

The Opportunities and Challenges of the Fourth Industrial Revolution in Management Science

By

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Abstract

This study was set out to review, theoretically, the opportunities and challenges of the fourth (4th) industrial revolution in Management Science with particular reference to the Nigerian economy and how the implications of the disruptive technologies can be driven to enhance the economic situation in the country. The study revealed that while Nigeria has made considerable efforts to adapt the technologies of the 4th industrial revolution, she is still far behind in keeping pace with its transformations. The study concluded that the speed of the current technological breakthroughs, along with its transformations, in all aspects of human life certainly shows the emergence of a 4th industrial revolution. Therefore, a change in the structure of the Nigerian economy is needed to adapt to these transformations. The study recommended, among others, a complete review of the curricula of the different levels of education in Nigeria (from primary and secondary schools to all the various forms of tertiary institutions) to include skills in Management Science – skills that form the bedrock of the 4th industrial revolution.

Keywords: 4th Industrial Revolution, Disruptive Technologies, Management Science

Introduction

When Great Britain first brought about technological changes in the 1760s by converting her economy from an agrarian and artisanal to one characterized by industrialization and innovation, the stage was set for a series of industrial revolutions: the first industrial revolution between 1760 to 1840; the second industrial revolution between 1870 and 1914; the third industrial revolution between 1914 and 1950; and the fourth industrial revolution which began in 2014 (Schwab, 2016; Ajah & Chigozie-Okwu, 2019; and Iberdrola, 2022). The invention of each

industrial revolution was a hallmark. Every successive industrial revolution was a refinement of the previous one and unique in nature. However, the 4th industrial revolution struck every living being on earth with awe, as it turned the entire globe into the smallest bedroom that can be accessed at the speed of light.

Though, it is said to be built on the third (3rd) one, the 4th industrial revolution cannot be compared to any of the three previous ones. It has been described as “unprecedented”, and “fusion of technologies.” Its changes have been seen to “disrupt every sphere of human living - physical, digital or biological” (Schwab, 2016; and Xu, David & Hikim, 2018). The disruptive technologies of the 4th industrial revolution include Artificial Intelligence (AI), Internet of Things (IoT), Robotics, Nanotechnology, Three-Dimensional (3D) Printing, Bio-technology, Energy Storage, Material Science, and Quantum Computing (Change, 2017; and McGinnis, 2020). These technologies, on the one hand, come with the potential to increase the level of income globally and raise the standard of living for populations all over the earth (Schwab, 2016). On the other hand, they present challenges for developing economies like Nigeria, that find it difficult to work out the mechanism to key into the 4th industrial revolution .

Report shows that Nigeria has continued to face huge developmental challenges despite the significant improvements the country has made in recent times (World Bank, 2020). These developmental challenges ranging from unemployment, inequality in terms of income and opportunities, to lack of diversification of the economy and governance issues can only be solved by embracing the technologies of the 4th industrial revolution. It is the need for Nigeria to attain sustainable economy by harnessing the advantages of the 4th industrial revolution that this study was carried out.

No doubt, there are many studies, locally and international, on the opportunities and challenges of the 4th industrial revolution (Omoh, 2015,

Schwab, 2016; Scheel, 2016; Ajah & Chigozie-Okwu, 2019, Onyeizugbe, Nnadi & Enaimi, 2019; Trendov, Veras & Zeng, 2019, Groncharov, 2020; Ladimeji, 2020; Obijole, 2020, Zervoudi 2020, Bode-Harrison, 2021; Change, 2022 and Iberdrola, 2022), but very few known studies address the implications of the 4th industrial revolution in the field of Management Science, with particular reference to the Nigerian situation. Thus, the objective of this theoretical study was to carry out a critical examination of the implications of the disruptive technologies of the 4th industrial revolution in the field of Management Science, with a view to finding the way forward for the overall growth and development of the Nigerian economy.

Evolution of Industrial Revolution

The word 'revolution' carries the idea of a dramatic, sudden, radical or complete change. While "industrial" relates to the industry or "characterized by highly developed industries" (Merriam Webster Dictionary, 2022). Simply put, industrial revolution is a remarkable change characterized by highly developed industries brought about by significant technological innovations and advancements.

Vries (2008) defined industrial revolution as the "emergence, during the transition from pre-industrial to an industrial society of modern economic growth, that is a sustained and substantial increase of GDP per capital in real terms". It is a period of major innovation and industrialization resulting from technological changes that fundamentally transformed the society in terms of its economy, way of working and standard of living (Schwab, 2016). In pre-industrial times, man was content with subsistence farming, using crude farm instruments and manual labour in a communal setting. As time went by, man saw the need to expand in knowledge through critical thinking in order to achieve a better and improved method of doing things. This gave rise to innovation/invention and the birth of the first industrial revolution which became one of the major forces of change in the 19th century. As a result, western

civilization leading to the industrial era that shaped the modern world was actualized. No wonder Zeidan (2022) referred to industrial revolution as a process of economic transformation than as a period of time in a particular setting.

As noted by Obijole (2020), industrial revolution often heralded disruptions in the operations of markets and economies, which are deviations from the status quo and are not always negative. This was the case with the first industrial revolution which began in England in about 1750 – 1760 and lasted to sometime between 1820 and 1840, during which it spread to other parts of Europe (Mohajan, 2019). It was an era of significant innovation as notable inventions like the steam engine, the spinning jimmy and the telegraph brought about mechanized production and social change (Schwab, 2016). There was a transition from human/animal labour technology into machinery leading to among others, improved efficiency in raw material usage, labour and overhead expenses (Mohajan, 2019). Despite the breakthroughs of the first industrial revolution, it was said to lack scientific base, giving way to another revolution known as the technological revolution – the second industrial revolution (Mokyr, 1998).

The second industrial revolution began in American between 1870 and 1914, with the invention of combustible engine, electricity and light bulb which brought about social, cultural and economic changes (Mokyr, 1998; and Schwab, 2016). It was characterized by urbanization and rapid territorial expansion which transformed the United States and some other parts of the world including China (Engleman, 2022).

The third industrial revolution, known as “Digital Revolution”, began in the late 1900s and was characterized by the spread of high-level automation and digitalization through the use of electronics, computer/internet facilities, Programmable Logic Controllers (PLCS) and robots (Ajah & Chigozie-Okwu, 2019; and Ward, 2019). With the dawn of the 21st century, a more aggressive and far-reaching industrial

revolution appeared in the world scene which, in many ways, was quite different from the previous industrial revolutions – the 4th industrial revolution.

The Fourth Industrial Revolution

Klaus Schwab was the first to describe the kind of technological change of the 21st century as the fourth (4th) industrial revolution. Though Schwab (2016) acknowledged the 4th industrial revolution as deriving its foundation from the third, he explained beyond all reasonable doubt that it was distinct, and not a continuation of the third one. He noted that the 4th industrial revolution was occurring at an “unprecedented speed, evolving at an exponential rather than a linear pace, and disrupting almost every industry in every country of the world, with a fusion of technologies that is blurring the lines between the physical, digital and biological spheres”. With these characteristics of the 4th industrial revolution manifesting at the same time, it could rightly be said that it was indeed unlike any previous industrial revolution. The 4th industrial revolution has been referred to as “innovation based on combination of technologies” and characterized by what is known as “cyber-physical systems” (Change, 2017; Xu *et al*, 2018; and Ajah & Chigozie-Okwu, 2019). Schwab’s view about the emergence of the 4th industrial revolution has been supported by many scholars (Inwalomhe, 2018 in Ajah & Chigozie-Okwu, 2019; Xu *et al*, 2018; and Goncharov, 2021).

Despite the strong arguments made by advocates of the 4th industrial revolution, researchers like Moll (2021) posited that the 4th industrial revolution was yet to come. He argued that a long-term socio-economic, cultural and technological changes, at a fundamental or structural level, must characterize an industrial revolution. However, Iberdrola (2022) emphasized that with the appearance of smart factories and online production management, there is no better way to describe the rise of a new industrial revolution – the 4th one.

In view of the far-reaching effects of the disruptive technologies of the 4th industrial revolution, one cannot deny its emergence and existence. One can only think of fitting into the 4th industrial revolution by a complete understanding of the use of its evolving technologies. It is only then that one can make good use of the opportunities of the 4th industrial revolutions.

Technologies of the 4th Industrial Revolution

Schwab (2016) listed Artificial Intelligence (AI), Robotics, Internet of Thing (IoT), Three-Dimensional (3-D) Printing, Nanotechnology, Biotechnology, Materials Science, Energy Storage and Quantum Computing as major technologies of the 4th industrial revolution, bringing about unlimited breakthroughs, with no historical precedent. Some of these technologies are briefly discussed below:

Artificial Intelligence (AI): This is the ability of a computer to perform tasks required by human intelligence and discernment. Such intellectual tasks include decision making, problem solving, perception, understanding/translating human languages (Copeland, 1993; and Findler, 2007). AI can be applied in all fields of human endeavour. Though Moll (2021) argued that AI was a technology associated with the invention of the 3rd industrial revolution, Zvika Krieger in Schwabs (2016) asserted that as AI began to impact the workforce and automation replaced existing skills, there would be an increased need for emotional intelligence, creativity and critical thinking. Hence, AI forms part of the evolving technologies of the 4th industrial revolution.

Robotics: This is a specialized branch of automation and is closely associated with AI. Robotics technology has to do with the design, construction and use of machines known as robots to perform tasks that are traditionally carried out by human beings (Schreiber, 2022). Robotics is constantly evolving and robots have been specifically designed to interact physically with humans in collaborative environment (Iberdrola,

2022). Robots help in performing repetitive and dangerous tasks, thus saving the lives of workers in manufacturing industry.

Internet of Things/Internet of System: Change (2022) referred to Internet of Things (IoT) as a network of interconnected smart devices that allow each separate device to interact (send or receive data from other devices on the network). It is designed to establish a connection between the physical and digital worlds (Iberdrola, 2022). Internet of Systems (IoS) refers to business-owned systems that can collect data from IoT networks to make an independent business such as in marketing and sales. Schwab (2016) opined that IoT describes everyday items such as medical wearables that can monitor users' physical conditions. Examples include blood pressure, electrical activity of the heart, to cars and other tracking devices connected to the internet and identifiable by other devices. IoT calls for decentralization of basic leadership, empowering continuous reaction as an entire organization is interconnected and companies could be connected with one another (Islam, Hashin Jantan & Rehman, 2018). IoT has a wide range of uses, from agriculture and manufacturing to healthcare. All of these are leading humans towards a better-connected lifestyle. IoT and IoS make up the "Cyber Physical Systems" (Change, 2022).

Three Dimensional (3-D) Printing: This technology, according to Iberdrola (2022), helps to develop prototypes of products for sales, quickly, accurately and economically. It allows "manufacturing businesses to print their own parts, with less tooling, at a lower cost, and faster than via traditional processes" (Schwab, 2016). It is now widely used in architecture, engineering and other areas of design and production.

Opportunities and Challenges of the 4th Industrial Revolution in Management Science – The Nigerian Situation

Management Science is a field of study which refers to a "broad interdisciplinary study of problem solving and decision making in human organizations, with strong links to management, economics, business,

engineering and other fields. It uses various scientific research based principles, strategies and analytical methods including mathematical modeling, statistics, and numerical algorithms” in providing solutions to complex problems in organizations and for optimal decision-making (Wikipedia, 2022). Management Science embraces different fields of study (Luenendonk, 2019) applying the knowledge derived from these in solving complex management problems such as business uncertainty, tracking team productivity, shaping the culture of the organization, recruiting, on boarding the right employees, employee welfare, effective communication, time management, and regulation and compliance (Growth Engineering, 2021).

Management Science is a function of industrial revolution. Its birth was brought about by the first industrial revolution. In fact, traditional management theories both pre scientific and scientific were derived from the first and second industrial revolutions. The functions of management science revolve around the challenges and opportunities of the technologies of the current industrial revolution.

According to Luenendonk (2019), Management Science helps to notice the availability and proper use of resources, realize the future possibilities and needs of the organisation’s consumer base, boost employee motivation and productivity through safer work environment, achieve higher productivity through proper time management and efficient workforce.

The fourth industrial revolution has mouth-watering prospects for Management Science. Scheel (2016) specifically pointed to increased production capacity/flexibility by 70% improved working capital/cash flow management by 73%, improved competitive position by 79%, improved operational efficiency by 76% and basis for competitive pricing by 82% as the benefits of the 4th industrial revolution through the use of its disruptive technologies. For example, AI helps in production

optimization through improved efficiency and quality processes for companies that are able to apply it in their business practices.

In discussing the possible future improvements information technology can provide to Management Science, Andrew McAfee in Luenendonk (2019) stated that one of the biggest changes Management Science must face is an unbelievable amount of horse power and a mass of data to apply to it. Scientific approaches that are technology facilitated must be used. This means that any company not migrated in the direction of the 4th industrial revolution certainly will lose a huge opportunity, which in turn will affect its survival, growth and development, and of course with the adverse effects on the economy. In another business discussion, Philip Evans in Luenendonk (2019) showed how the IoT has transformed businesses by making traditional business strategies obsolete. He argued that modern technology has collapsed the traditional value chain through falling transactions, allowing fragmentation of scales where individuals, instead of organizations, have taken over businesses. He then recommended that Management Science must accommodate collaboration and competition simultaneously, stating that since information revolution had moved the structure of industries from vertical to horizontal, whether in the private or public sector, business structure must accommodate different ideas and motivations from individuals, organizations and governments.

Despite its benefits, the 4th industrial revolution presents a lot of challenges in Management Science. In general, while the availability and wide use of social media can create opportunities for cross-cultural understanding and cohesion, this can lead to exposure of business secrets in many companies, resulting in cyber theft (Schwab, 2016; and Mayor *et al*, 2021). Income inequality, cyber security risk, core industries disruptions and ethical issues have been listed as challenges of the 4th industrial revolution (Bode-Harrison, 2021).

Omoh (2015) stated that countries would “either take off or fall behind in the new dispensation, depending on whether or not” they are learning and coping with evolving technologies of the 4th industrial revolution. This view was supported by Onyeizugbe *et al* (2019) who opined that structural and institutional changes are needed to achieve industrial revolution. How much has Nigeria done in this regard?

Although Nigeria has made considerable efforts in meeting up with challenges of the 4th industrial technology as could be seen in the wide use of AI and Block chain in the financial sector of her economy, the e-commerce digital platforms (such as Jumia and Konga), social media platforms (in creating markets for entrepreneurs across the country for easy accessibility), marketing resources that were once out of their reach, and the revolution in the transportation sector (which is creating jobs for many via digital platforms like uber and taxity), she still depends so much on numerical labour force and is weak with respect to advancements in science and technology (Ndagi & Salihu, 2018; and Bode-Harrison, 2021). The level of utilization of technologies of the 4th industrial revolution is currently not wide spread across Nigeria, even though there could be potential applications of these technologies to various sectors of the economy, causing disruptions in industries across the country (Obijole, 2020).

Bode-Harrison (2021) identified two major hindrances to the successful utilization of technologies of the 4th industrial revolution in Nigeria as:

- Poor Digital Infrastructure: He stated that as at the end of 2020, Nigeria’s internet penetration stood at 43.3% with major lag in rural areas;
- A Greater Demand for High-Skill/High-Pay: He posited that due to automation and new technologies of the 4th industrial, there was an increasing demand of high-skill workers and a gradual phasing out of unskilled workers. He opined that the high rate of unemployment was

due to Nigeria's lack of understanding, production and usage of the evolving technologies of the 4th industrial revolution.

In view of the above, Nigeria needs a complete “overhaul” of its economy. Adepetun (2018) in Ajah & Chigozie-Okwu (2019) emphasized the restructuring of the Nigerian educational system from the 9-3-4 system to one that can prepare successive generations for “technological tsunami” and application of theory to real life problems. Ajah & Chigozie-Okwu (2019) recommended a conducive business environment, politically and otherwise, to enable old and new businesses thrive. They appealed to the different stakeholders of the Nigerian economy especially governments at the different levels of governance, to adapt the disruptive technologies of the 4th industrial revolution as a way forward, by prioritizing local contents development.

Conclusion

This certainly is an era of the 4th industrial revolution, with its evolving technologies disrupting all aspects of human life and all fields of human endeavour. Management Science is especially affected by the 4th industrial revolution. This is because it emanated from industrial revolutions, its functions are based on the analytical tools of science and the effectiveness of its decisions shaped by the current existing technologies. With the 4th industrial revolution the traditional strategies of management science have become obsolete. The IoT, robotics and AI, among others, have transformed the structure of business organizations from vertical to horizontal, thus calling on all economies to key into this change for survival, growth and development.

The Nigerian economy is yet to transform the structure of its economy and the management of its institutions to fit into the 4th industrial revolution. Though, the economy has made changes in some areas, these changes are yet to cut across the entire country; hence, the massive developmental challenges still faced by the country (World Bank, 2021). As rightly pointed out by Omoh (2015), the issue of digital gap, resulting

from a low level of e-literacy and digital skills and weak technological infrastructure, continues to plague the country. Obviously, the Nigerian economy needs a transformation and an aggressive one at that, if it must survive the 4th industrial revolution. This calls for a repositioning of the economy. Therefore, as suggested by the World Bank (2021), Nigeria needs to reduce her dependency on oil and diversify her economy, address the issue of insufficient infrastructure, build strong and effective institutions, and address governance issues and public financial management systems. All these can only be achieved if adequate attention is given to the use of the disruptive technologies in management science, as advancements in science and technology can only add value to an economy when properly applied in management science.

Recommendations

- ❖ All stakeholders of the Nigerian economy, from individuals to organizations and governments, must conscientiously pay attention to the evolving technologies of the 4th industrial revolution with a view to acquiring the needed skills in adapting these technologies to the changing needs in their respective fields of endeavour. Here, the need of training and re-training on the use of these disruptive technologies of the 4th industrial revolution cannot be overemphasized.
- ❖ The Nigerian educational system – starting from the primary level – must be tailored to the needs of the society. To this end, a review of curricula at all levels of education is needed to include training in e-literacy and digital skills identified by Mayer *et al* (2021), as critical thinking, creativity, problem solving, flexibility, innovation and adaptability.
- ❖ The Polytechnic education is especially meant for the technological development of a nation, for self-reliance and self-sustainability. Sadly, Nigerian Polytechnics are yet to bring the Nation to the “promised land” in this regard. The Nigerian government is called upon to upgrade the Polytechnics in the federation through proper

funding and sensitization. Other stakeholders of the Nigerian Polytechnics are called upon to play their roles in helping to enhance the status of these Polytechnics to meet up with the advancements of the 4th industrial revolution.

- ❖ Experts in the field of Management Science in Nigeria should particular note that the extent to which they adapt the disruptive technologies of the 4th industrial revolution to the changing needs of organizations and industries will directly impact on the development of the Nigerian economy. Thus, they must work with the speed /velocity of the transformation of the 4th industrial revolution through continuous research, with the aim of moving Nigeria from a country developing retrospectively to a fully developed one.

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