergence of the Internet of Things (IoT), edge computing, 5G mobile networks and the recent Artificial Intelligence (AI) adoption. This is principally driven by increased internet penetration, the digital transformation of businesses, and the rising demand for cloud services.

As with major factors in the digital infrastructure ecosystem, a solid human capital (HC) model is crucial in developing skills and talent that will grow and sustain the digital infrastructure. DCs are at the forefront of digital infrastructure alongside telecoms masts and fibre optic rings whilst DCs enable the complex amalgamation of IT, Telecoms, and facilities like power and cooling technologies that maintain the DC environment for efficient data transmissions, processing, and storage.

With Nigeria as a case study, this paper sets out to illustrate the intricacies of human resourcing for the DC workforce and to outline strategies for acquiring talent to manage and sustain the gaps in technical knowledge, sustainability, and governance required for the future of what is commonly known in Nigeria as 'Solid Infrastructure'.

In Nigeria the vibrant youth in the country ages 18 to 35, forming 60% of the total population are well poised to take the reins of digital transformation in a culture engrained in digital technologies for social media, entertainment, and education with a plethora of business use cases which continue to drive demand in DCs and mobile technologies.

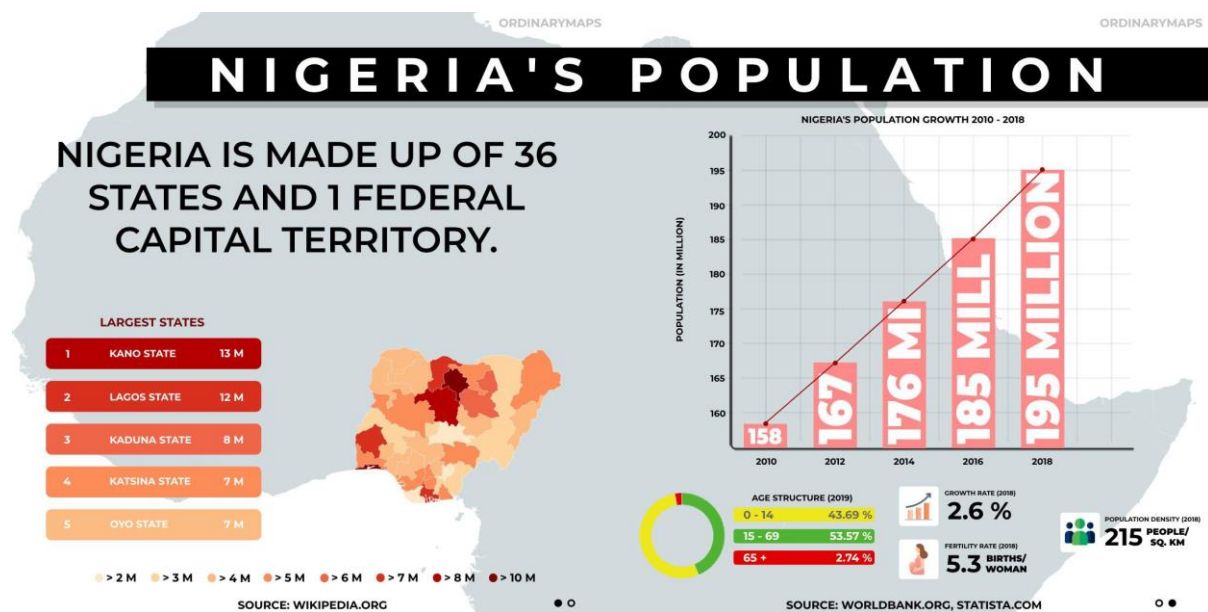
It has been highlighted by leading figures in the Nigerian DC community that skills development is lacking and not keeping up with the levels of ongoing digital developments. This was captured in a forum recently tagged 'Mainstreaming Data Centres for economic growth' in October 2023 attended by representatives of leading DCs such as Open Access Data Centre (OADC), Rack Centre, MainOne, and Medallion- Digital Realty.

Amongst known gaps within the Nigerian labour market, the *Japa* syndrome is a hindering factor endemic in the youth culture. *Japa* has been coined as the exodus of youth out of the country to benefit from better standards of living assumed or offered by foreign climes. The theory is that this may be inhibiting talent retention and widening the knowledge gap.

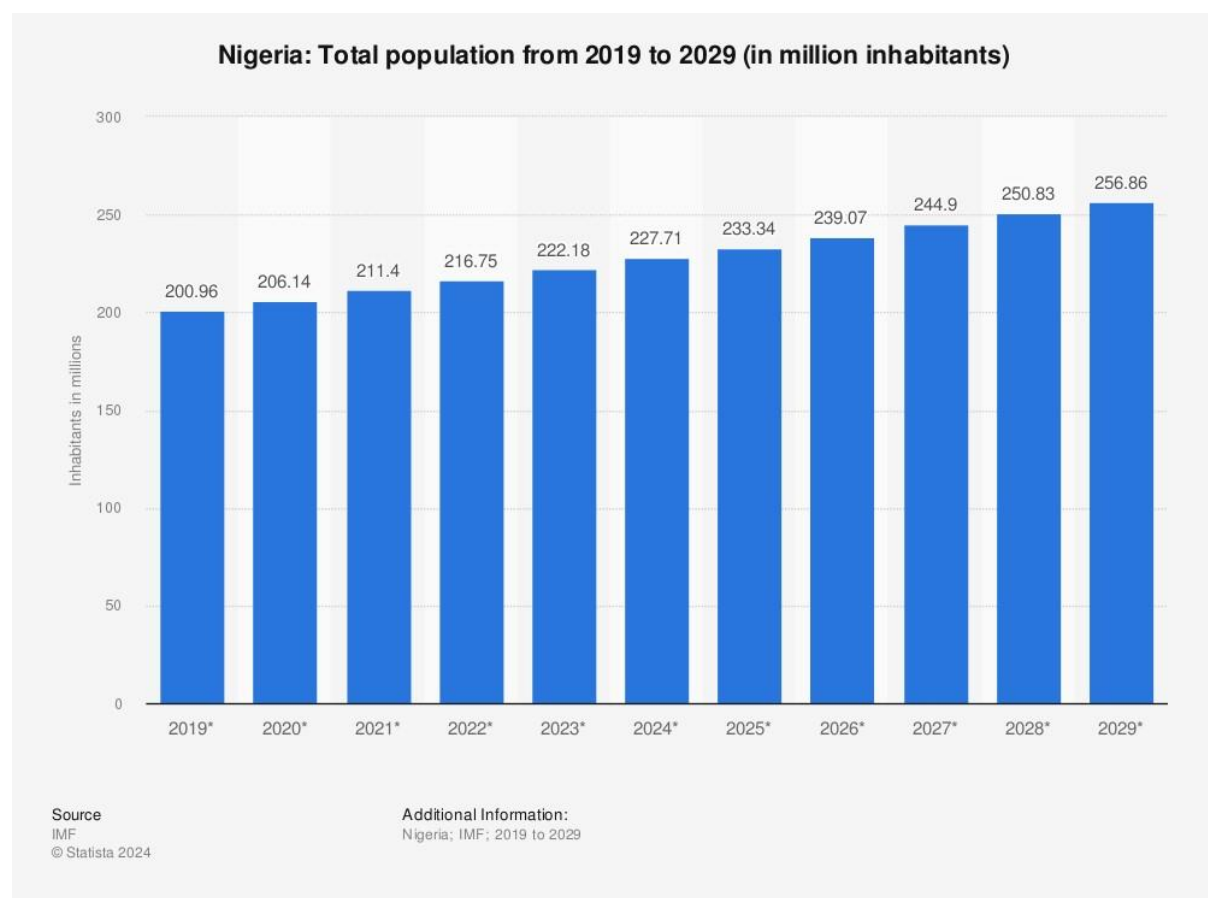
As there are no specific publications concerning talent management and employee retention in the DC sector therefore a broad skills and workforce research project is necessary offering specific, actionable recommendations to both the public and private sector stakeholders to develop a DC HC framework.

This research sets the foundation for future granular research and policymaking, aiming to enhance the resilience and diversity of the Nigeria DC sector.

1.1.1. Nigeria population density

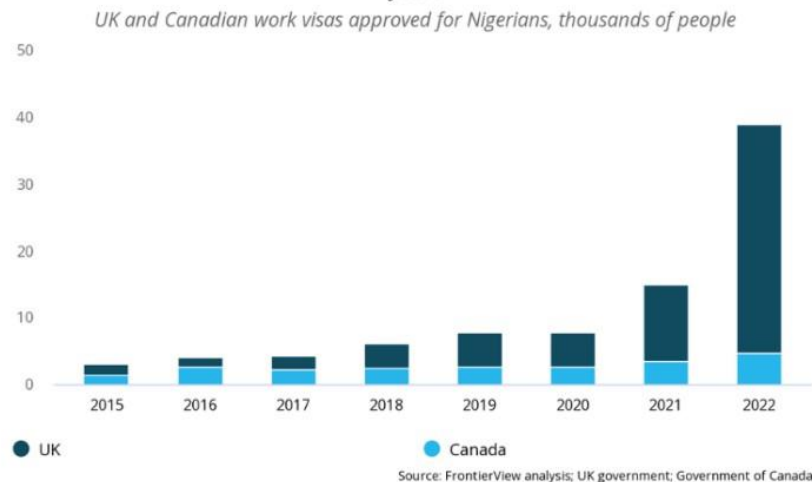


1.1.2. Nigeria population growth curve



1.1.3. Nigeria Japa statistics

Surging emigration of Nigerian workers will likely be sustained for the next few years



1.2.

Research problem

Several multinational organizations channel Foreign Direct Investments (FDI) into Africa for economic development in digital infrastructure projects based on a comparative advantage. In the FDI packages, costs for importing technical personnel in the technology offering are imposed where they dominate leadership positions in solutions architecture and technical delivery and contributing limited knowledge transfer to indigenous professionals. As there is a regular occurrence to this pattern, the seemingly unstructured HC in African technology sectors give room for deficiencies in home-grown talent to attain levels of technical mastery for leadership opportunities sufficient to accelerate the knowledge transfer. The failure of HC to grow at the rate of physical capital has been responsible for the low absorptive capacity of talent in underdeveloped countries (Jhingan, 1997 the economics of development and planning, Forty Revised & Enlarged Edition) hence the need for investment in HC becomes of paramount importance in Nigeria.

A plethora of European and Chinese FDI schemes for example are funding digital infrastructure projects in Nigeria. Most of the leadership and highly technical responsibilities are on the foreigner's side. Technical skills prevalent in the Nigeria DC environments centre mainly on Operations and Support functions with only a handful of indigenous leaders fitting to grow the sector. Without home-grown systems design and technical architectural professionals, the African digital economy will remain at the mercy of foreign technology imports.

Both the demand and supply profile of talent require examination to uncover areas of mismatch that could inform this notion and the requirement for revised HC strategies.

The inclusion of digital infrastructure learning in tertiary institutions creates exposure and awareness of the fourth industrial revolution (4IR) as an era of advanced technology essential for nation-building and economic growth. DC technology training will become attractive for further education

leading to lucrative career options in the ICTspace. This will also stimulate diversity and inclusion as areas to enhance the HC.

Besides technical disciplines, a variety of non-technical disciplines such as in the social sciences and environmental management areas are required to add to formulating new roles necessary for DC business and community support.

1.3.

Theoretical Framework

Tech leaders in the DC sector have mentioned skills shortages variously through media interviews and during plenary sessions at conference events. There are widespread notions of the hampered skills attainable to drive future developments, where also observations have not revealed any formulated policies or structures sufficient to gauge the growth of the required HC.

As there is no substantive material on specific HC issues for Nigeria DC design and operations, an inductive approach was adopted as a theoretical framework where facts and figures collected from scratch may reveal a theory. The DC HC would therefore be explored from a perspective of supply and demand of skills and attainable talent and to extract areas of plausible mismatches based on the theoretical themes below: -

Theory 1 – FDI and domestic investment levels, and impact on knowledge transfer and skill shortages

Theory 2 – Stimulating of young entrants. Skills supply side via education – tertiary, vocational training, and STEM programs against demands from DC organisations

Theory 3 – Non-technical entrants relevant to DC core objectives

Theory 4 – Diversity and Inclusion (D&I) policies in HR

1.4.

Aim and Objectives

1.4.1. Aim

A body of knowledge with informed sources to promulgate DC sector HC development is required for digital infrastructure growth that will support the digital economy. The research will investigate the present DC HC status to further reveal lapses or excellence in skills and talent requisition.

This report will advocate for the inclusion of varied non-technical disciplines to cater for the variety of skills needed to drive the next-generation DC developments.

The raft of digital technologies that will disrupt the Nigeria digital space requires a DC workforce planning strategy in readiness to aid the resultant business transformational processes.

Young talents that may enter the DC sector should be sought after with workable strategies for retention and career progression.

Diversity and Inclusion (D&I) are elements of general recruitment acted upon in several organizations. As the DC workforce is generally male-dominated, attracting and acquiring skills and talents from female groups will contribute to bridging talent gaps.

Specific hindrances in the youth culture may be addressed to reduce the brain drain experienced in the tech industries, most especially the socio-cultural issue - '*Japa*' syndrome mentioned earlier as causing significant shortages in the ICT workforce.

This paper aims to strengthen the case for government policies to augment: -

- Promulgating curriculum additions on digital technologies and infrastructures
- Creating programmes for skills development
- Investing in DC co-creation centres for innovation and creative activities

This research report aims to provide a basis to structure the HC platform as an impetus to attracting talent and promoting the DC sector whilst highlighting the varieties in technical disciplines, social sciences and environmental management required for formulating a forward-looking industry rich in capability, knowledge, and manpower.

The aim is underpinned by themed investigations into the current levels of DC skills acquisition opportunities in the country commensurate with the HC required for next-generation DC development.

1.4.2. Objectives

Underpinning the stated aim are the following in-exhaustive objectives: -

- To collect and assess the digital infrastructure learning methods offered in key-stage educational institutions (secondary and tertiary) and vocational training centres
- To promote the awareness of the DC as an instituted sector
- To explore the present diversity in the DC workforce
- To formulate templated strategies that can enhance skills development, training, and educational partnerships
- To improve technological entrepreneurship as it has been reported that tech entrepreneurs find it difficult to create, sustain, and grow their businesses

2. Literature review

As the overarching topic states - Building the Human Capital for the Nigeria Data Centre sector, some published research reports have explored present and past HC issues from a general ICT standpoint, but no exploration of specific DC skills and talent.

In the broader Nigeria ICT ecosystem, industry literature has identified the following key resourcing issues which link to the DC sector: -

- ICT Skills shortages
- Labour shortages
- Changing skills requirements in the face of disruptive technologies
- Lack of women in engineering
- Lack of new entrants to the DC sector

2.1.

ICT Skills shortages

A case study in 2021 by the Centre for Global Development and The World Bank recently discussed the need for partnerships to enhance skills development and knowledge transfer. It outlined a Global Skill Partnership between Nigeria and a few European countries including Germany, the UK, Belgium, and Lithuania within ICT. It included an overview of the training and migration landscape in all countries, the specific design of such a partnership, and risks and mitigation measures (Adhikari et al., 2021) but no indication of DC skills.

Nigeria is said to be Africa's biggest digital market, and the digital economy could add \$88 billion and 3 million jobs to the economy by 2027 yet employers say job readiness among young people is low. The training and education sector has not been able to keep up with the changing demands of employers (Kamalu, 2021).

A report from *Jobberman* discusses the ICT training infrastructure within Nigeria as being highly fragmented and informal. It describes that those interested in a career within the ICT profession often resort to online classes or informal work placements in computer repair shops. Many emerge with skills that are targeted at specific programming languages or specific data analysis tools, rather than general digital skills that are in demand among companies in Nigeria, let alone abroad. While there are several local and aid-supported start-ups attempting to remedy this situation, they could use more investment and support (Adhikari et al., 2021).

Likely problems that DC skills enhancements will face have been expounded similarly (Patience Tunji-Olayeni et al., 2021) the factors responsible for the diffusion of digital technology in Nigeria. The study indicated that lack of commitment to digital knowledge, lack of strategy for digital skills acquisition, unreliable power supply, and limited funding are the main factors affecting the diffusion of digital technology in Nigeria.

According to a recent iMason's report (For The Digital Future Insights and Predictions from 500+ Industry Leaders, n.d.) demand for electronic services will double and could triple the size of the industry over the next decade. A paramount challenge to fulfilling this demand is in the ability to find, train, hire, and retain people to build, operate, and maintain digital infrastructures. Though talent acquisition is universal but varies between established markets and emerging markets.

A report on workforce upskilling initiatives (Ajayi and Udeh 2024) presents a comprehensive response to various tech and ICT upskilling programs in the country focusing on their design, implementation, and outcomes, emerging digital transformation with the primary objective of identifying effective strategies to prepare professionals for the rapidly evolving digital landscape.

2.2.

Net migration

The causes and effects of the migration of IT professionals in Nigeria (Agbonkhese, n.d.) describes the 'Japa' syndrome and the decreasing net population of ICT professionals in the country. The study concluded that the number of ICT professionals leaving Nigeria will increase if Nigeria's difficult economic, political, and social situation is not improved. The report also states that the trend will be exacerbated by the growing demand for ICT specialists worldwide, particularly in Europe. The net effect is forecast to be negative, and the impact will be felt across the various sectors in Nigeria.

Another report (Okunade and Awosusi, 2023) describes the Japa syndrome and the migration of Nigerians to the United Kingdom for work opportunities.

2.3.

Diversity and Inclusion (D&I)

A report concerning the opportunities and challenges faced in Nigeria on D & I issue, state that the Nigerian work environment reflects the nation's kaleidoscope of cultures, ethnicities, languages, and religions however, the importance of leveraging this robust diversity, and achieving an inclusive workplace is rarely researched (Nwakanma, 2024).

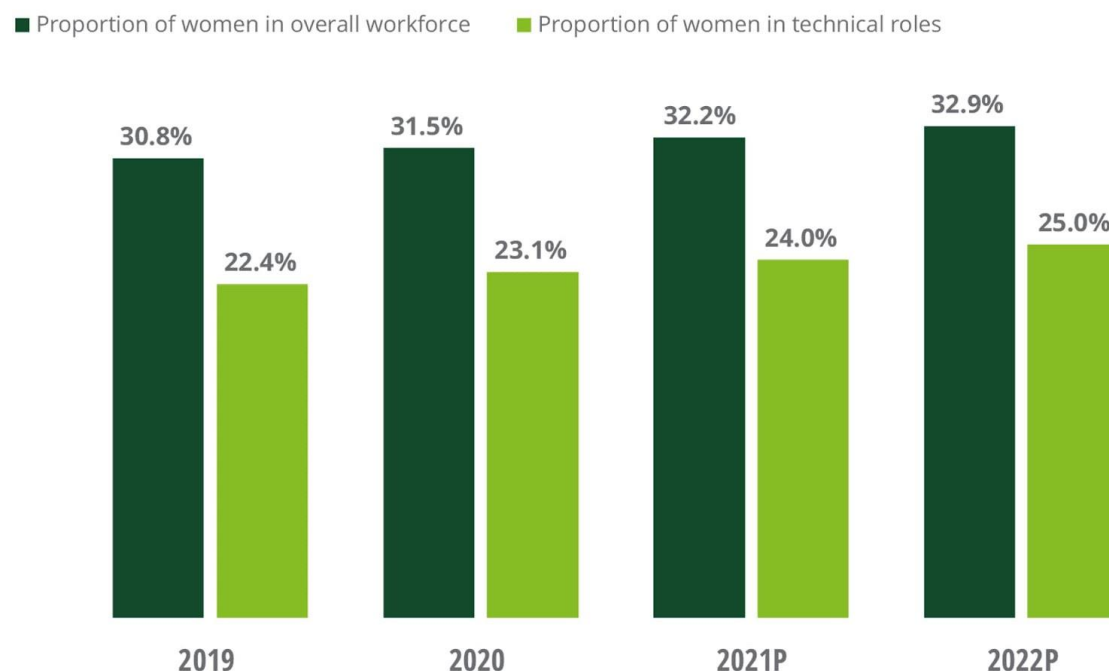
Nigeria is of course liberal in gender education and has no discriminatory tendencies despite any historic cultural influences, therefore it is expected that within the socio-cultural context, there should not be an underrepresentation of women in the DC sector.(Ojokoh, Adeola, Isinkaye, and Abraham, 2014) describe factors influencing career choices in ICT, while (Ogbo, Kifordu, and Ukpere, 2014)emphasize on the effect of workforce diversity on organizational performance of selected firms in Nigeria.

2.3.1. Nigerian workforce gender distribution

FIGURE 1

Large technology companies are making slow but steady progress in increasing female workforce representation

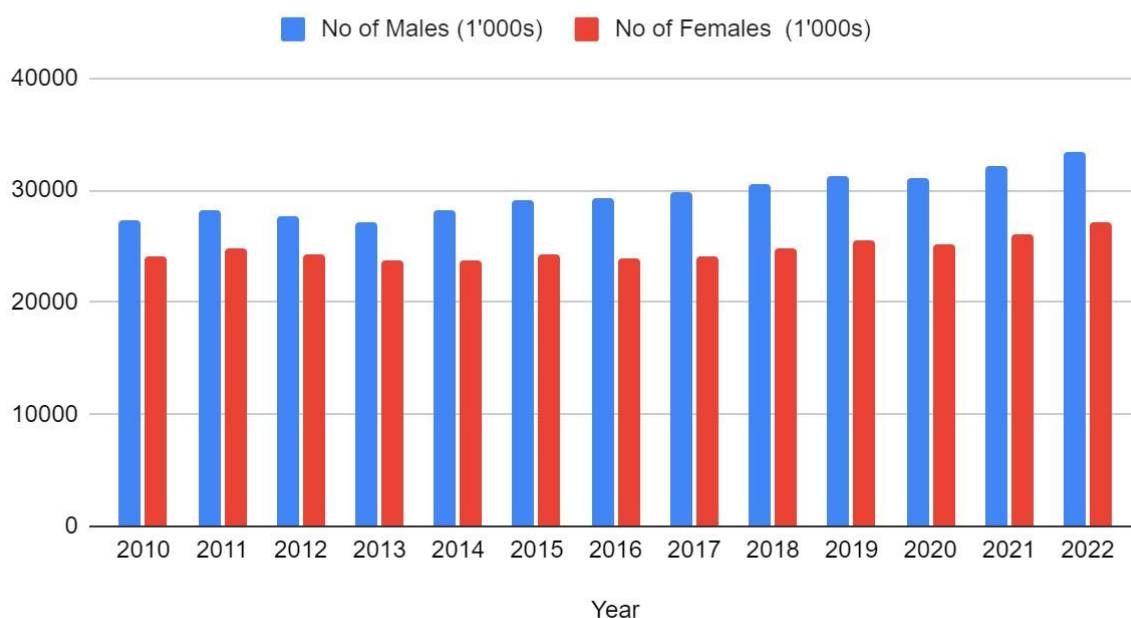
Female workforce representation in large technology companies



Source: Analysis and 2021 and 2022 predictions based on published diversity reports from 20 large technology companies (with an average workforce of more than 100,000 employees).

2.3.2. Total Employment in Nigeria by Gender

Total Employment in Nigeria by Gender



The latest report from the World Gender Gap report 2022 reveals that Nigeria ranks 123rd with a score of 0.639 out of a total of 146 countries. The ranking on gender gap parity, uses parameters like economic participation and opportunity, educational attainment, health and survival, political appointment and financial exclusion/wealth accumulation of the female gender in the world.

Although Nigeria moved 16 places up in the new ranking of the global gender gap index compared to 2021, it still has a gender gap of 63.9%. Nigeria has stayed between 60-63% in the last decade on all the sub-indexes, from political participation to economic participation.

2.4.

Human Capital

Human Capital (HC) is defined as the knowledge, skills, assets, and experiences that an individual has, that add value to an organization. The term HC was originated by Schultz in 1961 who elaborated his concept in 1981 that human abilities are either innate or acquired attributes that are valuable and can be enhanced by appropriate investment.

In the process of economic growth, it is customary to attach more importance to the accumulation of physical capital. Now it is increasingly recognized that the growth of tangible capital stock depends to a considerable extent on HC formation which is the "process of increasing knowledge, the skills and the capacities of all people of the country (Wolfe, 1964).

(global.uwi.edu, n.d.) Becker (1993) determined the basic approaches of the HC concept, including as a factor of economic growth (Barro, 1999) and a key means of production (Lucas, 1988) and conducive to ensuring competitive advantages.

The characteristics of HC can be indicated in education, work experience, life experience, health, and training. Other forms of HC value can be indicated in the emotional, networking, and social capital space.

The cruciality of HC forming a rock-solid foundation for digital transformation actualization cannot be over-emphasized.

2.4.1. Human Capital Theory

Human Capital Theory (HCT) asserts that HC is a key determinant of economic success in all industries.

HCT sees education as a tool that increases the stock of human capacities available in a nation, which then determines the level of economic growth. This theory further explains that the stock of output in an economy can be consumed and invested in physical capital and HC.

HCT rests on the assumption that formal education is highly instrumental and necessary to improve the productive capacity of a population. In short, HC theorists argue that an educated population is a productive population. HCT emphasizes how education increases the productivity and efficiency of workers by increasing the level of cognitive stock of economically productive human capability, which is a product of innate abilities and investment in human beings. The provision of formal education is seen as an investment in HC, which proponents of the theory have considered as equally or even more worthwhile than that of physical capital (Woodhall, 1997). HCT concludes that investment in HC will lead to greater economic outputs.

2.5.

Human Capital Index, Nigeria

Human Capital Index (HCI) is an annual measurement prepared by the World Bank. It assesses how well countries mobilize their HC considering health and education. The index measures the economic and professional potential of citizens and quantifies how much capital each country loses due to lack of education and health. HCI is not only about education. It is nuanced with health issues, social amenities, opportunities, and resilience that people have.

Nigeria records 0.4 as HCI in 2023 a 15% increase from the 2020 HCI Index. In comparison, UK 0.8, USA is 0.7, and South Africa 0.4. Nigeria's HCI is still relatively low (data.worldbank.org, n.d.). As Nigeria ranks low in the global HCI, which results in low ICT literacy, poor socio-cultural issues, and lack of basic infrastructure, forms part of the index, an HC formulation for the DC sector is of paramount importance to grow the digital economy.

A journal of Economics and sustainability development (Sarah et al., 2015) stresses that Nigeria must invest heavily in HC development to achieve impressive growth. Similarly, the United Nations Development Programme (UNDP), states that HC is an active factor that drives economic growth in every nation. The assessment reflects the reality of the Nigerian situation.

Nigeria's budgetary allocation to education has not been impressive. In 2020, education got N671.07 billion or 6.7 per cent; N771.5 billion or 5.8 per cent in 2021; and N1.29 trillion or 7.9 per cent in 2022. There is no indication that it is going to improve henceforth. For Nigeria's HCI to improve, the government should increase its annual budgetary allocations to education and health sectors. At the

same time, entrepreneurship education should be a compulsory course in our tertiary institutions to equip young graduates for a future that is not dependent on white-collar jobs.

2.5.1. Human Capital Index, Nigeria

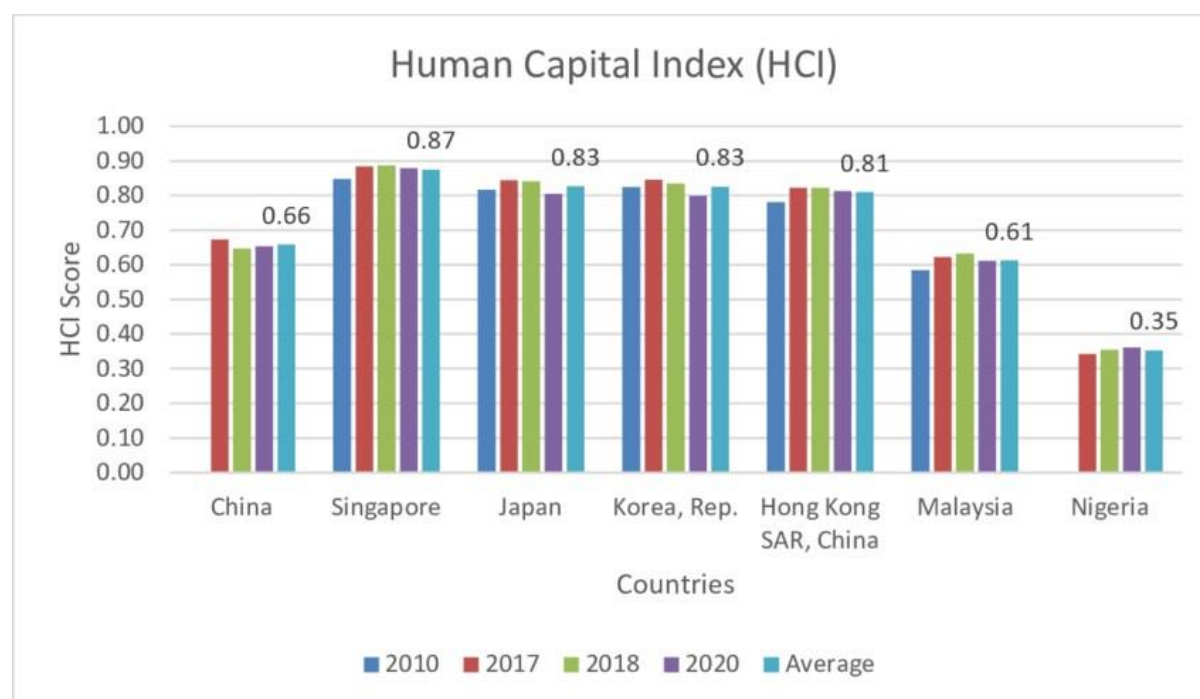


Table 1

2.5.2. Literature review summary

There is a gap in academic material concerning DC skills attainment and talent management required for the present digital age in Nigeria. What appears constantly in all attempts to describe digital infrastructure skills shortages in the ICT sector focuses mainly on software development and e-commerce, but no references to DC technologies or digital infrastructures.

The demand for digital infrastructure, where DC constructions and operations play a pivotal role, is fundamental to digital economy growth. Skills development is crucial in the present wave of significant advancements in digital technologies with Artificial Intelligence (AI), Smart Cities, Internet of Things (IOT), Big Data, 5G and so on entering the digital ecosystem.

New business imperatives like the need for adhering to sustainability goals and Environmental, Social and Governance (ESG) indexes are becoming paramount to investment frameworks required to grow the sector and hence a vital need to develop a diverse and inclusive talent to administer these elements.

A July 2021 report on the ICT skills partnership between Nigeria and Europe, by The World Bank (World Bank, 2020) highlighted skills shortage issues in Artificial Intelligence (AI), Machine Learning

(ML), data science, big data analytics, cloud infrastructure, etc. This was emphasized in a report by *Jobberman Nigeria 2020*, (Kamalu, 2021) that employers state that job readiness amongst young people is very low. The report also stated that difficulties are being experienced in recruiting digital talents with skills only in AI and ML, penetration testing, cloud infrastructure, UI/UX, as well as identity management and access. Employers are concerned that the skills gap will have implications for business productivity and organizational culture.

Another research report in August 2022 (Ogidiaka, Ogwueleka, Irhebhude, & Orji, 2022), mentions shortages in skilled personnel as a challenge to cloud computing adoption. Shortage of skilled personnel seems to be a leading limitation to the uptake of local cloud service vendors by businesses and organizations in the country. Most respondents, 91.0%, agreed that the skilled personnel needed for a full-blown cloud deployment by local cloud service vendors in Nigeria are few compared to 9.0% who answered.

Shortages in skilled personnel have been described concerning innovations, cloud vendor interoperability, service level management (SLM), security strategies, compliance and so on but no specific material on DC skills.

The various materials published for Nigeria only provide a fragmented position of ICT skills shortages. There is no focused material specifically on DC infrastructure skills development and the human resource challenges experienced. There are no available research papers as such embracing the issues sufficient to gauge a progressive DC skills development platform that may serve as a springboard for talent enhancements and retention strategies.

The Literature Review has thus described various studies relating to ICT generally, where digital infrastructures and DCs fall under. The studies attempt to explore in more depth gauging the form of HC currently in place in general ICT to draw attention to industry stakeholders and the relevant government agencies on the need to formulate a HC structure.

3. Research Methodology

The research design for this project is exploratory, setting out using a mixed methods approach to provide an outline assessment of the readiness of Nigeria to provide an Indigenous stream of skilled labour for its growing DC industry. This mixed methods approach spans two separate streams of inquiry:

1. The demand side, and the requirements of the DC industry for Indigenous skilled labour
2. The supply side, and the readiness of the tertiary education sector to provide skilled labour for the DC industry

The demand side will be investigated with a combination of an anonymous quantitative survey and a small set of qualitative interviews. The quantitative survey will comprise a set of Likert scale questions addressed to DC managers and HR staff which assess:

- The degree to which current DC skills needs can be met from indigenous sources
- Whether future skills needs are expected to exceed current skills needs

- Perceptions of the effectiveness of the tertiary education sector in producing graduates with the appropriate skill sets for the DC industry

A small number of qualitative interviews with DC managers will probe the themes in the quantitative survey in more depth, focusing especially on the specific skills required for the DC industry and perceived shortfalls.

The supply side will also be investigated with a combination of an anonymous quantitative survey and a small set of qualitative interviews. The quantitative survey will comprise a set of Likert scale questions addressed to students at tertiary institutions which assess:

- Awareness of careers in the tech sector, and more specifically the DC industry
- Readiness to acquire the kinds of skills required to function in the tech sector and DC industry
- Perceptions of the availability of learning options to prepare for a career in the tech sector and DC industry

A small number of interviews with tertiary education staff will be used to further probe the ability of the sector to cater for Nigeria's tech sector and DC industry needs, and the constraints under which the sector operates.

Further data relating to the above, both quantitative and qualitative, will be sought from secondary sources such as:

- Nigerian government reports relating to the tech sector
- Professional body reports from the tech sector and DC industry
- African Union reports on the development of Indigenous tech skills

The data streams above will be used to develop a holistic picture of the state of the Nigerian DC industry, and its prospects for development using indigenous skills, and highlight key action areas.

4. Findings

4.1.

Evolution of Data Centre roles

Historically, DC roles have been held by a mixture of specialists on the ICT side, such as: -

- Computer / Server specialists
- Network communications engineers
- Cabling and installer technicians

Larger environments with collocation functions require dedicated data hall specialists to perform Installations, Moves, and Changes (IMAC) with systems, and network monitoring usually under instruction by a site manager or DC manager.

Non-IT tech roles in Mechanical and Engineering (M&E) take responsibility for site power provisioning, standby generator support, cooling unit maintenance, fire suppression systems management and space management.

In private DCs, M&E resources are generally outsourced to contractors under *Facilities Management*.

The DC environment experienced ongoing evolution in the past 20 years and resulted in new role creations such as: -

- Data Centre Technician
- Data Centre Engineer
- Data Centre Supervisor
- Data Centre Manager
- Data Centre Cabling technician

These DC roles evolved with certificated training courses as described below.

4.2.

C Certification framework, iMasons

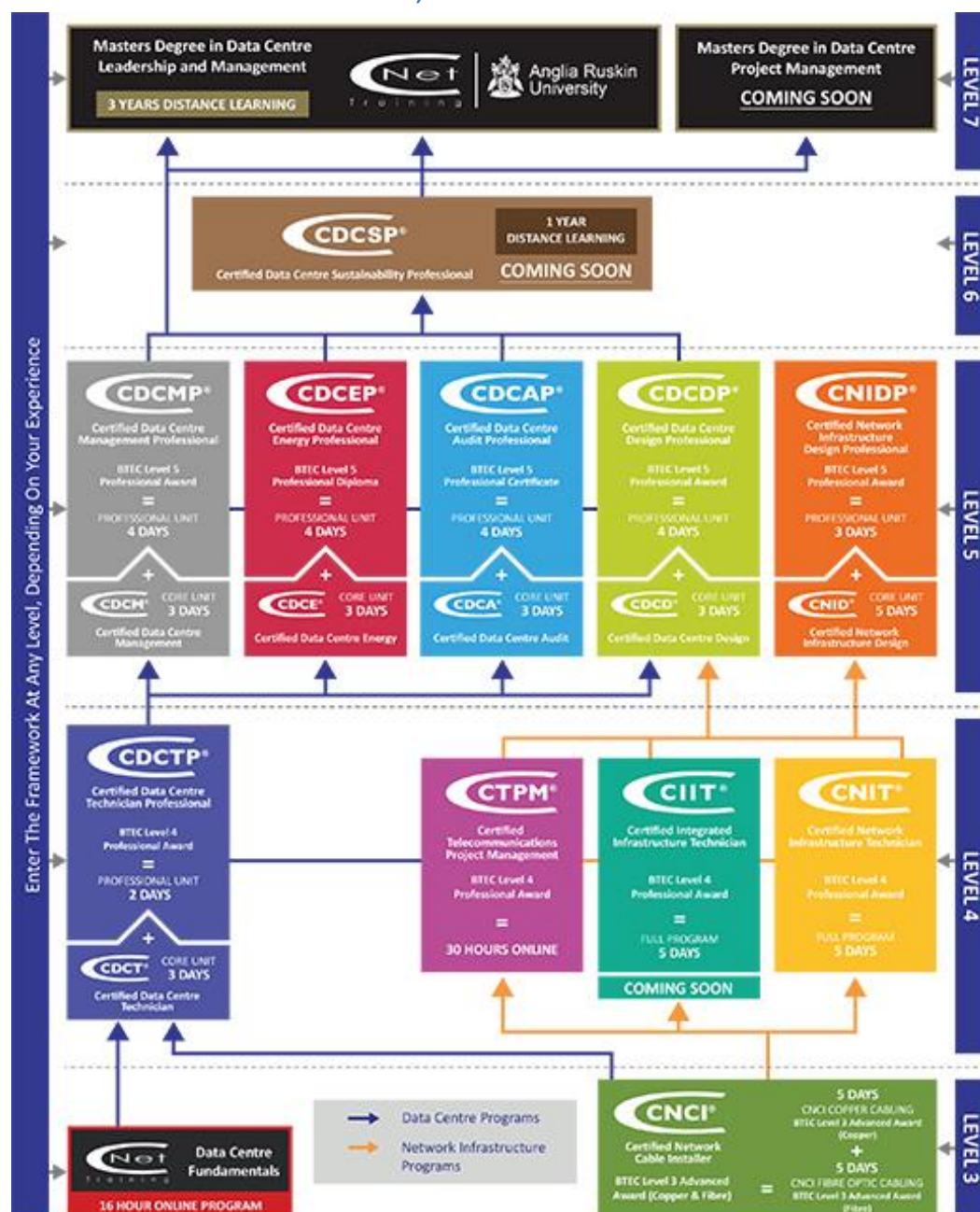


FIG 1. iMason’s training and certification progression

Managed services environments staff a Network Monitoring Centre (NMC) to perform proactive systems monitoring, incident management, and fault resolution.

4.3.

Nigeria Data Centre profile

There are both private and public DCs in Nigeria.

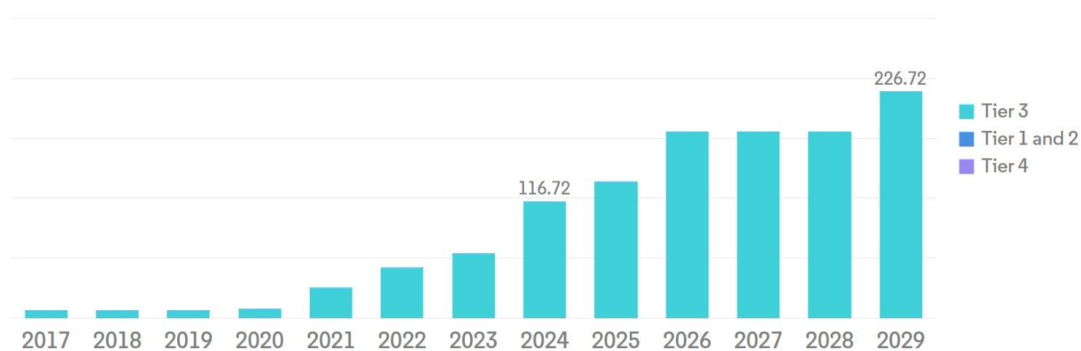
Private DCs are typically rated Tier 1 and Tier 2 environments sized between 100KW and 500KW and run by large organisations mainly in the BFSI sector with adequate in-house resource capabilities. Private DCs can run company-wide data processing requirements in private or hybrid cloud mode.

The public DCs, typically rated at as Tier 3 and Tier 4 DCs are larger environments offering colocation services, managed hosting, disaster recovery, cloud services, and so on. They are typically rated from 1MW to 10MW. There is an increased demand for local cloud computing, local storage and data sovereignty capable of running applications at scale such as – analytics, gaming, IoT, AI, data backup, blockchain, cryptocurrency and e-commerce.

Edge DCs, although nascent are under development around major economic hubs, and these could support the increase in internet penetration.

4.3.1. Nigeria Data Centre growthprojection

Volume of Tier type, MW, Nigeria, 2017 - 2029



Source: Mordor Intelligence



4.4.

Demand side survey

The demand side of skills and talent was investigated using a set of qualitative interviews with DC organisations who supplied information on the workforce and their capabilities.

It was not feasible to conduct a quantitative survey with the FTEs owing to the complex contact approval process, and therefore it was not possible to obtain primary data on employees regarding their career experience in the DC sector specifically.

The demand side was investigated using a set of qualitative interviews with DC hiring managers. The qualitative research was conducted with 5 public DCs and 3 private DCs. Patterns of correlation exist in the answers received from participants to deduce conclusions.

Data collection via a quantitative survey was attempted using *LinkedIn*, but the response level was significantly low.

4.4.1. Demand-side questionnaire and results compilation

HC qualitative analysis questionnaire for DC organizations									
Recruitment Strategies:									
Candidates are hired based on merits in qualifications, experience and personal attitude commensurate with the role offered									
Candidates include fresh graduates from universities, technical colleges and experienced tech professionals									
Technical Proficiency:									
DC tech skills requirements and qualifications are assorted and equally important for separate functional roles									
Tech proficiency is assessed considering the individual's knowledge, drive and innate capability									
Candidates are expected to undergo continual training and development in their roles									
Are there skills shortages experienced in Nigeria?									
No									
Industry Awareness:									
100% of DC hiring staff state - they keep abreast with global industry changes in technology and standards									
Diversity and Inclusion:									
100% of DC hiring managers state that - Applications are open to all genders									
100% of DC hiring managers state that - Tech roles are mostly taken up by males									
30% of DC hiring managers state that they encourage applications from females as part of company policy									
Challenges in Data Center Recruitment:									
We are mostly capable with our available workforce									
50% of Pan-African DC hiring managers state that - Architectural and design skill requirements can also be pooled from other zonal divisions in Africa									
Do you place foreign candidates on temporary roles with knowledge transfer to nationals as value added ?									
80% of DC Managers stated that foreign expertise is utilized temporarily on new system build and later handed over to capable workforce									
Continuous Improvement:									
All DC hiring managers state that - The workforce are supported with regular skills development programmes and training									
Regular performance appraisals practised by HR on each resource									
Other roles e.g Non-tech:									
Business layer									
ESG - 30% of DC managers state that the recent Environment, Social, and Governance (ESG) function in investment management, used for measuring organizational sustainable metrics is gradually adopted into DC management objectives.									
Although nascent in the country, ESG expertise is becoming a key resource.									
Finance and investments - 20% of DC hiring managers state that -									
Candidates from the social sciences and finance background are helping to shape investment portfolios to expand the organisation									
Environment layer									
Energy provision - 75% of DC hiring managers state that -									
Resources are gaining expertise in renewable energy strategies, microgrid management, captive energy and hydro-Power									
Energy trading - Most power sources are off grid. Expertise in power sourcing and renewable energy credits are low									
Social development									
Talents to create DC use cases (e.g in Healthcare and Retail sectors)									
with the upcoming technologies like 5G mobile technology, AI and IoT are low at the present moment									
Strengthening leadership									
55% of DC hiring managers state that - Individuals are rising through the ranks of expertise, diligence and professional development to compete for leadership roles.									
Indigenous talent are gaining opportunities to lead OEM technology input and FDI backed investments									

4.4.2. Key findings

DC hiring managers indicate that they are keen to use home-grown skills rather than foreign hires and there are abundant candidates eligible to fill the roles made available.

Experienced DC tech professionals are present in the country to handle more senior and critical roles, and they are also able to guide and mentor young entrants.

The overarching employability issue is that there are too many job seekers competing for too few jobs.

The current tech learning scope and knowledge obtained from tertiary institutions provide platforms for skills development in the DC work environment.

From the demand side, there appears to be an adequately resourced workforce with the requisite skill set, which is also attestable by published customer feedback and SLA requirements.

Some DC hiring managers perceive that the foundational skills for DC engagement are not well learned. Skills requirements are under regular review as part of overall workforce preparedness.

Future skills requirements are also part of the workforce preparedness plans and are appraised according to prevailing technical developments.

Contrary to the views postulated in the research problem, leading DC managers in the Nigeria DC industry maintain that technology operations in architecting, design, and support are managed and resourced satisfactorily within the home-grown talent pool. As Nigeria has missed out on the 3rd industrial revolution, measures are taken to embrace the 4IR and develop HC on par with internationally recognized standards. A proponent for Nigeria tech emancipation in the ICT sector states that foreign-designed solutions usually phase out rapidly in favour of solutions that embrace the business realities in the country. They emphasized that Nigeria must develop its technology to align with the enabling environment.

The role of government in the DC sector is minimal other than to create enabling business policies. There is room for trialling renewable energy sources such as solar and wind power generation. Systems assembly plants should be established as manufacturing units for components that perform suitably in tropical climates.

4.5.

Supply side survey

The supply side of skills was investigated using a set of qualitative interviews with learning institutions that supplied information on the curricula on offer as sufficient for skills and knowledge acquisition. It was not feasible to conduct a quantitative survey with the students owing to the complex contact approval process, and therefore it was not possible to obtain primary data on student awareness of careers in the DC sector specifically. The information was collected from qualitative and secondary sources online.

The qualitative research was conducted with 3 tertiary institutions, 1 public secondary school, and 1 private secondary school.

Secondary data sources presented the curriculum in use by the secondary schools, the Nigerian Universities Commission (NUC) web portal, and some training organization's websites.

The NUC portal's study disciplines range from traditional engineering (MEP), Computer engineering, Computer science, Cybersecurity, and Software engineering.

The total number of graduates from Nigeria's tertiary institutions is recorded as over 570,000 for year 2023. Science and tech graduates are between 25% to 35% of total graduate count.

It was not feasible to follow an order of data collection due to availability issues of the stakeholders. Participation was low from the organizations contacted to provide quantitative input. Most preferred researchers to use their published online data. Gatekeeper letters were perceived as a binding

contract to divulge sensitive information that they may not be able to control, thereby they were not too comfortable due to the risk of exposure.

The responses provided mirror the business reality in other DC organizations of similar scale and organizational structure, therefore the qualitative methodology was sufficient to arrive at a clear HC position. The contacts interviewed are knowledgeable and aware of the prevailing DC ecosystem issues from both the demand of skills and the supply.

The institution authorities expressed that knowledge, and skills are attainable via their curriculum, which positions learners in all industry sectors. The universities have not incorporated a curriculum assessment that includes advanced technologies such as AI, IoT, and 5G. Some constraints mentioned by lecturers include a lack of training materials, limited online access, and power outages on campus.

4.5.1. Supply-side questionnaire and results compilation

HC qualitative analysis questionnaire for learning institutions									
Institution: Universities' assessment									
Curriculum Overview:									
Some traditional universities claim that the curriculum on offer is robust and well grounded to impart skills necessary for the digital tech									
The courses at tertiary level are general traditional ICT and engineering courses									
A private University focused on digital tech management maintain that there curriculum is world class and well aligned to industry needs									
Graduate and Post graduate courses in - Computer engineering, software engineering, mechanical engineering, electrical engineering and Cybersecurity engineering									
Curriculum Components:									
Basic studies in computer networking, programming, cybersecurity and cloud computing									
Engineering disciplines such as - Mechanical engineering and Electrical engineering									
Teaching Methodology:									
Standard class lectures and some hands-on in labs									
Practical skills are encouraged amidst limited resources									
The teaching model is based on regular assignments, practicals and written examinations									
Private universities include in their teaching methods, room for critical thinking and problem solving									
i.e giving students opportunities for exploring innovative solutions to industrial and economic problems.									
Teaching methods include - Adaptive learning, Service learning and Project Management.									
Some other private universities offer entrepreneurship skills' developments for postgraduate co-horts.									
The private universities offer work experience via collaborations with some tech organisations for innovative synergies									
e.g Cisco , Microsoft									
This makes candidates competitive and to stand out in the industry									
There are limited partnerships with DCs.									
Industry Integration:									
Traditional universities - there are no evidence of deliberate industrial integration that									
offers students vast opportunities other than the usual 'intern' positions which are scarce and obtained usually via the NYSC route									
There is no partnerships with DCs.									
Technology Tools/Resources:									
The private universities provide students with practical exposure to real-world tools									
Assessment and Evaluation:									
Students are assessed with standard examinations, coursework and major projects									
Student Support and Resources:									
The general socio-cultural position in the country provides limited opportunities for student support services or career counselling									
Challenges and Improvements:									
Lack of training materials. Instructor/lecturers lack of exposure/ lack of means to motivate students									
The private institutions are able to afford foreign instructors who help to align curriculums with global standards									
Government Support:									
There is no government support for DC learning.									
The 3MTT program by the FMCIDE and NITDA focuses on sotware based ICT									

4.5.2. Key findings

For the supply of skills, there is an enormous base of graduates and experienced hires that meet selection criteria and subsequently gain career development, given the opportunity.

For public secondary schools, the findings indicate that STEM subjects are taught as part of the standard national curriculum. Private secondary schools possess additional facilities that incorporate basic computing technology subjects, e.g. software programming.

Tertiary institutions contacted reported that they strive to strengthen their STEM learning as much as possible, but there have been no changes to the teaching methods. Science and tech laboratories are often dysfunctional and dilapidated.

The significance of this qualitative study indicates a relatively low standard of knowledge and skills preparedness at both secondary education and university stage. There is an abundant supply of traditional engineering and ICT degree holders competing for entry-level roles in DCs.

A representative of a leading recruitment agency in Nigeria stated in a YouTube interview panel that despite the oversupply of able workers, skills gaps exist in the areas of employment preparedness.

Focusing on the core functions of a DC, a hiring manager of note states that gaps exist in the knowledge attained from tertiary institutions and the skills requirements at the workplace, and in fact, DC tech skills for new entrants could only be acquired sufficiently in the course of their duties at a DC site where mastery of specific tech specialties is developed continually within their career journey.

The DC is an unfamiliar institution, unlike the OEMs that are recognizable as 'household' names.

There was no data from any DC training centres published online. There are a handful of private IT training centres online that incorporate DC training courses, but they were unreachable for enquiries.

There is presently no scope for DC learning curriculums in secondary schools and Nigerian Universities, other than sets of training modules on offer when hired by DC organisations.

DC design and architecture skills are normally grasped at the workplace. At elementary levels, skills in Rack-mounting, IMAC, Cabling, Connectors, Cable-management are also functions undertaken whilst hired.

Facilities management skills in space management, cooling, power distribution and so on is normally acquired when hired by a DC organisation.

Industry professionals can also be involved in teaching, instructing and lecturing.

The NUC have announced a need to augment the curriculum with disruptive technologies such as AI, IoT, 5G and so on but no concrete plans yet.

4.6.

Demand and Supply matching

The survey results attempt to address the key themes in the theoretical framework.

Theory 1 – FDI and domestic investment levels, and impact on knowledge transfer, skill shortages.

There appear to be no barriers to knowledge transfer from foreign skills exports. The share volume of tertiary institution graduates and job seekers provides an abundant pool available for the workforce and to build an HC. This may be the case relative to the available DCs and the optimal FTE count required to function.

Theory 2 – Stimulating young entrants. Skills supply side via education – tertiary, vocational training, STEM programs, Catch Them Young schemes. The knowledge of DCs as an establishment is low compared to the knowledge of tech brands. Weaknesses in the skills supply are identifiable right from the education sector by way of the teaching methodologies employed and the curricula in use.

According to a Centre for Global Development (CGD) report (Adhikari et al., 2021), Nigeria is said to be Africa's biggest digital market, and the digital economy could add \$88 billion and 3 million jobs to the economy by 2027 yet employers say job readiness among young people is low and the training and education sector has not been able to keep up with the changing demands of employers.

The crucial knowledge and skills factor is in the educational domain where tech learning curriculums in tech colleges, universities, and even secondary schools require adjustments to the needs of the 4IR.

Theory 3 – Non-technical entrants relevant for DC Core objectives. The capacity for non-technical roles is gradually building up. A leading figure in ESG states that there is some traction amongst the most capitalised companies on the Nigerian Stock Exchange (NGX) and private companies with multinational funding, however, most organisations have not understood ESG as businesses tend to focus on short-term growth and survival.

Theory 4 – Diversity and Inclusion Policies in HR. D & I matter attract low attention generally in Nigeria. Tech roles are predominantly taken up by males, which includes DCs, which are by default a male-dominated organisation.

The supply of entry-level roles will generally come from tertiary institutions churning out tech graduates. Experienced hires may cross over from other sectors or DC organizations, and they could progress alike into more senior roles and leadership positions in their career journey.

With the few DCs in the country, the demand side can be adequately met via the ample supply of candidates. Labour is abundant generally in Nigeria, where graduates and experienced hires alike are readily available to take up roles in a DC. These can now be used to formulate the HC structure.

The exploration of the HC position hinges mainly on a demand and supply matching process. The demand side was investigated with a qualitative process within this current period and mode of business operations. The survey demonstrates an HC position but no agreed empirical facts cooperatively amongst the major stakeholders, substantive to deduce skills and talent shortages.

4.7.

Diversity and Inclusion (D&I)

Dealing with D&I issues in Nigeria's ICT is commonly tagged with the phrase *Closing the gender digital divide*. There are a few alliances with forums and events that encourage D&I.

Some of these ongoing forums are: -

- Women in Engineering
- Women in IT. The offshoot hashtag #GirlsInICT, #She-Tech, #Potential International Girls in ICT Day
- *Enabel* -promotes women in tech
- Women in Data Centres is a recent forum, Jan 2024

A leading activist in Diversity and Inclusion Programmes in Nigeria reported that D&I are critical components of HC development in Nigeria. In recent years, there has been a growing awareness and commitment from both the public and private sectors to enhance D&I initiatives. These programmes

are aimed at creating an inclusive environment where all individuals regardless of gender, physical ability or other differences can thrive and contribute effectively.

In the private Sector, many private companies in Nigeria, especially in the technology sector, have begun to recognize the importance of D&I. Initiatives such as mentorship programs for women in tech, partnerships with organizations that support physically challenged individuals and inclusive hiring practices are becoming more common. Companies are also investing in training and development programs to ensure that diverse talent pools are nurtured and retained.

In the public Sector, the Nigerian government has implemented various policies to promote D&I. Policies aimed at encouraging the participation of women and physically challenged individuals in the workforce are in place. However, the effectiveness and practical implementation of these policies can vary. The government has also partnered with international organizations to support initiatives that promote D&I in education and professional development.

4.8.

Governmental response to DC HC developments

Several government-led programs listed below are in place, enhancing the digital economy and ICT generally from their respective focus points.

Science, Technology, Engineering, and Mathematics education (STEM)

The STEM educational program launched by the USA in 2001 has been adopted globally, and the federal ministry of education, Nigeria, has also taken steps to intensify education in scientific and engineering disciplines by increasing the numbers of students and teachers in STEM. Some regional governments are also supporting STEM education in partnership with private organizations.

Examples of STEM education programs are: -

- Prime STEM, Nigeria – Offering STEM education in one of the states in the eastern region
- MTN Foundation – sponsoring student STEM courses
- Ty Danjuma Foundation – Empowering teachers on STEM skills
- Association of Professional Women Engineers of Nigeria (APWEN) – Supporting and encouraging girls in STEM courses

It was reported that the STEM take-up has been facing challenges due to a systemic lack of funding in the education sector, poor instructional facilities, lack of skilled teachers and limited access to internet services amongst many other issues.

Essentially, the school curricula on STEM subjects and the teaching methods are outdated. These call for improvements in government policies in: -

- Funding for STEM
- Improved programs for embracing D&I i.e, encouraging females from a younger age via the educational programs

D&I

Findings from the recent survey reveal there is a significantly low rate of females in engineering professions generally inclusive of the DC sector. Applications for entry-level and experienced roles in DC engineering and management are mostly received from males.

Government policies supporting D&I include the National Gender Policy and various initiatives under the Ministry of Labour and Employment, however the practical implementation of these policies does not usually keep up with intended outcomes. Continuous monitoring and evaluation are necessary to ensure these policies translate into real-world impact.

The federal government agency, National Information Technology Development Agency (NITDA), a parastatal under the Federal Ministry of Culture and Innovation and Digital Economy (FMCIDE) have drafted programmes to encourage digital literacy at various levels of capability indiscriminately.

Collaborative efforts within the NITDA and FMCIDE have programmed events to encourage girls and young women into the ICT engineering field.

National Digital Economy Policy and Strategy 2020-30 (NDEPS)

The federal government of Nigeria has created digital economy development programs in alignment with the United Nations Sustainability Development Goals (SDG). The National Information Technology Development Agency (NITDA) took steps in 2019 in creating programs such as the National Digital Economy Policy and Strategy 2020-30 (NDEPS), 8-Pillar strategy where Pillar 2 makes a case for digital literacy and Skills and knowledge in digital technologies. This is aimed at creating a pool of Nigerians with globally recognised and certified digital skills. In the last few years, however, the ICT sector, like many other sectors, has faced several challenges due to macroeconomic slowdown and currency depreciation because of the 2015-16 recession. The stated objective is to achieve a 95% digital literacy level in Nigeria within the next 10 years. The target was to provide an enabling environment for the public sector, private sector, civil society and development partners to support the training of 5 million Nigerians.

Three million Technical Talent (3MTT)

Under the FMCIDE, the 3 million Technical Talent (3MTT) programme, a critical part of the Renewed Hope agenda, is aimed at building Nigeria's technical talent backbone to power the digital economy and re-position the country as a net talent exporter.

The programme aims to generate a pipeline of technical talent in line with the new governmental vision of creating 2 million digital jobs by 2025.

The 3 million Technical Talent (3MTT) programme, a critical part of the Renewed Hope agenda, is aimed at building Nigeria's technical talent backbone to power our digital economy and position Nigeria as a net talent exporter. The first phase of the programme, executed in collaboration with NITDA, will involve multiple stakeholders including fellows, training providers, partners and placement organisations.

Policies have been drafted and operational for mass upskilling in ICT soft-based disciplines like AI, IoT, and Cybersecurity. Currently, there are no provisions of this opportunity targeted at the Solid Infrastructures that can favour DC tech HC development.

The 3MTT program could borrow a leaf from the Horizon Europe Program 2021 2027, and the new investment scheme in their digital transformation of Europe which provided for the allocation of EUR 2.5 billion directly for AI, and an additional EUR 700 million for investments in ensuring advanced digital skills through education and training courses (Grigorescu et al., 2021).

The development of a digital society at EU level involves the allocation of significant funding for the growth of R&D in the field of technologies in partnership with the private sector and their commercialization.

International agency frameworks

Under the African Union (AU) there have been several agencies and committees charged with drafting strategies for African digital economy enhancements. The AU Agenda 2063 with UNCTAD embraced the following agencies UN SDG, AU Commission, UN Economic Commission for Africa, Smart Africa, AU DA NCPAY and Africa capacity building fund to draft the **AU Digital Transformation Strategy (DTS) was issued in Q1 2020.**

The AU DTS aims to harness digital technologies and innovation to transform Africa's societies and economies to promote Africa's integration, generate inclusive economic growth, stimulate job creation, erase the digital divide and eradicate poverty to secure the benefits of digital revolution for socio-economic development.

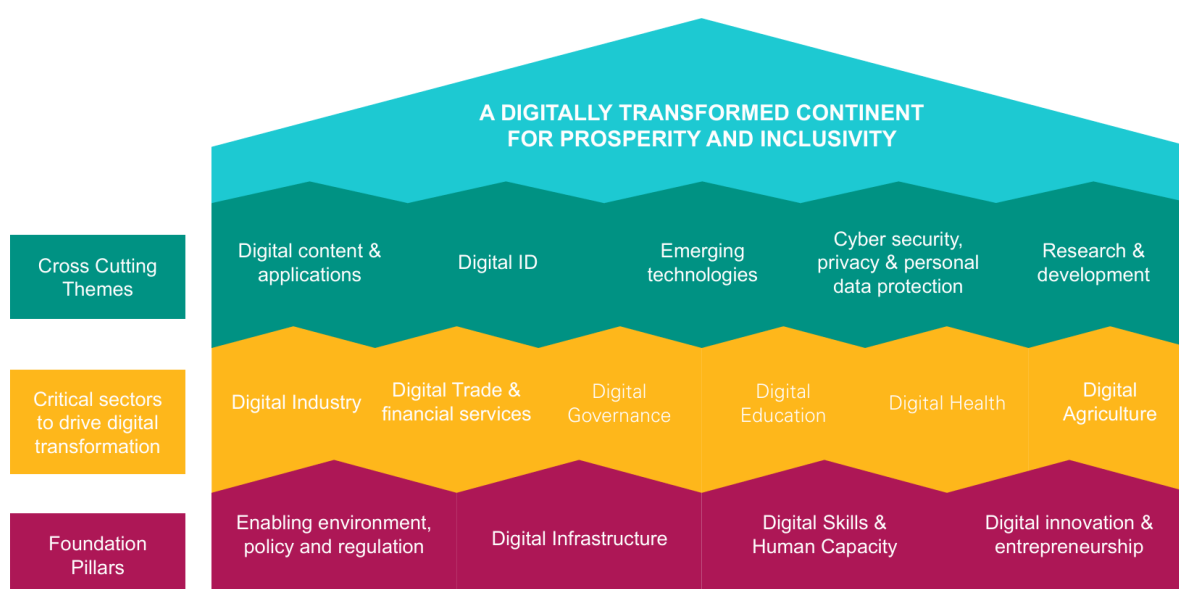


Fig 2. A Digitally Transformed Continent For Prosperity and Inclusivity

In the AU DTS framework, Digital skills and Human Capacity form the base of the Foundation Pillars as critical to the DTS. This strategy advocates for the development of Indigenous tech skills.

A World Bank report has also emphasised on the need for skills development and adequate digital literacy programmes as the 4IR is gradually spreading in adoption and practise.

The Nigerian government response to this AU DTS has seen the formulation of programmes and policies like 3MTT mentioned above under NITDA and the recent FMCIDE.

5. Impetus for a sustainable DC HC framework

Several enabling opportunities are rapidly springing up which will pave the way for increased DC projects.

Nigeria ICT sector recorded a 10.32% growth in Q1 2023. In the fourth quarter of 2023, Nigeria's Information and Communications Technology (ICT) sector played a pivotal role in the nation's economic landscape, contributing 16.66% to the real Gross Domestic Product (GDP), as revealed by the National Bureau of Statistics (NBS) in its Q4 GDP statistics released on Friday.

The government has announced plans for a 90,000 km fibre optic ring. This will stimulate and promote DC distribution in the country.

The Electricity Bill 2023 is set to liberalize power provision entrepreneurship. This will give rise to increased power provision technologies for DCs.

In Q2 2024, there were new DC announcements of 1 tier 3 DC and a tier 4 DC developments.

Edge DCs sprawling the country will require homegrown skills and experienced techies for operational support.

A smart city project is under development in Lagos which will be replicated widely in the country.

The next 36 months will see the establishment of 50 MW to 60 MW of facilities, a 50% leap from present capacity.

In preparation for this development, DC HC must be sufficiently structured to provide the workforce to operate and support the forthcoming DCs.

Increased 5G networks will provide backhaul capacity.

Tier 1 and 2 DCs for backhauling capacity to Tier 3 and 4 DCs.

The forecasted increase in applications based on AI, IoT, Smart technologies will require DCs.

The OEMs below have practiced an HC program in the last 5 years:

- **Cisco** - Empowering Africa with 3 million more tech workers, 2017
- **Huawei** - Offering systems training to customers and Graduate Internship opportunities

Other software OEMs like Oracle, Google, Microsoft, AWS and HP have also supported general HC with free online classes.

Increased collaboration with DC co-creation hubs stationed at all Tier 3 and Tier 4 DCs will accelerate the stimulation needed to grow the sector.

Policies related for data governance, including data protection laws, are crucial for creating a framework that ensures responsible and ethical use of data in AI applications. Efforts to keep data within national borders and compliance with international data protection standards are emerging trends that will stimulate DC capacity building in the country.

6. Recommendations for DC HC development

HC plays a critical role in creating and sustaining competitive advantage for organizational success. For Nigeria, a multi-layered approach will be required to structure the DC HC. Several factors must converge and co-exist to build a solid HC. The list of recommendations raised in this paper provides some key action points.

Education and Curriculum Development

DCs are not a topic taught in schools, and it is not often a career choice. Most tertiary-level students (around 90%) have no clue where data is stored or processed. They may know of the *Cloud*, but they have no idea that the data resides somewhere in a building.

A DC is characterized by a complex composition of ICT (Computing, Networking, and Data storage technologies) with facility engineering support services, such as Power and Cooling technologies, Fire suppression systems, and CCTV monitoring systems. In basic terms, schools and tertiary institutions are required to introduce digital infrastructures by teaching topics like telecommunications, cloud computing, and elementary DC engineering topics.

Design future-ready Curricular

In the context of emerging technologies, the effectiveness of upskilling initiatives is contingent upon several factors, including the relevance of the skills being taught, the mode of delivery, and the alignment with industry needs. Traditional educational approaches are not sufficient to meet the demands of this rapidly changing landscape. As such, innovative teaching (Ajayi & Udeh, P.No. 1119-1137, Page 1120), International Journal of Management & Entrepreneurship Research, Volume 6, Issue 4, April 2024 methodologies, such as experiential learning, online platforms, and industry-academic partnerships, are increasingly being adopted to enhance the efficacy of upskilling programs. These methodologies offer flexible, practical, and context-specific learning experiences essential for developing the advanced skills required in the DC sector.

Curricula that encourage critical thinking, creativity, and emotional intelligence, as well as to accelerate the acquisition of digital and STEM (science, technology, engineering, and mathematics) skills to match the way people will work and collaborate in the future, must be a principle to building a knowledge roadmap in tertiary institutions.

As we realize the 4IR, and for the youths to succeed in this new information age, STEM education needs to take centre stage of skills development.

For investments in HC, business stakeholders assert that STEM are some of the key subjects to intensify now for the country to evolve the scientific and technological innovations needed to face the challenges of globalization and to build an evolving knowledge-based economy.

It is recommended that the formulation of an educational policy focused on STEM is key to orchestrating and stimulating the practice nationwide with collaborative partnerships in the private sector. Private tech organizations could be encouraged to invest in local STEM programs, invite participants to their work environment for work experience and mentoring.

Internship and Apprenticeship programs

Government policies can be drafted to support a set number of mentees, outstanding graduates from tertiary institutions to pursue careers in the DC sector.

Scholarships can be awarded to exceptional candidates for the pursuit of added skills beneficial for DC design, operations, and management.

Continuous learning and development

Skill development programs must be arranged in all spheres of tech learning. As the tech landscape continues to evolve, so too must the strategies employed to ensure the workforce remains equipped to navigate and thrive in this dynamic environment. The ongoing commitment to workforce upskilling is not just a response to immediate needs but a foundational investment in the future of the DC sector and, by extension, the broader economy. The future skills are said to be heavy on advanced IT, agile DCs, AI, smart systems, and so on. Continuous learning creates room for the adaptability of new ideas and innovations.

DC localization

The location of DCs will play a major part in HC formation. Most DC professionals are likely to be resident within closer proximity to the larger urban environs where their DCs are located. 95% of the DCs in Nigeria are in densely populated areas like Lagos, which consists of thriving local economies and offers more jobs and skills development within that area.

Plans to invest in more DCs must embrace plans for HC formulation within or closer to the new DC environs. The DC HC must be built so that the knowledge exists in the public sector for policy making as well as it exists in the private sector for top-level research and innovation, improved business services, consulting, vertical market growth, and progressive downstream operations.

DC investments tend to follow an as-needed basis where the projected economics warrants the investment. Considerations should be engendered for DCs to spread around the land mass, ideally offering services abundantly to the populace and business communities.

Industry-Academia collaborations

Research and innovation centres can be created in universities to provide room for students and academic staff to research real-life DC problems. Students can be exposed early in their education to critical business issues and to develop a stimulation to seek solutions.

Public-private Partnerships

Government collaboration with institutions for HC building commenced by the NITDA, an example being the 3MTT organized in Q4 2023 which focuses on data analytics, cyber security, cloud computing, AI and so on.

The Information Technology Association of Nigeria (ITAN) organized a workshop Q3 2023 to bridge the gap between government, regulatory agencies in the ICT sector and private players.

Several programs can also be offered by the agencies below whomayexplorecollaborative partnershipswith the business communities to produce solutions needed in the country.

- Nigerian Technology Institute (NTI)
- Nigeria Computer Society (NCS)
- Computer Association of Nigeria
- Association of Telecommunications Companies, Nigeria (AFCON)
- Nigerian Millennials Technology

Professional Associations and Networks

Local DC associations are paramount to creatingthink tanks on key DC subject matters.

Drawing on the sociology of networks, the primary argument has been that relational capital in networks mitigates transaction costs through reciprocity and trust (Holm, Eriksson, & Johanson, 1996, 1999; Powell, 1990). Conversely, digital platforms emphasize the economics of networks, particularly increasing returns to scale (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013; Parker & Van Alstyne, 2005).

There is the Africa Data Centre Association (ADCA) accessible to DC organisations under a tiered membership subscription.

The LinkedIn-based, Digital Infrastructure Africa Alliance forum (DIAA) forumstrives to engender knowledge-sharing and Networking opportunities amongst DC professionals. It is developing as a strategic platform established by like-minded individuals with the aim of fostering multi-stakeholder partnerships and boosting investments to advance a human-centric DC ecosystem.

Cross-Sector Collaboration

Disparate industries using similar system specifications can unite for collaborative efficiencies in design, operations and procurement.

A common problematic element to most heavy-duty industries in Nigeria is power generation and power stability. Various kinds of assembling and manufacturing plants use similar-grade diesel-powered generators to run their productions. M&E personnel in either industry can be encouraged to explore synergetic prospects in operational efficiency and procurement. This enables resource cross-over from other sectors. Mission-critical talents such as in the M&E areas could emerge from non-DC sectors.

DC Centres of excellence

Dedicated DC Co-creation hubs are essential for R&D activities. Accessible environments in the form of DC playgrounds which are essentiallyDC training schools can be established across major hubs in the country.

Industry awards and Recognition

HC can be enhanced with rewards and recognition. There are awards listed below: -

- Beacon of ICT Awards - BoICT Awards
- Datacloud Africa Award for Excellence in Data Centre (Africa)
- Africa Cloud Service Provider of the Year
- African Digital Economy Awards
- Personal awards to distinctive individuals

With the above, recognition scope may include DC organizations with outstanding '*digital infrastructure innovation*'.

As part of organisational CSR, resources can work on specific socio-economic projects that enhance community and human well-being, using data and DCs. Such projects can span social, health, security, and agricultural sectors.

D&I

DCs can benefit from robust D&I policies. DC tech roles in simulation, project management, M&E design, etc are becoming prevalent to complement physically demanding engineering roles, which improves HC.

To further enhance D&I in Nigeria's Data Centre sector, the following steps are recommended: -

- Strengthen collaboration between government, private sector, and educational institutions to create a cohesive strategy for D&I
- Ensure that government policies on D&I are effectively implemented and regularly reviewed to meet evolving needs
- Increase awareness and provide training on D&I best practices across all levels of organizations
- Establish mechanisms for regular monitoring and evaluation of D&I initiatives to measure progress and impact
- Introduce incentives for organizations that demonstrate strong commitment to D&I, such as tax benefits or public recognition.

A DC HC framework recommendation

Collaborative efforts by myriads of agencies across private and public sectors are required to create a sustainable structure for a DC HC.

The key ingredients to HC maturity cover the areas of knowledge, abilities, training, good health, judgement, wisdom, creativity and innovation.



Fig 1. DC HC components

HC formulation can be approached by layering the key HC components to attain capacity levels. For a tech ecosystem such as a DC, an approach to the HC policy framework is described below: -

- ❖ Development from the Individual level – **Good health, Health and Training, and Wisdom**
- ❖ Development from the Societal level – **Individual level + Knowledge + Abilities**
- ❖ Development from the National level – **Societal + Collaboration + Judgement**
- ❖ Development from the Inter-National – **National + Innovation and Creativity**

Knowledge sharing and capacity building are essential for HC strategies in emerging DC markets. These activities help to ensure that local stakeholders have the knowledge and skills necessary to sustainably manage and maintain critical systems (Wisdom Ebirim et al., 2024).

HC policy level	Capacity building	R&D, Knowledge	Product	Value add
International	National	Innovation	Creativity	Strategic
National	Societal	Collaboration	Judgement	Socialble
Societal	Individual	Training	Explicit	Abilities
Individual	Good health	Education	Explicit	Wisdom

(Academic-publishing.org, 2024) classified knowledge into tacit and explicit. Tacit knowledge or know-how is the knowledge embedded in people, systems, and organizations, and is difficult to articulate or codify. Explicit knowledge (or “know-what”) is the knowledge easily identified, articulated, and shared. *Explicit* knowledge is usually via the education route, i.e., studying, and reference materials to curate the knowledge, whilst *Tacit* knowledge is knowledge and skills acquired over a period that enable critical reasoning, complex problem-solving, networking, and leadership.

DC technology focus areas

Aligning the framework with the tech layers of a DC reveals

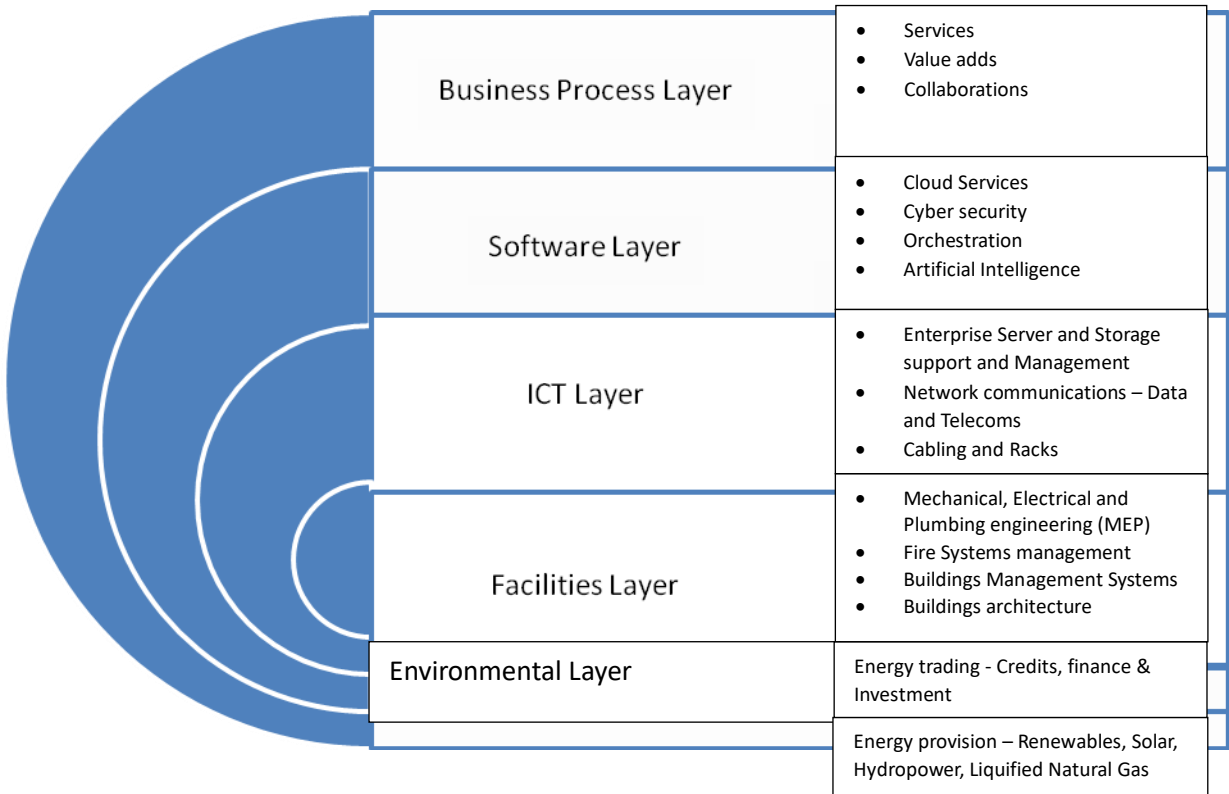


Figure 2. DC technology stack

Additional DC role requirements

Aside from the core engineering composition of a DC which is run by digital technologists and M&E professionals, there must also be room for specialists in climate control issuesas African regions battle with utility sourced energy. Climate problems are beginning to inflict the continent therefore investments are required in green energy – Wind and Solar, and Waste to Energy initiatives that DCs could benefit from.

The ecosystem encompasses the need for sustainability and ESG professionals, therefore candidates in disciplines from the humanities and environmental sciences should also be encouraged into the DC workforce such as from disciplines like Geography, Aquatics and Biology, Accounting, Finance and Law.

DC building architecture and design are skills to be homegrown and harnessed as the country prepares for the next wave of greenfield DC developments.

While all Nigeria DCs utilize off-grid solutions, arrangements can be put in place for energy trading on the public LNG networks which will span most hubs.

7. Conclusion

This paper has attempted to develop a rounded depiction of the Nigeria DC industry, highlighting the key elements of HC and apparent shortcomings with prospects for development using indigenous skills via the key action areas highlighted.

Contrary to the foremost issue in the research problem, it is the author's opinion that expertise and limited knowledge transfer from imports during FDI may not be responsible for asserted skill shortages, other than the endemic poor approach to educational methods on the supply side, which has not led to a well-structured HC formulation. A quantitative survey with larger samples of DC CIOs and DC CTOs may provide added validation to strengthen this fact. A qualitative survey extending to FDI stakeholders may also reinforce the argument that knowledge transfer and skills enhancements have been sufficiently delivered as part of the transactional FDI package.

DC HC requires a major rethink. The present workforce will require rapid preparation for the near future DC technologies. The key recommendation on HC formulation is on education. The learning curriculum should be relevant to the present and future economy. The human performance should centre on keeping pace with technology trends. The 4IR will disrupt businesses in so many ways and preparedness is required to adopt revised structures to rapidly adapt advanced technologies like AI, Smart tech, renewable energy and so on that are set to dominate the digital space soon where solid measures are required to enhance the HC that will contain these technologies in a DC.

Technical skills can be enhanced with revised learning curriculums. At the government level, an intentional program that focuses on STEM education and dedicated DC engineering education is now necessary to uplift attainable skills and talent development. It is of paramount importance that there is advocacy for reforms in the national education policies to fix the inadequacies in the curricula used both in schools and tertiary institutions for purposefulness in the labour market where there is a clear demand for up-to-date digital skills.

The concept of HC formation in the context of investment in education poses several problems. How much is the total stock of HC required? At which stage of development is it needed the most? What should be its rate of accumulation? What type of education should be imparted, to what extent, and at what time? And how should the return from educational investment be measured? (Jhingan, M.L. 1997 The economics of development and planning, Forty Revised & Enlarged Edition).

Capacity is available for skills and talent acquisition, which can be enhanced with provisions to explore, experiment, and practice. Facilitation environments for budding DC experts to architect and build to both local needs and global standards could be created in the form of DC playgrounds to stimulate co-create and curate technology to reimagine and future-proof the next generation DCs for example, the way data halls will look in say 10 years with agile racks, solar-driven power systems and so on.

Stimulating young entrants, as part of 'catching them young', excursion to DCs further ignites curiosity and activates critical thinking to stimulate innovation. This is part of how the opportunities can be created to explore, engage with the tech, experiment, expand the knowledge base, cultivate the entire human abilities, and bridge the imaginative deficits. This key action helps to address diversity and inclusion.

The DC is a monolithic establishment of significant investment in complex engineering technologies, orchestrating a myriad of digital processes in cloud computing, telecom services, data storage, internet services, and so on. DCs are required to be agile, physically and logically secure, self-healing, and adaptable to be future-proof and 'smart'. The goal of any HC strategies should engender, micro-cultures in leadership, engineering, innovation, and creativity, enabling them to adapt to global business changes and tech disruptions.

In summary, there is a myriad of partnering initiatives and siloed pilot projects for digital skills and labour mobility that can be structured to formulate a progressive and sustainable HC position. In the face of the growing population, ICT pervasiveness, and ensuing DC footprint expansions, building the HC for the Nigerian DC sector requires a multifaceted approach, involving collaboration between the government, private sector, and educational institutions to ensure a skilled and diverse workforce capable of meeting the industry's evolving needs.

Further HC formulation however requires to be drafted for the ensuing developments. This should aim to lay the foundations for self-reliant DC technology manufacturing, production, and operations. A DC business framework for the country should be constructed to produce tangible growth, sustainable operations, adaptable to the business climate, and accessible for all market players.

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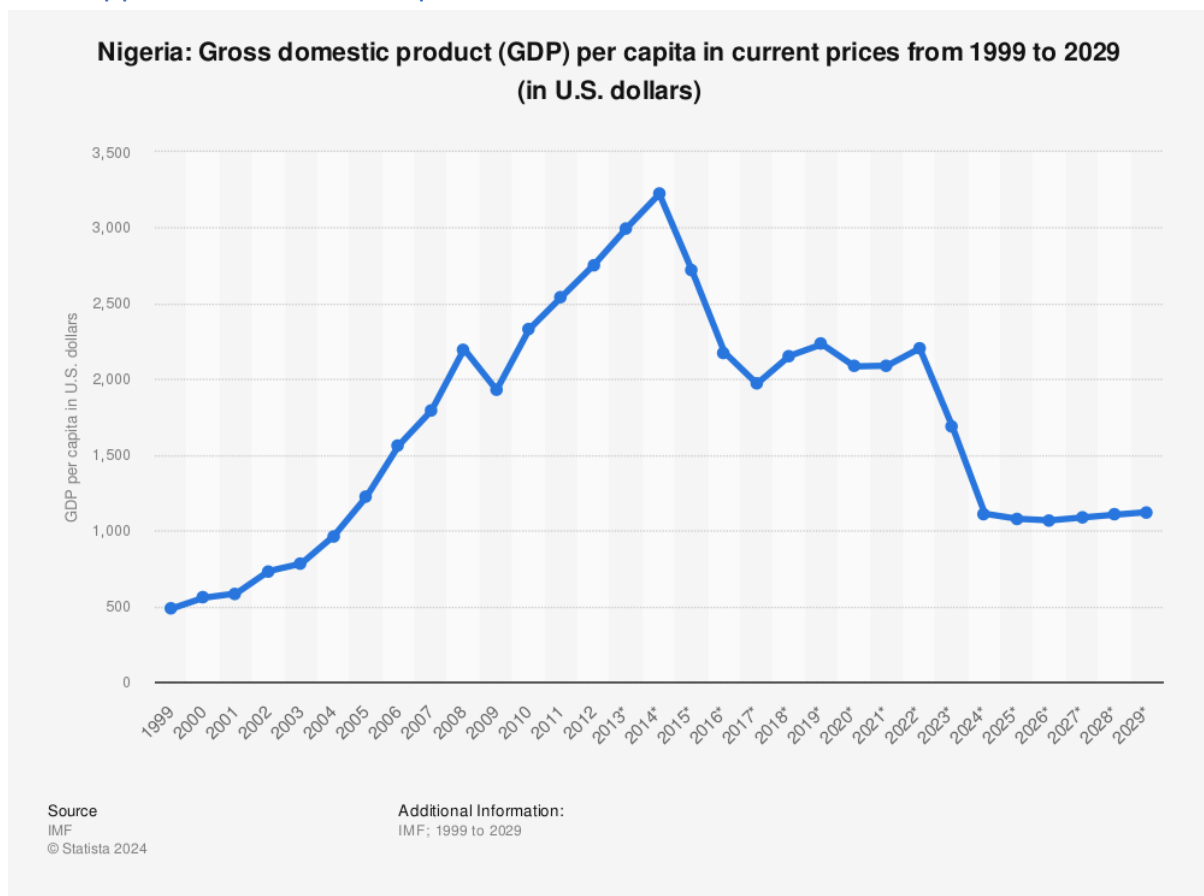
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9. Appendices

9.1.

Appendix A: GDP Per Capita



The main sectors of Nigeria's economy are quite diverse, reflecting the country's rich resources and growing industries. Here are the key sectors:

Agriculture: This sector remains a cornerstone of Nigeria's economy, contributing around 20.4% to the GDP in the first half of 2023¹. It includes crop production, livestock, forestry, and fishing.

Trade: The trade sector is significant, contributing about 12.5% to the GDP. This sector encompasses both domestic and international trade activities.

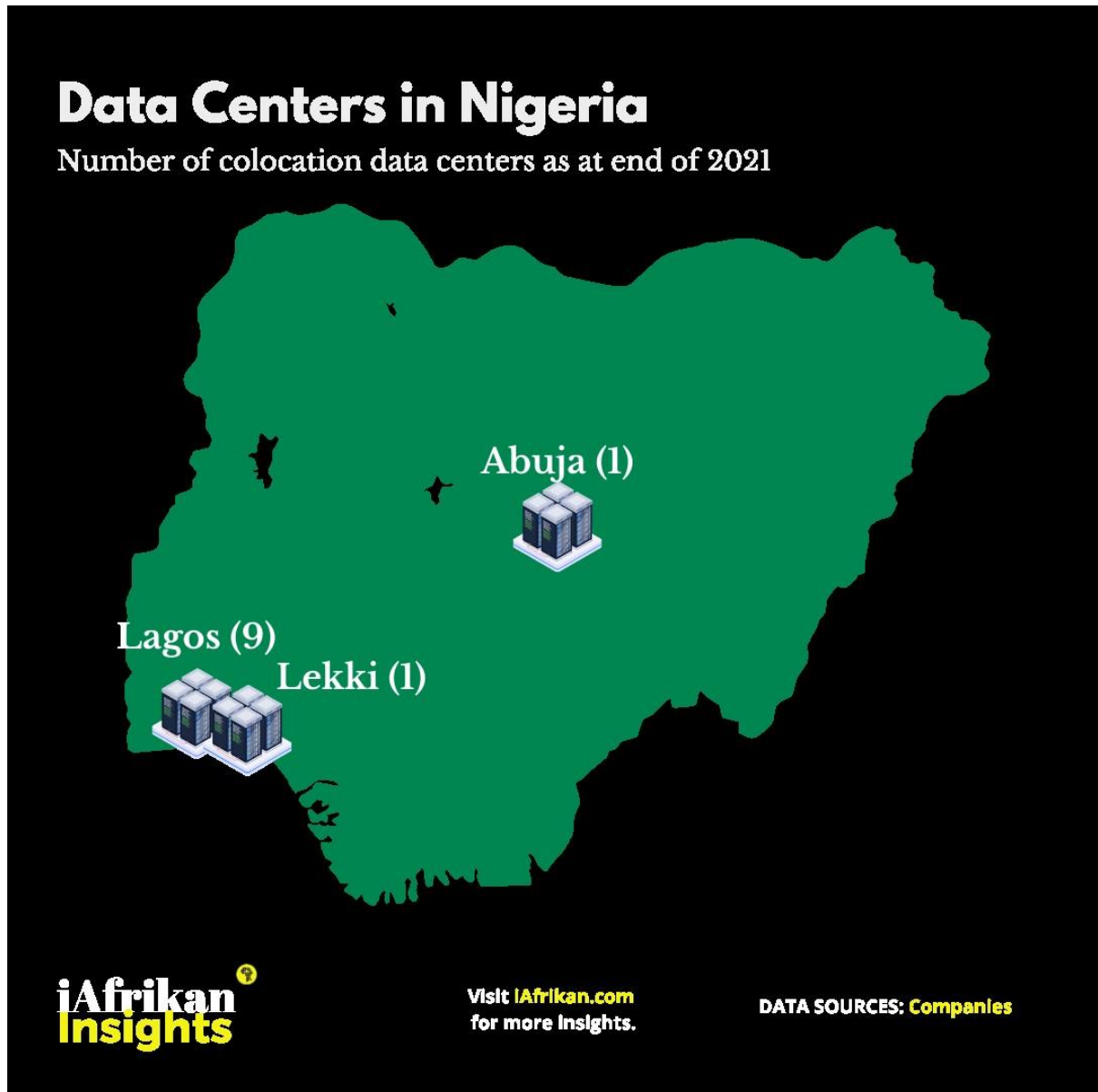
Manufacturing: Manufacturing is a vital part of the economy, contributing approximately 15.1% to the GDP. Key sub-sectors include food and beverages, cement, textiles, and tobacco.

Information and Communication: This sector has been growing rapidly, contributing around 14% to the GDP. It includes telecommunications, IT services, and media.

Oil and Gas: Although its contribution has decreased over the years, the oil and gas sector still play a crucial role, contributing about 7.24% to the GDP. Nigeria is one of the largest oil producers in Africa.

9.2.

Appendix E: Nigeria DC locations



As from 2022, DC development announcements were made from KASI Cloud, OADC, Airtel and Galaxy Backbone.

Q3 2024 –Announcement for DC construction, BDIC (AfricaHyperscalersNews, 2024), and MTN (Staff, 2024).

9.3.

Appendix J: Glossary

3MTT–3 Million Technical Talent

4IR – Fourth Industrial Revolution

5G – 5G Networks

ADCA – Africa Data Centre Association

AI – Artificial Intelligence

ATCON – The Association of Telecommunications Companies of Nigeria

APWEN - Association of Professional Women Engineers of Nigeria

AU – Africa Union

AUDTS–Africa Union Digital Transformation Strategy

CCTV – Closed Circuit Television

CO₂- Carbon dioxide

CSR– Corporate Social Responsibilities

DC – Data Centre

DTS–Digital Transformation Strategy

ESG – Environment, Social & Governance

EU – European Union

FDI – Foreign Direct Investment

FM - Facilities Management

FMCIDE – Federal Ministry of Communication, Innovation and Digital Economy

FTE - Full Time Employee

GDP – Gross Domestic Product

HC – Human Capital

HCI – Human Capital Index

HCT – Human Capital Theory

ICT–Information and Communication Technology

IMAC– Installation, Moves and Changes

IOT – Internet of Things

ITAN–Information Technology Association of Nigeria

Japa – Japa syndrome - The term *Japa* is commonly used in various contexts to describe a rapid departure from a place, situation, or circumstance. It is often employed humorously and is prevalent in discussions related to avoiding trouble, danger, or undesirable encounters. The usage of "Japa" reflects the resourcefulness and adaptability of Nigerian youth in navigating challenging situations.

LNG – Liquefied Natural Gas

M&E – Mechanical and Electrical

MEP – Mechanical, Electrical and Plumbing

NCS–Nigeria Computer Society

NDEPS–National Digital Economy Policy and Strategy

NGX – Nigeria Stock Exchange

NITDA – National Information Technology Development Association

NMC–Network Monitoring Centre

NTI – Nigeria Telecommunications Institute

NUC– National Universities Commission

OEM – Original Equipment Manufacturer

R&D – Research & Development

SDG – Sustainable Development Goals

SLM – Service Level Management

STEM – Science, Technology, Engineering and Mathematics

UNCTAD–United Nations Conference on Trade and Development

UNDP–United Nations Development Programme