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Fourth Industrial Revolution Game Changers: the case of South African Tertiary Institutions: A Literature Review

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Abstract

The fourth industrial revolution brings a diversity of changes in the globe including the education sector and the industries. Education sector is ready to implement new technologies, although the technology efficiency and the changes that comes with the fourth industrial revolution are not well documented in this sector. There is a debate that lecturers and students believe that technology advancement has the power to solve many problems related with the societal change in attitude and delivery of education. With that being-said, there is a need for higher education to adapt to the new technologies in order for them to fast track the benefits that comes with the 4IR. This paper employ an extensive literature reviews to drive the need for South African higher education institutions to harness 4IR in order to enhance existing educational infrastructure. Firstly, the aim of this study is to identify the challenges facing HEIs to 4IR adoption and to investigate the fourth industrial revolution game changers for higher education institutions in South Africa

Keywords
Fourth industrial Revolution, Higher Education Institution, South Africa.

1. Introduction

According to Manyika (2017), industry 4.0 plays a huge role in changing business models in education sector and industries. The purpose of industry 4.0 is to create a better future for higher education institutions and other sectors. According to Maigida, Saba & Namkere (2013), the world at large has no control over additional skills that comes with fourth industrial revolution. Instead, people expect better transformation arising with the fourth industrial revolution: fewer problems among designers and market places, the active part played by Artificial Intelligence (AI) accumulation of different technics, improved excellence of our lives (robotic) and combined lifespan (Internet). 4IR will need the world to produce innovative employees, an informative employee, and future industry leaders' need to adapt to new expertise sets towards conveying the benefits of 4IR. They must be critical thinkers, communicative and deliver ambitious leadership (Gray, 2016). Alex Gray (2016) believed that "Change won't wait for us: business leaders, educators and governments all need to be proactive in up-skilling and retraining people so that everyone in higher education institutions can benefit from the Fourth Industrial Revolution". HEIs need to adapt to 4IR, since there is limited implementation of 4IR in HEIs, training is noticeably low, and its effectiveness is not well recognized in the education sector (Tymon (2013) and Wang (2008). Tymon (2013), and Wang (2008), went on to say that, the initial point on understanding the roles and relevance of 4IR in accelerating education and learning practices is to have enough knowledge of diverse constituents of 4IR. Tymon (2013), further stated even though there is a diversity of technologies that can be used in facilitating teaching and learning but the education sector, is lagging behind when it comes to accepting technology for teaching and learning. Some of the reasons given as problems in the acceptance of new technology in the education sector are the issues of high costs and the lack of training.

2. Literature Review

2.1. Fourth Industrial Revolution in South Africa

The fourth industrial revolution comprises the digital revolution; it establishes the new ways in which technology becomes embedded within society. According to World Economic Forum (2016), the existing revolution consist of 'cyber-physical systems' integrated into its production processes. Schwab (2016), stated that there are synthesis of technologies that are distorting the lines amongst the physical, digital as well as biological compasses. It is noticeable by developing technology breakthroughs in numerous fields, counting robotics, artificial intelligence, nanotechnology, quantum computing, biotechnology, the Internet of Things, 3D printing and autonomous vehicles. World Economic Forum (2016), highlighted that 4IR implies a variation in the way growth takes place from industries in limited workshops to being in craft studios. The term 'Cyber-Physical-Systems' is used to define this revolution. The specific features that describe 4IR comprise: a rate of alteration considerably faster than in previous industrial revolution, there are continuing developments in new and developing technologies including nanotechnology, 3D printing, biotechnology, quantum computing, renewable energy and energy storage, the development of "smart manufacturing" and "smart factories" that is manufacturing processes based on the integration of physical production with digital technologies collecting data on plant operations and the supply chain, which analyze data and contribute to real-time improvements in production, procurement and supply chain management (Schwab, 2016). The replacement and augmentation of certain kinds of labour using automation technologies, including robotics and machine learning. This also opens up the possibility of automation of certain types of knowledge work (World Economic Forum, 2016).

Three years ago, 4IR was the central theme at the World Economic Forum (WEF) annual meeting, Davos 2016. 4IR and Artificial Intelligence (AI) have remained prominent each year, and a lot of research documentation has come from this. At Davos 2019, the theme was "Globalization 4.0: Shaping a Global Architecture in the Age of the Fourth Industrial Revolution", based on the idea that we "are entering a fourth industrial revolution, where a new wave of technological progress will launch us into a new era of globalization" (Davos, 2016). Davos (2016) further stated that the 4IR, or 'Industry 4.0" (manufacturing-focused) is the term popularized by the WEF for the current and developing environment in which disruptive technologies and trends are changing the way we live, work and relate to one another. Such emerging technologies include artificial intelligence (AI) the Internet of Things (IoT) cloud computing, cyber security, the sharing economy, robotics, autonomous robots and vehicles, additive manufacturing (3D printing) cyber-physical systems, genome editing, block chain technologies, big data and analytics, virtual reality (VR) augmented reality (AR) and hybrid or mixed reality (MR). Energy infrastructure and distribution. Smart grid technologies are transforming how energy is manufactured and distributed, enabling utility operators to estimate usage and source energy from the most cost-effective suppliers (Bloem, Van Doorn, Duivestein, Excoffier, Maas and Van Ommeren 2014).

According to Davis (2016), as with previous revolutions, the term 4IR is often used in an encompassing manner to describe a range for new applications of technologies. Specifically, the 4IR describes technological disruptions driven by increased automation of labour and increased digital connectivity. As a result, ICT processes are an integral component throughout the business value chain and necessary for participation in the global economy and improved public service delivery. Therefore, the Sustainable Development Goals (SDGs) have identified digital connectivity as a fundamental human right. Reliable, secure and affordable digital connectivity is also an important component and core of 4IR technologies and services. Smart network technologies with variable quality of service demand are thus crucial to enable 4IR in emerging economies of Africa (Davis, 2016).On the Figure 1 below, Davis (2016) characterized the four industrial revolutions.

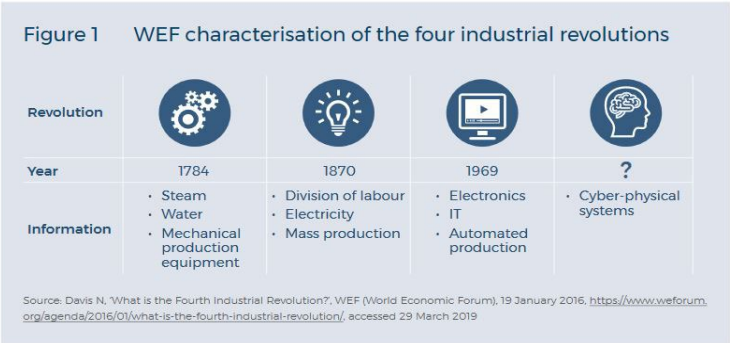

Figure 1: Four industrial revolutions
Source: Davis (2016)

2.2 Challenges Facing HEIs to 4IR adoption

2.2.1 Technology integration in the classroom

Technology usage in higher education institutions has many promises. Ottenbreit-Leftwich *et al.* (2013), revealed that most lecturers are not using ICT when teaching, they may not be trained to use technology in order to encourage meaningful learning in their lecture halls, they need to consider the importance of ICT in education & learning. Mixed technology has been implemented for lecturers' preparation, training and development. Hew and Brush (2007), opined that obstructions that can be close to institutional are referred to six fundamental components, to be specific: Lecturer frame of mind, beliefs and inspirations, knowledge and aptitudes, institution; resources, subject culture and assessment. Below is the model showing the relationship among the various barriers. The Figure 2 below highlights the relationship amongst the various barriers.

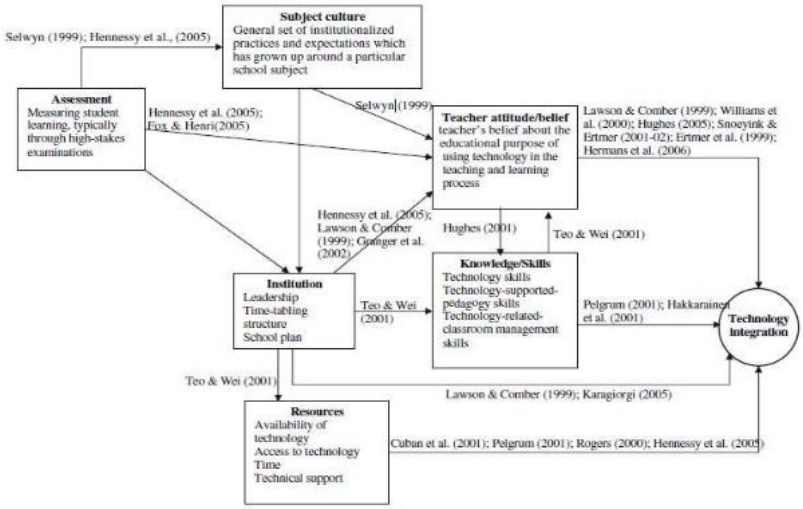

Figure 2: Model showing the relationships among the various barriers

Source: Hew & Brush (2007)

Most researchers found that the organizations capacity to successfully incorporate innovation in the higher education institutions is affected by the assets focused on the reconciliation of innovation, the skills, information on the instructors, and their mind towards innovation (Hew and Brush, 2007).

2.2.2 Digital background of educators on technology knowledge & skills

Regardless of the beginning of computerized stages as a method for information collection, global researchers have discovered that many lecturers showed extraordinary support and positive opinions towards innovation, (Lei, 2009),

pointed out that a large portion of lecturers was digital native. Furthermore, Lei (2009), stated that lecturers still require introduction and skills to utilize new innovation and computerized media for educating adequately.

2.2.3 The role of lecturers' training & development programs

Wei-Ying (2012) stated that lecturers need a day-by-day guidance in the incorporation with innovation. Cervera and Cantabrana (2015), recommended ICT as a basic influence to improve the higher education institutions. In addition, Hew and Brush (2007) also recommended innovation information and skills as a huge hindrance to effective learning in classrooms.

2.2.4 Barriers that affect lecturers' usage of technology

Tsai and Chai (2012) stated that the absence of technological innovation can hinder innovation can be a hindrance for innovation combination in education. Hew and Brush (2007) pointed out the three most obstructions affecting innovation: assets, lecturer's information and skills and instructor's natures and beliefs. This affirms detections of prior investigations, which refer to a scope of hindrances in innovation improvement including financial, mechanical, administrative and social obstructions (Kanie Suzuki and Iguchi, 2013).

2.2.5 Unrecognition of innovation

Advances in innovation have essentially improved instructors' capacity to make a useful reality for students by developing all-over access to learning assets. Davies, Dean, and Ball, 2013; Kim, Kim, Lee, Spector, and DeMeester (2013) revealed that the value got from innovation use for students learning is remarkable because of the scheming it has on students. Cut and Brush (2007) recognized university assets as an immediate driver of innovation combination in training as a significant comprehension of assets as an empowering influence or obstruction to effective innovation incorporation in universities. Carrasco and Torrecilla (2012) stated that the entrance to innovation is the proper PCs, and resulting utilization of those devices, good impacts on innovation reconciliation and student execution. Cambodia, Dotong, De Castro, Dolot, and Prenda (2016) stated that equipment conflict, PCs, the absence of power, restricted understanding among students, and learners' poor understanding of the advantages of these innovations to be a portion of the key hindrances to innovation.

2.2.6 The transformation of curricula, teaching & learning strategies

According to Manyika (2013), the challenge for universities is to transform their curricula, teaching and learning strategies, pedagogical approaches, and the very assumptions on which curriculum design is currently an embedded. These assumptions include a strong focus on the deficit model, a content-driven understanding of knowledge, and narrow and constraining assessment modules and requirements. Manyika (2013) further stated that there is no question that it is necessary to move from the current deficit model, which relies on the outcome statements and the content and 'skills' needed to 'fill' these deficits that, and which is circumscribed by conventional teaching and learning engagements, and assessment models, into a more dynamic and systemic approach to how to 'do' higher education.

2.2.7 HEIs are struggling to produce technologically perceptive students

According to Henderson (2017), the challenge for the HEIs is on how to produce graduates with innovative ideas and relevant expertise to work in this digital globe while contributing to the organizational functioning and productivity if the education sector is not receptive to 4IR. Brown (2015), stated that it is high time the debate is shifted from computer technology and focuses on transforming the teaching and learning process, including the transformation of the education sector through digitalization by embracing 4IR. According to Davis (2018), perceiving the usefulness of technology is an essential building block for the users' intention to accept (Figure 3).

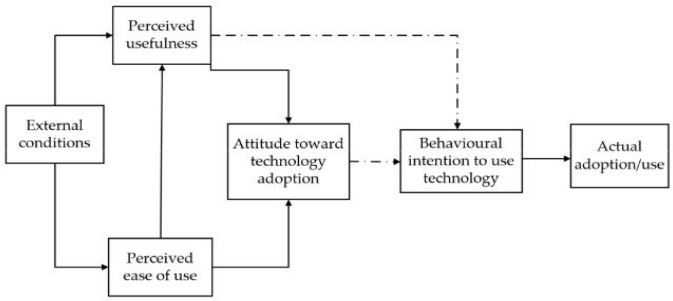

Figure 3: Usefulness of technology

Source: Davis (2018)

3. Research Methodology

This study exploits existing literatures from published research journals and conference proceedings with the aim of identifying the challenges facing HEIs to adopting 4IR in South African Higher Institutions. This study reviewed literatures on the 4IR game changers for higher education institutions in South Africa.

4. Results and Discussion

4.1 The Fourth Industrial Revolution Game-Changer for South African HEIs

4.1.1 Sharing of resources & promotion of collaborative learning

Eze, Adu, and Ruramayi (2013,) stated that the combination of ICTs in education offers a few advantages: sharing assets and learning conditions just as the advancement of collective learning and a general move towards more notable student self-governance. Mereku (2015) pointed out that innovation coordination provides PCs and a web association; it includes the launch of learning exercises with academically educated use regarding ICT apparatuses. The accompanying computerized devices have been referred to regarding ICT mix in the study hall: word processors, information projectors, PowerPoint spreadsheets, web crawlers, intelligent whiteboards, portable advancements, PDAs (messages, web journals, recordings and so on.) tablets, texting, digital recordings, CD-ROMs, Wikipedia, reenactments, movements and digital books (Mooketsi and Chigona, 2014; Mereku, 2015; Assan and Thomas, 2012; Lorenz, Banister, and Kikkas, 2015; Batchelor and Olakanmi, 2015; Govender, 2014; Molotsi, 2014; Tamim, Borokhovski, Pickup, and Bernard, 2015). Nkula and Krauss (2014), demonstrated that ICTs are being used in the study hall; in any case, more top to bottom information is required towards understanding the classes of innovations utilized and how this encourages teaching method and substance information. Tamim *et al.* (2015) pointed out that an absence of self-viability of lecturers and misunderstandings concerning why professors are not drawing in with ICTs in the classroom show that there is misinterpretation. The misrepresentation is that by essentially placing this innovation in the hands of students' issues regarding access of, educational will be settled and educational change will take place.

4.1.2 Computer Literacy

Vandeyar (2015), revealed that reasonable implementation of the e-learning arrangement is lacking. Ndlovu (2016) noted that the irregularities in the comprehension of approaches might influence the reasonable take-up of ICTs in the study hall. Vandeyar (2015), recommended four key systems to improve ICT combination in training, these techniques include building up a connection between the use of ICT in the study hall and learning objectives, understanding the different kinds of advancements accessible, setting up joint efforts with partners to drive e-instruction and breaking down the standard of e-training activities and their imagined outcomes.

4.1.3 Brings educational concept to life

Given the use of computerization in lecturer education, Rosi Braidotti (2015) stated that, "it is no longer sufficient to side with the critical educational theory that accuses computation of reducing human thought to mere mechanical operations"._ That is to say, using computerized learning should not certainly be considered the opposite of reason based on the fact that computerization depends on calculation, which is why it is established. Heaven (2017), demonstrated that when students for example are originated into deliberations about deficiency and inequality in SA communal, lecturers could use 3D pictures; also, students would be familiar through virtual reality to picture

portraying poverty as well as unemployment. Additionally, Heaven (2017), further stated that students might become more passionate about helping others work out sympathetic visualization over seeing and putting themselves in the shoes of vulnerable others.

4.1.4 Emerging technology breakthroughs

Schwab (2016), demonstrated that industry 4.0, commonly depicted as 4IR, the conception has knowingly changed the numerous ways universities in South Africa look and intends to discourse their institutional practices, particularly, education and learning meetings. Furthermore, Schwab's (2016) pointed out that a "new technology" revolution that would convert the way humans interrelate in the globe today is stimulated by "emerging technology breakthroughs, covering wide-ranging fields such as artificial intelligence (AI) robotics, the internet of things (IoT) autonomous vehicles, 3D printing, nanotechnology, biotechnology, materials science, energy storage and quantum computing".

5. Conclusions

A review of the literature indicates that higher education institutions in South Africa is being transformed from the traditional monodisciplinary trajectory which entails narrowing the perspective and focus of one as they go further with their studies towards a multidisciplinary approach because of the advances in technology brought by the 4IR. This study reviewed a literature on challenges facing HEIs adopting 4IR such as minimal integration of technology in classrooms, the important of upskilling the knowledge of 4IR on lecturers and students, the important of training and development programs within the HEIs etc. The study further reviewed literature on how the 4IR would change the HEIs for better if implemented effectively, the solution was developing technology breakthroughs, bringing education concept to life, reasonable implementation of e-learning, sharing of resourcing and collaborative learning etc. In order for students to achieve excellent academic results, the universities must take into consideration the implementation of 4IR technologies.

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