

# **Review of the Fourth Industrial Revolution (4IR) Nexus COVID-19 Pandemic in African Education Sector**

**Chinaza Uleanya <sup>a</sup>, Samuel Oluwatobi Taiwo <sup>b</sup>,  
& Mofoluwake Oluwadamilola Uleanya <sup>c</sup>**

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**Abstract:** The Fourth Industrial Revolution (4IR) is fast growing in different sectors and nations, especially the western and developed world. Meanwhile, the 4IR is grossly less embraced in the African continent. However, with the outbreak of the COVID-19 pandemic, the education sector, amongst many others, is beginning to embrace the technologies of the 4IR. Hence, this study explores the connection between the adoption of the technologies of the 4IR and COVID-19 pandemic. A review method was adopted for the study. The findings of the study that the education sector of many African nations was reluctant to accept any form of advancement coming from 4IR due to various reasons and challenges. However, with the outbreak of the COVID-19 pandemic, the narrative is fast changing.

**Key-words:** African continent; COVID-19 pandemic; developing; underdeveloped; African nations, Fourth Industrial Revolution (4IR).

## **1. Introduction**

Several challenges have been highlighted by various scholars (Tony Blair Institute for Global Change, 2019; Fu, 2020; Lee, 2021) to have affected the acceptance and implementations of the technologies of the Fourth

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<sup>a</sup> University of South Africa (South Africa). Correspondence: Chinaza Uleanya, Department of Business Management, University of South Africa, Nkoana Simon Radipere Building, Preller street, Muckleneuk, Pretoria, 0003, South Africa chinazamoses90@gmail.com,  ORCID 0000-0002-7732-0905. <sup>b</sup> Department of Business Management, University of FortHare (South Africa). <sup>c</sup> Department of Communication Science, University of Zululand (South Africa).

Industrial Revolution (4IR) in many developing and underdeveloped African nations regardless of the opportunities. These challenges include policy issues, economic strength, and the size of nations (Tony Blair Institute for Global Change, 2019). In congruence, Fu (2020) states that African nations have opportunities to embrace the technologies of the Fourth Industrial Revolution. Nonetheless, factors such as little or no understanding of the opportunities as well as the challenges presented by the 4IR, and also good policies that can be contributory to the growth of the economies of African nations to enable them to benefit from the technologies of 4IR can be hindering forces (Fu, 2020). According to Lee (2021), there are opportunities for developing nations to accept the Fourth Industrial Revolution (4IR). However, factors such as access to technology, market conditions, and workers' skills are constraining challenges that are to be addressed first.

A work of Benyera (2021: 71) suggests that a contributory reason hindering the acceptance of the Fourth Industrial Revolution (4IR) in Africa regardless of the embedded opportunities, could be as a result of the experiences of African nations during the industrial revolutions were “African resources are pilfered to service the ever-increasing resource appetites of developed economies, in the process, further marginalizing and hindering development in Africa.” This implies fear of the unknown for African nations during the Fourth Industrial Revolution (4IR), thereby causing some forms of setback in embracing the technologies and opportunities attached to the revolution. Benyera (2021: 71) further states that “Each passing industrial revolution becomes a proverbial death nail in Africa’s coffin. Instead of the industrial revolutions bringing respite and opportunities for Africa, by reinstating its humanity, recognizing its epistemologies, and resuscitating its economies, the opposite has happened, with more and more resources being exported to what Samir Amin termed “the centre” (Amin, 1972, 1976) wherein Euro-North America constitutes the centre of civilization, power, economics, law, and virtually every aspect of life. All other parts of the world outside Euro-North America, especially Africa, Latin America, the Caribbean, and Asia form the periphery, hence the center-periphery notion.” This implies that in the event of the Fourth Industrial Revolution (4IR), many underdeveloped and developing nations alike are more likely to be affected in accepting and embracing the technologies and opportunities accrued to the revolution.

This could be traceable to fear of the unknown considering the notion that the previous revolutions tilted towards favoring the global North comprising of developed nations. The revolutions are considered to have left the South global scrambling for survival with their resources pilfered, and the nations left feeling marginalized. The inclusion of the term by Samir Amin: “the centre” which is as dated as far back as (1972, 1976) suggests the longevity of the geographical and economic polarization of the nations across

the continents and globe. This also suggests the issue of marginalization to some extent. Thus, this implies that the marginalization of certain nations and continent(s) has been in existence for a long time. Meanwhile, Mejias (2019) had earlier explained in corroborating the idea of pilfering African resources sequel to coloniality.

The changes to be envisaged to be experienced in the colonial project revolves around the item(s) that would be taken from African nations and how such would be pilfered. For instance, Mejias (2019), cited in Benyera (2021: 71) states that “Today, apart from minerals and fossil fuels, corporations are after another precious resource: personal data. As with natural resources, data too has become the target of extractive corporate practices.” This suggests neo-colonialism for African nations. In furtherance, Mejias and Couldry (2020) explain data colonialism is as follows, “data colonialism is the startling new social order, based on continuous tracking of our devices and online lives that has created unprecedented opportunities for social discrimination and behavioral influence by corporations. It goes well beyond the social media platforms and search engines that have attracted the most criticism and completely reorganized everyday life and business.

True, data colonialism may not have all the features that historic colonialism is now most remembered (extreme physical violence, for instance). But, if we think about the core function of colonialism in world history – to exploit the world’s resources on a completely new scale, redefining human relations to economic production in the process – the parallel is clear (Mejias and Couldry, 2020 cited in Benyera, 2021: 84).” The explanations of Mejias (2019) as well as Mejias and Couldry (2020) as cited in Benyera (2021) suggest new forms of colonization from different approaches related to acceptance and embracing of technology. This possibly accounts for many African nations' reluctance to accept, embrace and uphold technologies as would have been expected following the Fourth Industrial Revolution (4IR), given it opportunities.

Also, the fear of the pilfering of the resources of African nations possibly accounts for the reason behind the clamor for decoloniality by scholars such as Ndlovu-Gatsheni (2015), Mignolo and Walsh (2018), as well as Benyera (2021), amongst others rather than the push for decolonization which is described to be in favor of the colonizers (Benyera, 2021). However, the outbreak of the COVID-19 pandemic seems to be changing the status quo for many African nations who tend to have given in on accepting and embracing the use of technologies. This is evident in happenings revolving around the use of technology for political matters, business meetings, summits, everyday activity amongst others in various sectors and human endeavors within the continent.

Sequel to the foregoing, different identified factors accounts for the challenges promoting the reasons behind African nations' reluctance to

embrace the Fourth Industrial Revolution (4IR) and all its envisaged opportunities. Meanwhile, the outbreak of the COVID-19, as explained above, also identifies the supposed reason behind the reluctance in embracing the technologies of the Fourth Industrial Revolution (4IR) in the continent. On the other hand, reviews of the works of Schwab (2017); Lee, Yun, Pyka, Won, Fumio, Giovanni, HangSik, Jeonghwan, KyungBae, KwangHo, Min-Ren, SamYoul and Xiaofei (2018); Uleanya and Yu (2019), as well as Govindarajan and Srivastava (2020) show that recent trend in technology, especially with the evolution of the Fourth Industrial Revolution (4IR) seems to have affected and is fast changing happenings in various spheres of human endeavors across the globe.

This change includes happenings in the education sector. In the meantime, while Schwab (2017) opines that many nations in the advanced world are prepared and others fast preparing for the Fourth Industrial Revolution (4IR), the African society is less prepared. In support of this, the submission from the 2018 World Economic Forum (WEF) and the work of Uleanya and Yu (2019) show that many African nations are less prepared for the Fourth Industrial Revolution (4IR). The lack of preparation is reflected in the education system of many African nations attempting to align themselves to 21<sup>st</sup>-century educational practices.

However, the abrupt outbreak of the COVID-19 pandemic seems to have made many nations: developed, developing and underdeveloped to embrace expected educational practices in the Fourth Industrial Revolution (4IR) era. This implies that many African nations seem to have been forced to accept and hurriedly embrace the use of technology in education and virtual learning, which is a major feature of education in the Fourth Industrial Revolution (4IR) era. Suffice to state that the Covid-19 pandemic has made many developing nations, predominantly African countries, accept and infuse technologies of the Fourth Industrial Revolution (4IR) in their education systems where the innovation of the era is envisaged be disruptive and sustainable. This aligns with the findings of the work of Christensen, Raynor and McDonald (2015), who state that the Fourth Industrial Revolution (4IR) innovations are characterized into two major features known as disruptive and sustainable. However, from the findings of the works of Conrads, Rasmussen, Winters, Geniet and Langer (2017), as well as Uleanya, Rugbeer and Duma (2019), the success of the adaptation and inclusion of the Fourth Industrial Revolution (4IR) technologies in any education system regardless of the nation either during COVID-19 pandemic or other situation, the role of policymakers cannot be overemphasized.

Meanwhile, policymakers in any sector, especially in education, which is the focus of this study, are not expected to design and implement policies without properly conducting certain research. Hence, this study aims to explore the link between Fourth Industrial Revolution (4IR) and COVID-19

pandemic as it concerns developing and underdeveloped nations that are predominantly Africans. This is to assist and guide policymakers in designing and implementing policies that will enable the adoption of Fourth Industrial Revolution (4IR) technologies in the education system and their infusions during the COVID-19 pandemic.

## **2. Background: Fourth Industrial Revolution (4IR) and the Education Sector in Developing and Underdeveloped African Nations**

Over the years, previous industrial revolutions have caused major societal changes through their unique technological shifts. Scholars such as Kagermann, Wahlster, and Helbig (2013), Schwab (2015), Klingenberg and Antunes Jr, (2017), Liao, Loures, Deschamps, Brezinski, and Venâncio (2017), Xu, David, and Kim (2018), Stearns (2018) as well as Uleanya and Yu (2019) archive that the First Industrial Revolution occasioned mechanized production through water and steam power, the second industrial revolution occasioned mass production through electric power while the Third Industrial Revolution occasioned automated production through electronics and information technology. Hence, the 4IR which is sometimes referred to as digitization or automation cannot be discussed apart from its unparalleled changes which is experienced through its unique technological shifts.

Kagermann, et al. (2013), Schwab (2015), Lee, Bagheri, and Kao (2015), Khaitan and McCalley (2015), Future of Jobs Report (2016), Klingenberg and Antunes Jr (2017) and Liao et al. (2017) in their discussions on 4IR show that the 4IR concept encapsulates the dynamic nature and rate at which certain technologies are causing unparalleled changes across several sectors in several nations of the world. These technologies include Internet of Things (IoT), Robotics, Augmented Reality (AR), Virtual Reality (VR), Artificial Intelligence (AI), and Cyber-Physical System (CPS). Thus, it is safe to say that the 4IR concept gained attention in many platforms, sectors and nations due to the nature and rate of the changes 4IR technologies have occasioned. For example, it can be deduced from Crnjac, Veža, and Banduka (2017), McKinsey Global Institute (2017) as well as Runde, Bandura, and Hammond (2019) that robotics is dehumanizing many low-skilled workers, causing a need for job-switch, IoT is generating a great amount of data and giving access to many personal data causing a need for High Performance Computing (HPC) and review of privacy policies. CPS is increasingly transforming the manufacturing environment into a smart one with its digital-physical work blend leading to a need for reskilling and upskilling. The foregoing examples show a need for workforce transformation through human capital development, culminating in a need to review education curriculum and pedagogy.

Runde, Bandura, and Hammond (2019) suggest that even though the 4IR will impact every nation, the measure of the impact would vary due to differences in demography and inherent challenges of individual nations. Therefore, the 4IR technologies and, by extension, the 4IR changes have varying degrees of adoption across sectors and nations globally. Whereas some nations were early adopters of the 4IR technologies and their changes, other nations were pessimistic about the 4IR technologies thus, slowing down the rate of adoption and changes. Phillips, Seedat, and Westhuizen (2018) explain that 4IR is advantageous for countries and organizations prepared for human-machine collaboration. Findings from the Economist Intelligence Unit (2018) reveal that developing nations lag in terms of readiness to automate compared with developed nations.

Ndung'u, and Signé (2020) disclose that because Africa lacks many important indicators for digitization, the continent has not owned the 21st century. Passion Incubator (2018) expounds that the current skill levels of the workforce in developing nations generally show that they have a low capacity in adjusting to the 4IR job requirements. Although, the young African population is increasing, they are largely low-skilled. Hence, Ndung'u, and Signé (2020) assent that in an attempt to prioritize the young African population, African governments are non-enthusiast of 4IR technologies because they threaten low-skilled jobs. In a recent study, the Economist Intelligence Unit (2018) used 52 indicators to select and investigate the level of automation readiness of 25 nations. Amongst these nations, South Africa ranked the only prepared in the African continent. Meanwhile, although, South Africa is the only African nation that made a list, the Economist Intelligence Unit (2018) ranked South Africa 22nd in the automation readiness index.

Therefore, the Economist Intelligence Unit (2018) unveils that South Africa, the only African nation on the list of nations preparing for the Fourth Industrial Revolution (4IR), is sluggish in its automation readiness. PricewaterhouseCoopers (2016) and Santiago (2018) affirm that the adoption of the Fourth Industrial Revolution (4IR) is low in South Africa, notwithstanding the beneficial pointers in the country. Evidence of the automation sluggishness in South Africa is seen in studies conducted by scholars such as Naudé (2017), Roux, Viljoen, and Samson (2019), Magwentshu, Rajagopaul, Chui and Singh (2019), Mhlanga, and Moloi (2020) among others. Even though the 4IR demands workforce transformation through human capital development, Magwentshu, Rajagopaul, Chui and Singh (2019) lament that South Africa is sluggish in cultivating the skills needed for the competitiveness and growth organizations in a technology-driven society. Roux, Viljoen, and Samson (2019) add that most of the skills South Africans possess are obsolete because they oppose attempts at re-skilling and up-skilling.

Another core area needed in the 4IR is Science, Technology, Engineering and Mathematics (STEM). However, Naudé (2017) archives that Trends in International Mathematics and Science Study (TIMSS) in a study discovered South Africa is one of the lowest ranking nations in terms of education. This tends to put South Africa as one of nations across the globe with the worst education system. As a result, Mhlanga, and Moloi (2020) disclose that the process of automating education in South Africa is sluggish and limited in scope. On account of these evidences, recommendations from scholars which inter-alia include Phillips, Seedat, and Westhuizen (2018), Roux, Viljoen, and Samson (2019) and Magwentshu, Rajagopaul, Chui and Singh (2019) are paramount. Phillips, Seedat, and Westhuizen (2018) allude that South Africa needs to ensure its workforce has the skills relevant for human-machine collaboration to reduce the jobs at risk to 2.5 million in 2025.

Roux, Viljoen, and Samson (2019) propose pragmatic retraining and up-skilling of the South African workforce such that they will be motivated, receptive and skilled to speed up the rate and extent to which technology is adopted. Ndung'u, and Signé (2020) confirm that the globally forceful 4IR changes in the labor and production systems require that job seeker cultivate the skills and capacities vital to African organizations and digitization. Magwentshu, Rajagopaul, Chui and Singh (2019) stress the necessity of speeding up the transformation of South African graduates to accommodate the need for workers that have higher education in the workplace. The Economist Intelligence Unit (2018) affirms the centrality of education as a long-term strategy in solving the challenges of automation.

Passion Incubator (2018) explains that realigning developing countries' skills development agenda using basic and higher educational reforms that focus on curricula, accreditation, and manner of education delivery is important. Furthermore, Passion Incubator (2018) adds that the restructure of the skills development agenda of developing countries by re-skilling the existing workforce through adult learning, vocational and technical training, and apprenticeships is highly significant. Magwentshu, Rajagopaul, Chui and Singh (2019) assert that a focus on reskilling will help to manage the transition of workers in South Africa and enable the education system to produce the required technical and life skills in a large scale. Xu, David, and Kim (2018) drew attention to the changing priority of education across the previous phases of industrial revolution.

Xu, David, and Kim (2018) elucidate that the priority in the first industrial revolution was systematic learning, while systematic testing was the priority in the second industrial revolution and personalized learning was prioritized in the third industrial revolution. Consequently, the authors argue that the 4IR will entail a modification in the nature of the curriculum, teaching and learning. The Economist Intelligence Unit (2018) agrees that learning institutions need to teach learners skills that are difficult to substitute. Such

skills include technical skills, critical thinking, AI skills and robotics. For instance, according to President Ramaphosa (2020), the president of South Africa, reskilling and massive investments in curriculum innovation are important to make the South African people ready for future jobs. Meanwhile, the outbreak of the COVID-19 pandemic seems to have fast-tracked the expectations of the Fourth Industrial Revolution (4IR), thereby meeting many underdeveloped and developing nations unaware. and making them embrace its technologies and practices regardless of their fears, bias, lack of resources, policy issues, amongst other varying factors. This has hampered many practices in various sectors. Hence, this study aims to review literature on the link between COVID-19 pandemic and the Fourth Industrial Revolution (4IR).

### **3. Methodology**

The study employed the literature review method. The adoption of this method was based on the provided possibility for the researchers to explore various published literatures relevant to the study. Also following the submission of Thomas G. Carpenter Library (2021), conducting a literature review allows researchers to assess the most up-to-date trend of investigation on the topic of focus and identify major topics in the area. It also helps researchers to identify main question(s) about the topic of focus (Thomas G. Carpenter Library, 2021) and other areas which need further investigation (Thomas G. Carpenter Library, 2021; Snyder, 2019). Hence, in adopting this method for the study, literatures relevant to the study were reviewed.

Vieira (2015) and Snyder (2019) in support of the adoption of such method in research state that literature review method in a research, especially as it concerns the social sciences gives opportunity for critical evaluation of various opinions of different scholars concerning a particular subject matter which is of interest. Thus, this present study explored the works of different scholars in the areas of the Fourth Industrial Revolution (4IR) and the education sector in developing and underdeveloped African nations. Other areas of interest where relevant literatures were reviewed include the fears and reasons for the reluctance of the embracing of the technologies and practices of the Fourth Industrial Revolution (4IR) by African nations, COVID-19 pandemic and the education sector in developing and underdeveloped African nations, Information Communication Technology (ICT) and education in developing and underdeveloped African nations during COVID-19 pandemic. Information Communication Technology (ICT) and education was explored because ICT is a crucial part of the Fourth Industrial Revolution (4IR).

Hence, the use of Information Communication Technology (ICT) during the COVID-19 pandemic becomes crucial. The table below shows concisely



the various areas of relevant literature reviewed in this present study and some scholars, after that the findings from the study are discussed.

Area covered	Search Item(s)	Study
Fourth Industrial Revolution (4IR) in the African continent	Factors hindering the acceptance of the Fourth Industrial Revolution (4IR) in Africa.	Tony Blair Institute for Global Change (2019), Fu (2020), Lee (2021), Benyera (2021)
	Technologies and unparalleled changes in the 4IR	Kagermann, et al. (2013), Schwab (2015), Lee, Bagheri, and Kao (2015), Khaitan and McCalley (2015), Future of Jobs Report (2016), Klingenberg and Antunes Jr (2017) and Liao et al. (2017)
	Africa and its unpreparedness for the 4IR	Passion Incubator (2018), The Economist Intelligence Unit (2018) Ndung'u, and Signé (2020)
	South Africa and its readiness for the 4IR	Pricewaterhouse Coopers (2016); Naudé (2017); The Economist Intelligence Unit (2018); Santiago (2018); Roux, Viljoen, and Samson (2019), Magwentshu, Rajagopaul, Chui and Singh (2019), Mhlanga, and Moloi (2020)
	Robotics and the dehumanization of low-skilled workers	Crnjac, Veža, and Banduka (2017), McKinsey Global Institute (2017) as well as Runde, Bandura, and Hammond (2019)
	Impacts of the 4IR	Economist Intelligence Unit (2018); Phillips, Seedat, and Westhuizen (2018) as well as Runde, Bandura, and Hammond (2019).
	Education in the Fourth Industrial Revolution (4IR) era in developing and underdeveloped African nations	Christensen, Raynor and McDonald (2015); Conrads, Rasmussen, Winters, Geniet and Langer (2017); Schwab (2017); Lee, et al. (2018); Uleanya, Rugbeer and Duma (2019); Uleanya and Yu (2019), Govindarajan and Srivastava (2020)

	STEM education in the 4IR	Naudé (2017); Phillips, Seedat, and Westhuizen (2018); Roux, Viljoen, and Samson (2019); Magwentshu, Rajagopaul, Chui and Singh (2019) as well as Mhlanga, and Moloji (2020).
	Changing priority of education	Passion Incubator (2018); Xu, David, and Kim (2018) as well as Magwentshu, Rajagopaul, Chui and Singh (2019).
	Upskilling of workforce in Africa	The Economist Intelligence Unit (2018); Magwentshu, Rajagopaul, Chui and Singh (2019); Roux, Viljoen, and Samson (2019); Ndung'u, and Signé (2020).
	Learning and the Industrial Revolutions	Xu, David, and Kim (2018); The Economist Intelligence Unit (2018) and Ramaphosa (2020).
First Industrial Revolution (IR), Second Industrial Revolution (2IR), Third Industrial Revolution (3IR)	Features of and shifts in the First, Second and Third Revolutions	Kagermann, Wahlster, and Helbig (2013), Schwab (2015), Klingenberg and Antunes Jr, (2017), Liao, Loures, Deschamps, Brezinski, and Venâncio (2017), Xu, David and Kim (2018), Stearns (2018) as well as Uleanya and Yu (2019)
Methodology	Review method	Vieira (2015), Snyder (2019)
COVID-19 pandemic and education	Education in developing and underdeveloped African nations during COVID-19 pandemic	

*Table 1.* Areas covered in the study and search terms

#### 4. Discussion of Findings

The findings of the study following review of relevant literatures show that prior to the outbreak of the COVID-19 pandemic, various sectors inclusive of education of many African nations have been skeptical about the Fourth Industrial Revolution (4IR) and have been reluctant to accept it (Ndung'u & Signé, 2020; Masood, 2019). The reason for the hesitance of the

acceptance of the Fourth Industrial Revolution (4IR) by the governments of many African nations in spite of the benefits alluded to the revolution are predicated on challenges experienced by the nations with their different sectors. For instance, review of literatures suggest that the reluctance has been due to fear of the unknown and loss of resources based on past experiences (Benyera, 2021). According to Akileswaran and Hutchinson (2019, 7, italics added for emphasis), "... *if Africa is to participate meaningfully in the global economy of the future, outside of its traditional role as a resource extraction continent and market, then governments and corporations need to re-assess the priority of their investments.*" The reason for clause in this submission is further explained: "... *African resources are funnelled out of their countries by individuals and corporations both legally and illegally, at the expense of much needed public investment.* If African governments are to meaningfully invest in their digital infrastructure and harness policies to support the growth of their future economies, a serious review of the global parameters for domestic resource mobilization in the world's poorest and most disadvantaged countries is essential (Akileswaran & Hutchinson, 2019, 102, italics added for emphasis)." The foregoing indicates fear which causes reluctance in embracing the 4IR and its potential benefits. This is based on the past experiences emanating from the dealings of African nations with other developed countries.

Also, lack of the needed technological facilities/infrastructure (Lee, 2021; Mloi & Mhlanga, 2021), poor funding (Mloi & Mhlanga, 2021), lack of skills/personnel (Mloi & Mhlanga, 2021) to promote the Fourth Industrial Revolution (4IR). According to Kayembe and Nel (2019, 79, italics added for emphasis), the "challenges include *insufficient funding, infrastructure, and skills* to prepare graduates to participate in the 4IR."

Additionally, policy issues (Fu, 2020). According to Tony Blair Institute for Global Change, 2019, 33, italics added for emphasis) "... If African countries are to seize the productivity opportunities that 4IR can offer, the continent's governments and the donor community must pay serious heed to Africa's digital infrastructure needs. They must also *provide the right policy and regulatory environment to ensure Africa's adoption of 4IR technology* keeps pace with other frontier developing economies."

Furthermore, lack of technology support due to fear of job loss (Ndung'u & Signé, 2020). For example, Ndung'u and Signé (2020), reporting for Foresight Africa on how The Fourth Industrial Revolution and digitization will transform Africa into a global powerhouse, state that "Since creating jobs for the burgeoning youth population is a priority in most African countries, many governments are reluctant to support technologies that threaten existing jobs." In congruence, Oke and Fernandes (2020, 17) report that "... there are feelings that technology will displace and replace humans, especially in jobs that require low-level skills, which may have detrimental effects on the social

and economic stability of nations.” All the identified factors amongst others are reasons for African nations' reluctance to accept, embrace, and implement the practices of the Fourth Industrial Revolution (4IR).

On the other hand, and more specifically with the education sector, reviewed literatures show that education through teaching and learning activities played a significant role in the first, second and third revolutions. For instance, in the first industrial revolution, systematic learning was the priority, while during the Second Industrial Revolution (2IR), systematic testing was the main concern and in the Third Industrial Revolution (3IR), personalized learning was the focus and received priority (Xu, David & Kim, 2018). During these times, education was used to inform people and adjust to embracing the revolutions. Similarly, findings from reviewed literatures for this study further show that in the same manner, education has crucial role(s) to perform in the Fourth Industrial Revolution (4IR). It is envisaged to entail a modification in the nature of the curriculum and teaching and learning practices (Xu, David & Kim, 2018). Meanwhile, this was slowly becoming the case in many underdeveloped and developing nations prior to the outbreak of the COVID-19 pandemic. However, with the pandemic outbreak, it seems to have become the case in an expedited manner with the needed technologies yet lacking. Hence, the unanswered question remains: How well and how long can underdeveloped and developing nations handle and cope with such?

## 5. Conclusions

The study explored the interconnection between the Fourth Industrial Revolution (4IR) and the COVID-19 pandemic with regards to underdeveloped and developing nations having South Africa in view. Review method was adopted for the study, hence, relevant literatures were reviewed and the findings adopted for this present study. Literatures on the first, second and third industrial revolutions were reviewed. The reviewed literature shows that virtually all African nations are unprepared for the Fourth Industrial Revolution except for South Africa, which is considered partly ready and ranked 22nd in the automation readiness index. Conversely, whilst underdeveloped and developing nations which predominantly consists of African countries remain unprepared for the Fourth Industrial Revolution (4IR) in different sectors, education inclusive, the outbreak of the COVID-19 pandemic seems to have put the nations on the spot, thereby forcing the government and various sectors to forcefully embrace the Fourth Industrial Revolution (4IR); its technologies and practices. This is evident in the adoption of technologies in the new normal practices as described.

Suffice to state that while, many African nations tend to have neglected the realities of the Fourth Industrial Revolution and lack adequate preparation for it, the outbreak of COVID-19 tends to have forced them into accepting

such, though still unprepared. Sequel to the findings of this study, the following recommendations are made:

- Different governments of African nations, inclusive of developing and underdeveloped, should encourage the adoption of Fourth Industrial Revolution (4IR) technologies in the education sector. This can also be done through periodic organizing of relevant seminars and workshops targeted at exposing lecturers, teachers, students and other education stakeholders on the need to embrace the technologies of the Fourth Industrial Revolution (4IR) in the education sector, especially as it helps to proffer solution to some of the needs and challenges experienced during the COVID-19 pandemic.
- Policies relevant for promoting the Fourth Industrial Revolution (4IR) technologies in the education sector during the COVID-19 pandemic should be designed and implemented. Meanwhile, this would be mainly possible when the necessary facilities and gadgets are made available. Hence, the necessary facilities, gadgets and enabling environments should be made provided by the government.

*Limitation and suggestion for further study.* This present study was limited to reviewing and analyzing relevant literature, consequently lacking empirical data. Hence, it is suggested that a similar study be conducted using a specific research site. This can be done by using different research approaches that involve the collection of quantitative and / or qualitative data. Thus, quantitative, qualitative and / or mixed methods could be desired.

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