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EXPLORING THE BENEFITS OF THE 4TH INDUSTRIAL REVOLUTION: THE NIGERIAN EXPERIENCE

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ABSTRACT

This paper identified the ways in which Nigeria and her Information technology professionals can beneficially position themselves in the wake of the Fourth Industrial Revolution (Industry 4.0). The fourth industrial revolution refers to a range of new technologies that are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human. The research identified that key driving forces for the fourth industrial revolution included disruptive technologies, Internet of Things, Robotics, Artificial intelligence, and Virtual Reality. Skills that would be sort after in this digital economic era include professionals who have expertise in artificial intelligence, cyber security, as well as proactive developers who can build dynamic systems to suit into the digital revolution. Nigeria as seen in the research missed out on the three previous industrial revolutions and is about to miss out on the fourth industrial revolution and the research proffers solutions on how to prevent this disaster from happening and the role IT educators need to play to ensure a smooth glide of the Nigerian economy into the fourth industrial revolution.

KEY WORDS: Industrial Revolution, Artificial Intelligence, Industry 4.0, Computing, It Professionals

INTRODUCTION

In a rapidly changing world, only those who adapt to the changing times stand the chance of reaping the benefits associated with this rapid evolution. Information technology has become the main driving force for sustainable development of nations the world over. The world has experienced revolution of economies from mechanical based to the most recent digitalization of economies as characterized by the 4th industrial revolution. This paper aims as conceptualizing the 4th revolution, going down memory lane to trace the historical development of industrial revolutions, identifying key players that fuel the 4th industrial development, and highlighting Nigerian preparedness in keying into the 4th industrial revolution. According to Techtarget (n.d), the fourth industrial revolution is the current and developing environment in which disruptive technologies and trends such as the Internet of Things (IoT), robotics, virtual reality (VR) and artificial intelligence (AI) are changing the way we live and work. The First Industrial Revolution used water and steam power to mechanize production. The Second used electric power to create mass production. The Third used electronics and information technology to automate production. Now a Fourth Industrial Revolution is building on the Third, the digital revolution that has been occurring since the middle of the last century. It is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres. It is a revolution that will shift societal reliance for investment decisions from investment managers singled out for talent to big data and advanced algorithms. It will move the world from its dependence on fossil fuels to new and renewable sources of energy. It will destroy old jobs and replace it with robots as well as create new ones in the process. Even governance will be revolutionized.

This paper conceptualized on the fourth industrial revolution, identifies key players in the fourth industrial revolution, x-rays Nigeria and the fourth industrial revolution as well as discusses on IT-skill sets to be sort after in a truly digital economy.

CONCEPTUAL OVERVIEW OF THE 4TH INDUSTRIAL REVOLUTION

The catchphrase of the day is the Fourth Industrial Revolution or Industry 4.0. Industrialists have started talking about it since 1999, predicting human civilization that is geared by the Internet in the near future. True enough, it did not take long for the revolution to go full-fledged with many breakthroughs in technologies such as artificial intelligence, robotics, the internet of things, autonomous vehicles, 3D printing, the block chain, biotechnology and so on (Thonhill, 2017). Where people communicate within the information technology domain less than two decades ago, devices and machines are doing the talking now in an era powered by the Internet of Things (IoT) over the world. The extent and depth of these changes is a sign of transformations to entire production, management and governance systems (Sentryo, 2017).

In January 2016, the World Economic Forum, a Swiss non-profit foundation convened business leaders, politicians, public figures, and, young and upwardly mobile executives in Davos. The purpose was to discuss and brainstorm about the nature of a new wave of technological advancement that will change the world in the foreseeable future. This wave of technological advancement it called the Fourth Industrial Revolution. Coined by the founder of

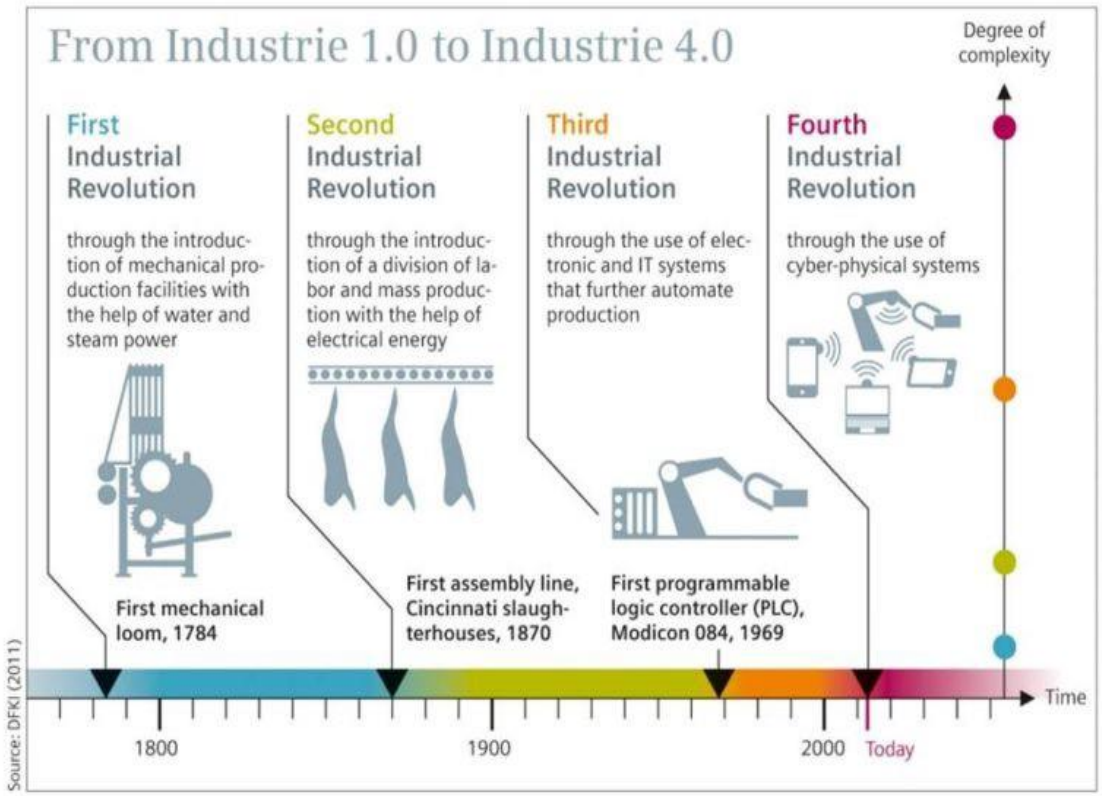
the Non-Governmental Organization Klaus Schwab, it refers to a unique era of tech development marked by a fusion of digital, biological, and physical systems.

Previous industrial revolutions liberated humankind from animal power, made mass production possible and brought digital capabilities to billions of people. This Fourth Industrial Revolution is, however, fundamentally different. It is characterized by a range of new technologies that are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries, and even challenging ideas about what it means to be human, ubiquitous, mobile supercomputing, intelligent robots, self-driving cars, neuro-technological brain enhancements. Genetic editing, are ways in which industry 4.0 is changing our lives. The evidence of dramatic change is all around us and it's happening at exponential speed. Virtual reality that allows us to transport to new worlds or consume and interact with information in new ways, robots and software working side-by-side with humans, nano-bots that could one day be injected into the blood stream to cure an illness, 3D printing tools and limbs, voice controlling houses, tools like IBM Watson being used to help a doctor diagnose patients or handle legal proceedings, amongst others. We also have to consider things such as the internet of everything and big data, (Morgan, 2016).

According to Frangos (2017), 50 billion things will be connected from cranes to coffee machines by 2020. People will be able to control items and their values since the data provided by the IoT enable the owners to understand the product performance and manage their assets better. For example, they will be alerted if any parts of a car require maintenance. This way, risks involving security, safety or finance can be minimized thus, extending the product life-cycle and rejuvenate the environment by reducing carbon emission in the long run. The world is now in the fourth stage of industrial revolution. This fourth industrial revolution would bring digital lifestyle where automation and Internet of Things or IoT widely applied in almost all aspects of daily life, (Abdullah, 2017). The resulting shifts and disruptions mean that we live in a time of great promise and great peril. The world has the potential to connect billions more people to digital networks, dramatically improve the efficiency of organizations and even manage assets in ways that can help regenerate the natural environment, potentially undoing the damage of previous industrial revolutions.

HISTORICAL DEVELOPMENT OF THE INDUSTRIAL REVOLUTIONS

Industrial Revolution in modern history is the process of change from an agrarian and handicraft economy to one dominated by industry and machine manufacturing. This process began in Britain in the 18th century and from there spread to other parts of the world. Although used earlier by French writers, the term *Industrial Revolution* was first popularized by the English economic historian Arnold Toynbee(1852–83) to describe Britain's economic development from 1760 to 1840 (*Encylopedia Britanica*, 2017). The first industrial revolution used water and steam to mechanize production, the second used electric energy to create mass production and the third used electronics and information technology to automate production. Today a fourth industrial revolution is underway which builds upon the third revolution and the digital revolution that has been taking place since the middle of the last century. This fourth revolution with exponential expansion is characterized by merging technology that blurs the lines between the physical, digital and biological spheres to completely uproot industries all over the world. The extent and depth of these changes is a sign of transformations to entire production, management and governance systems (Sentryo, 2017).



THE FIRST INDUSTRIAL REVOLUTION – 1765

Following a slow period of proto-industrialization, this first revolution spans from the end of the 18th century to the beginning of the 19th century. It witnessed the emergence of mechanization, a process that replaced agriculture with industry as the foundations of the economic structure of society. Mass extraction of coal along with the invention of the steam engine created a new type of energy that thrusted forward all processes thanks to the development of railroads and the acceleration of economic, human and material exchanges. Other major inventions such as forging and new know-how in metal shaping gradually drew up the blueprints for the first factories and cities as we know them today (Sentryo, 2017).

THE SECOND INDUSTRIAL REVOLUTION – 1870

Nearly a century later at the end of the 19th century, new technological advancements initiated the emergence of a new source of energy: electricity, gas and oil. As a result, the development of the combustion engine set out to use these new resources to their full potential. Furthermore, the steel industry began to develop and grow alongside the exponential demands for steel. Chemical synthesis also developed to bring us synthetic fabric, dyes and fertilizer. Methods of communication were also revolutionized with the invention of the telegraph and the telephone and so were transportation methods with the emergence of the automobile and the plane at the beginning of the 20th century. All these inventions were made possible by centralizing research and capital structured around an economic and industrial

model based on new "large factories" and the organizational models of production as envisioned by Taylor and Ford (Sentryo, 2017).

THE THIRD INDUSTRIAL REVOLUTION – 1969

Nearly a century later, in the second half of the 20th century, a third industrial revolution appeared with the emergence of a new type of energy whose potential surpassed its predecessors: nuclear energy. This revolution witnessed the rise of electronics—with the transistor and microprocessor—but also the rise of telecommunications and computers. This new technology led to the production of miniaturized material which would open doors, most notably to space research and biotechnology. For industry, this revolution gave rise to the era of high-level automation in production thanks to two major inventions: automatons—programmable logic controllers (PLCs)—and robots (Sentryo, 2017).

THE FOURTH INDUSTRIAL REVOLUTION (INDUSTRY 4.0)

The fourth revolution is unfolding before our eyes. Its genesis is situated at the dawn of the third millennium with the emergence of the Internet. This is the first industrial revolution rooted in a new technological phenomenon—digitalization—rather than in the emergence of a new type of energy. This digitalization enables us to build a new virtual world from which we can steer the physical world. The industry of today and tomorrow aim to connect all production means to enable their interaction in real time. Factories 4.0 make communication among the different players and connected objects in production line possible thanks to technology such as Cloud, Big Data Analytics and the Industrial Internet of Things. The applications for the industrial sector are already enormous: predictive maintenance, improved decision-making in real time, anticipating inventory based on production, improved coordination among jobs, etc. Day after day, all these improvements are gradually optimizing production tools and revealing endless possibilities for the future of industry 4.0, the crossroads for an interconnected global system. However, this fourth industrial revolution could be the first to deviate from the energy-greed trend—in terms of non-renewable resources—because we have been integrating more and more possibilities to power our production processes with alternative resources. Tomorrow, factories 4.0 will be embedded in smart cities and powered by wind, sun and geothermal energy (Sentryo, 2017).

KEY PLAYERS POWERING THE 4TH INDUSTRIAL REVOLUTION

Key players fuelling the fourth industrial revolution include the following, disruptive technologies, and trends like the Internet of Things, Robotics, Virtual Reality and Artificial Intelligence. The subsection below elaborates on these technologies that are fuelling the 4th industrial revolution:

DISTRUPTIVE TECHNOLOGY

Disruptive technology refers to any enhanced or completely new technology that replaces and disrupts an existing technology, rendering it obsolete. It is designed to succeed similar technology that is already in use. Disruptive technology applies to hardware, software, networks and combined technologies. Because disruptive technology is new, it has certain advantages, enhancements and functionalities over competitors. For example, cloud computing serves as a disruptive technology for in-house servers and software solutions. It has slowly been adopted by organizations and individuals with the main objective of completely removing traditional computing. As an unused, unapplied and untested alternative,

it takes time for disruptive technology to be dominantly deployed, ultimately degenerating existing technology, (Technopedia, 2018).

INTERNET OF THINGS (IoT).

Internet of Things is the concept of basically connecting any device with an on and off switch to the Internet (and/or to each other). This includes everything from cell-phones, coffee makers, washing machines, headphones, lamps, wearable devices and almost anything else you can think of. This also applies to components of machines, for example a jet engine of an airplane or the drill of an oil rig. On a broader scale, the IoT can be applied to things like transportation networks: "smart cities" which can help us reduce waste and improve efficiency for things such as energy use. The reality is that the IoT allows for virtually endless opportunities and connections to take place, many of which we can't even think of or fully understand the impact of today. It's not hard to see how and why the IoT is such a hot topic today, it affords a lot of opportunities and benefits, (Morgan, 2018).

ROBOTICS

Robotics is a branch of engineering that involves the conception, design, manufacture, and operation of robots. This field overlaps with electronics, computer science, artificial intelligence, mechatronics, nanotechnology and bioengineering. Science-fiction author Isaac Asimov is often given credit for being the first person to use the term robotics in a short story composed in the 1940s. In the story, Asimov suggested three principles to guide the behaviour of robots and smart machines. According to Techtarget, (2018), Asimov's Three Laws of Robotics are:

1. Robots must never harm human beings.
2. Robots must follow instructions from humans without violating rule 1.
3. Robots must protect themselves without violating the other rules.

VIRTUAL REALITY

Virtual Reality (VR), according to Jackson (2015), is the use of computer technology to create a simulated environment. Unlike traditional user interfaces, VR places the user inside an experience. Instead of viewing a screen in front of them, users are immersed and able to interact with 3D worlds. By simulating as many senses as possible, such as vision, hearing, touch, even smell, the computer is transformed into a gatekeeper to this artificial world. The only limits to near-real VR experiences are the availability of content and cheap computing power.

ARTIFICIAL INTELLIGENCE

Beal (n.d), defined Artificial intelligence as the branch of computer science concerned with making computers behave like humans. The term was coined in 1956 by John McCarthy at the Massachusetts Institute of Technology. Currently, no computers exhibit full artificial intelligence (that is, are able to simulate human behaviour). The greatest advances have occurred in the field of games playing. The best computer chess programs are now capable of beating humans. In May, 1997, an IBM super-computer called Deep Blue defeated world chess champion Gary Kasparov in a chess match. In the area of robotics, computers are now

widely used in assembly plants, but they are capable only of very limited tasks. Robots have great difficulty identifying objects based on appearance or feel, and they still move and handle objects clumsily.

Artificial intelligence includes the following areas of specialization:

- Games playing: Programming computers to play games against human opponents.
- Expert systems: programming computers to make decisions in real-life situation, example medical expert systems that help doctors diagnose patients.
- Natural language: programming computers to understand natural human languages.
- Neural Networks: Systems that simulate intelligence by attempting to reproduce the types of physical connections that occur in animal brains.
- Robotics: programming computers to see and hear and react to the sensory stimuli.

NIGERIA AND THE 4TH INDUSTRIAL REVOLUTION

Inwalomhe (2018) submitted that Nigeria missed out of the First Industrial Revolution which is widely taken to be the shift from our reliance on animals, human effort and biomass as primary sources of energy to the use of fossil fuels and the mechanical power. Nigeria missed out of the Second Industrial Revolution which occurred between the end of the 19th century and the first two decades of the 20th century, and brought major breakthroughs in the form of electricity distribution, both wireless and wired communication, the synthesis of ammonia and new forms of power generation. Nigeria missed out of the Third Industrial Revolution which begun in the 1950s with the development of digital systems, communication and rapid advances in computing power, which have enabled new ways of generating, processing and sharing information. Nigeria is about to miss out of the Fourth Industrial Revolution which can be described as the advent of "cyber-physical systems" involving entirely new capabilities for people and machines because those who are agitating for restructuring are focusing on the components of first industrial revolution in the 21st Century. While these capabilities are reliant on the technologies and infrastructure of the Third Industrial Revolution, the Fourth Industrial Revolution represents entirely new ways in which technology becomes embedded within societies and even our human bodies.

Oil has saved us but it is on its way out. The next wave of growth will be fuelled by 4th industrial revolution with higher mental capacity of our people; what they can see; what they can create and what they can give to the world. That is why we must invest aggressively in 21st century education. If Nigeria wants to benefit from the dividends of the fourth industrial revolution, we must teach our children to code and write programs from a very early age so that they can develop technology solutions for the challenges that are specific to our environment and beyond. This means emphasis on Science, Technology, Engineering and Mathematics, First, if technology is the core resource of the information age, programming and coding literacy becomes the currency of trade in that world. A computer is not a toy; every child in school today should have access to one. The Internet is not just for Facebook, WhatsApp, Instagram and Snapchat; it is the platform for exponential knowledge and information that will help our young people to develop real world problem-solving skills.

In Nigeria, the impact of this inevitable tide is getting clearer as a rising sun. The mode of trade is being changed from the conventional mode of buying and selling within a brick-and-

mortar store to ecommerce. Start-ups like Jumia, Konga, Mall for Africa, Olx, Jiji, and others have revolutionized trade. In the process, new jobs have been created and many old ones have disappeared as a result of automated processes. The entrance of new players such as Cars 45,an ecommerce platform that facilitates trade in fairly-used cars is threatening to phase-out conventional merchants who deal in the trade. Furthermore, Automated manufacturing which requires very few humans as seen in the Dangote-Sinotruk initiative a joint venture that aims to locally produce 10, 000 commercial vehicles annually with very few employees are all indication that Nigeria is not entirely idling away from the trend but the efforts are minimal and not commensurate with our counterparts the world over. With industry 4.0, every aspect of the productionchain, like the turning over machine, filling machine, inspection line, debugging workshops to finished products is to be handled by high-tech devices. In the same vein, Uber, the $68 billion car-hailing app has also changed the face of the taxi sub-set of the transport system in major cities in Nigeria. The usual yellow taxis have become a symbol of a dystopian past as Uber has pooled together many saloon cars that move ready customers from point A to B at a very competitive price thereby pushing out the old. And in this displacement, Taxify has joined the race sometimes sharing drivers with Uber itself.

However, the advent of the digital economy should force us to do more than eke out new sources of revenue that's too myopic. Oil and gas is dwindling to a halt and the earlier Nigeria keys into the industry 4.0 the better chances we stand to become and industrialized economy as opposed to our developing economy status. The conversation should now be:

- In light of the Fourth Industrial Revolution, what happens to the teeming population, especially the young?
- How do we get them prepared for an economic system undergirded by advanced technology?
- What system needs to be put in place?
- What are the policy actions that governments at all levels need to put in place to prepare the population especially the 18–30 demographic for the change?

Two things come to mind, the Nigerian 9-3–4 systemof education, with many fine areas is adequately inadequate to prepare us for the technological tsunami. Apart from the emphasis on a theoretical mode of learning divorced from application to real-life problems, it doesn't belong in this age. An educational framework that produces people ill-fitted for employment shouldn't even get a mention in a cerebral discourse, except to mention why it was consigned to the dustbin of history. Hence, a remodeling of the base of our educational framework is in order. Another point of action is the creation of an environment conducive for new and old businesses to flourish. Within the context of a digital economy, government must seek to understand the rules of the game so it can support infant businesses and carry out its duty of regulating the economy as is befitting of a tech-literate government. This means government needs to learn to evolve and modify its roles in the new economy. What we have seen with the entrance of tech-savvy businesses is their *overwhelming* capacity for change and innovation. Governments at different levelsmust understand the nature of these businesses in order to effectively regulate them. One relevant way to go about it is to update its laws especially with regards to privacy of its citizens. Because of the ubiquity of technology which facilitates easy access to the internet through our various devices, large volumes of data are generated every second. How this data is collected, where it is stored, who has access to it, and

what it will be used for when a third-party access it, are issues that our governments need to start addressing.

Another way to prepare for the industry 4.0 Tsunami is to invest massively in science, technology, engineering and mathematics (STEM) education. Beyond this, government has to be at the forefront of the process of building the next generation's tech-savviness. It is in realization of this that one admires the efforts of the Lagos State Government in this regard. Through its Code Lagos program, the state wants to have trained 1 million Lagosians with coding skills by 2019. Through Public-Private Partnership, it was able to carry along many private sector entities and so points to a fundamental lesson for survival in the tech age: partnerships.

Adepetun (2018), states that for Nigeria to partake fully in the next industrial revolution, which is the fourth, local content development, must be a priority.

OPPORTUNITIES PRESENTED BY THE 4TH INDUSTRIAL REVOLUTION

According to Schwab (2016), like the revolutions that preceded it, the Fourth Industrial Revolution has the potential to raise global income levels and improve the quality of life for populations around the world. To date, those who have gained the most from it have been consumers able to afford and access the digital world; technology has made possible new products and services that increase the efficiency and pleasure of our personal lives. Ordering a cab, booking a flight, buying a product, making a payment, listening to music, watching a film, or playing a game any of these can now be done remotely. In the future, technological innovation 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. At the same time, as the economists Erik Brynjolfsson and Andrew McAfee have pointed out, the revolution could yield greater inequality, particularly in its potential to disrupt labour markets. As automation substitutes for labour across the entire economy, the net displacement of workers by machines might exacerbate the gap between returns to capital and returns to labour. On the other hand, it is also possible that the displacement of workers by technology will, in aggregate, result in a net increase in safe and rewarding jobs.

Some of the potential implications for the digital recruitment sector are;

1. Developers who understand AI will be in high demand

Businesses will need developers who are not only capable of the technical aspects of the job, but developers who are able to spot the wider business opportunities too. So, the candidates in greatest demand will be those able to tailor Artificial Intelligence applications to enhance companies and optimise business processes.

2. Increasing need for digital project team members

Team members, such as product owners/managers, channel managers and other similarly highly skilled talent will also find themselves in high demand. The delivery method for AI-based projects more than likely continues to be Agile, increasing demand for those with the right experience.

3. Increased use of AI and automation in the technology industry

The tech industry is already realising the benefits of Artificial Intelligence and automation, especially those operating within areas such as IoT, big data or financial technology. This again is resulting in increased demand for those candidates with experience of these technologies.

4. Heavy reliance on the tech industry to provide business-ready solutions

Companies looking to improve efficiency through Artificial Intelligence or machine learning will need the tech industry to deliver the right solutions quickly and efficiently. This will present those in development with a great opportunity.

5. The challenge of finding and keeping top talent

In this skill-short market, companies are already experiencing difficulties in attracting and retaining top talent. Much more will need to be done to attract future generations and ensure there is a talent pipeline for the future.

6. New industries will be born

There are many jobs in existence today that didn't exist ten or even five years ago. With the continued advancement of technology, we must be prepared for new roles, even industries, to be created and ensure we have the talent with the necessary skills.

7. Cyber-security will be a major focus

As the workplace becomes more and more digitalised, companies will need to make sure their cyber-security stands up to any potential attacks. So, having the necessary skills and experience in place is a must for any business.

8. Increased recruitment by start-ups

Any start-up experiencing exponential growth will need a highly skilled workforce. They will need to recruit them quickly as the start-ups look to capitalize on their growth. This will be good news for contractors, whose flexibility will be attractive.

CONCLUSION

It's important that businesses keep up with the demand that the fourth industrial revolution will bring and that it doesn't leave any negative impact on the current workforce. This means up-skilling current employees and looking at potential regulations to safeguard workers. IT professionals should harness the benefits coming their way by upgrading their skills in buzzing areas of cloud computing, artificial intelligence, virtual reality, internet of things, pervasive computing, software engineering amongst others. This will make them marketable and best positioned to harness the benefits of the 4th industrial revolution. Producing skills fit for the fourth industrial revolution therefore, becomes a task information technology's educator must ensure they see to a logical conclusion, else, Nigeria continues to miss out on the benefits of industry 4.0.

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