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The fourth industrial revolution and the future of the entrepreneurial university in South Africa



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ABSTRACT

Globally, digital disruption has accelerated in the last few years. It is argued that this technological revolution would fundamentally alter our interactions with one another, our work, and our lives. The Fourth Industrial Revolution (4IR) can blur the boundaries between the physical and biological worlds. Although the extent of the effect is unclear, many anticipate massive changes in the economic and educational spheres. Given the close relationship between the economy and the drivers of entrepreneurship in universities, the survival of entrepreneurial universities remains contingent on the influence and preparedness of the 4IR. This review aimed to ascertain South African entrepreneurial universities' readiness for the 4IR. Systematic literature analysis was adopted for this study; it draws on journal articles, books as well as online publications relating to disruptive innovation, entrepreneurial universities and 4IR. The paper argues that there is a need for a radical overhaul of the current curriculum, as retraining lecturers to prepare for 4IR disruptions.

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Introduction

Higher Education Institutions (HEIs) play a crucial role in promoting economic growth, which impact's students' employability (Ilie, 2010). By being at the forefront, the Entrepreneurial University gains significance, as this is where new skills in innovation, technology and problem-solving skills can be taught. Hence the role of Higher Education Institutions (HEIs), including Entrepreneurial Universities, in knowledge creation and shaping entrepreneurship intentions has become more relevant today than ever before. This hinges on the continued interest in promoting a more entrepreneurial university globally (Rorwana and Tengeh 2015). Collaboration between HEIs and their industry partners has sometimes led to the promotion of research results for commercialization and establishment of corporations, most especially in Europe and the United States of America (USA) (Pattnaik and Pandey 2014). As a result, stakeholders often exert pressure on HEIs to become more entrepreneurial and innovative, as they contribute to economic development and competitiveness (Gibb and Hannon 2005).

Part of the motivating factor for HEIs to become more entrepreneurial is contributing to socio-economic development through job creation and employment (Alessandrini, Klose and Pepper 2013). In South Africa, the government plays a leading role in ensuring HEIs become more entrepreneurial, thereby competitively contributing to knowledge production, leading to economic development (Tengeh and Rorwana 2017). Nevertheless, Blackmore and Kandiko (2012) argued that HEIs face much competition in the 21st century due to technological advancement and globalization. Furthermore, an increase in disruptive technologies, ranging from 3D printing to digitization, robotics to unprecedented big data application, poses many challenges to universities' entrepreneurial initiatives (Valavanidis 2020). These challenges are brought about by the 4IR and could hinder knowledge advancement, notwithstanding the need for these technological advancements by entrepreneurial universities to leverage opportunities, which could also contribute to their levels of competitiveness, both locally and internationally. As such, it is now becoming mandatory for

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universities to develop strategies that will enable the advancement of knowledge in disruptive technologies while encouraging collaboration with industry partners to achieve set objectives. This initiative and expectation from various stakeholders is now propelling most academic institutions to become entrepreneurial universities (Tengeh and Rorwana 2017), and South African universities are no exception.

According to Wood (2011), academic institutions are supposed to be the citadel of digital technology idea generation, development, and transfer that would promote entrepreneurial activities towards sustainability and competitiveness. With digital technology and technological disruptions driving competition today, it becomes critical that digital education is incorporated into the curriculum in the various faculties and departments at academic institutions, most especially at entrepreneurial universities. This study aims to answer the main research question: How will disruptive innovation that accompanies 4IR impact the entrepreneurial university in South Africa?.

The continued global economic transformation and the disruption that the industrial revolution and smart technologies may cause give cause for concern on how academic institutions globally are prepared for the disruption associated with 4IR. Generally in Africa and South Africa in particular, some of the challenges facing HEIs range from unskilled lecturers, thus making it almost impossible for them to adequately embrace digitization and respond to the potential digital disruption that comes with 4IR in a manner that could help to improve teaching and learning activities. Understanding the potential challenges and the South African higher education institutions' readiness for the 4IR in the entrepreneurial universities is important for practical and theoretical implications. Therefore, the knowledge could assist researchers in gaining more insights into the possible and varied challenges that these institutions may face regarding their entrepreneurial intentions, research, collaboration and the possible way forward, in a manner that will assist them to be more innovative and their preparedness on how to respond to those challenges associated with 4IR, also it could assist policymakers to come up with adequate policies that could help to reduce the unprecedented effect on the HEIs sustainability.

This paper is structured as follows; immediately after this introduction, there is a discussion of the theoretical perspective on disruptive innovation theory and its application to HEIs, followed by a review on entrepreneurship universities, after which universities and disruptive innovation are examined, with next the discourse on the 4IR and entrepreneurial universities, then the South African university and disruptive innovation, followed by the conclusion and implications, then limitations and future research direction and lastly, the way forward for entrepreneurial universities on the 4IR dispensation..

Theoretical Perspective: Disruptive Innovation and its application to Higher Education Institutions

Disruptive innovation theory is explained by Christensen et al. (2011, 2) in their study as having "... significant explanatory power of thinking through the challenges confronting higher education institutions". Blackmore and Kandiko (2012) argued that more than ever before, HEIs face considerable competition due to technology advancement and globalization, thus leading to a move towards online learning, propelled by digitization (Yuan and Powell 2013). Therefore, disruptive innovation is described as the entry of a process into a market that has been either neglected or only attended to by a small organization due to either complexity in science, cost implication or accessibility problems. Entry into these markets is enabled by introducing less complicated and cheaper services or products, without necessarily focusing on only the wealthy but rather on affordability to all (Christensen et al. 2011).

When applied at first, the theory of innovation does not necessarily focus on perfection but instead on affordability and accessibility, with quality gradually improved over time, to then take a larger share of the market once it can solve more challenging problems experienced within the sector (Christensen et al. 2011). Disruptive innovation is further mentioned to have the capacity to help solve problems of prominent HEIs going forward. Therefore, in an attempt to help proffer solutions to these impending problems, technology can be used as an enabler, where innovation is introduced gradually, to first assist or be used by an underserved group of scholars not privileged to access a secular mode of education (Christensen et al. 2011).

Besides, Blackmore and Kandiko (2012) described disruptive innovation as applied to educational institutions, as online modes of learning or distance-learning are made available to students who do not have the opportunity or cannot attend university classes physically but are now served through available technologies. This was corroborated by Christensen et al. (2011, 3), who posited that "By making a degree program more accessible or convenient to students who would otherwise not be able to attend classroom lectures, it is arguable that technologies that make online, distance-learning possible are a potential source of disruptive innovation in the educational field"; this also applies to the ability of a student to continue their work full-time while simultaneously having the opportunity to study at a higher institution.

Furthermore, Christensen et al. (2011) argued that this disruptive technology comprises online learning for HEIs, including the Entrepreneurial University, presently acting as a disruptor to typical higher education. This mode of delivery offers a clear picture of "the rapid growth in the Up-start for-profit higher education sector over the last 10 years, even as many colleges and universities have struggled financially and had to cut back." (Christensen et al. 2011, 3). The authors further posited that disruptive innovation could be assumed to be a business model innovation where should this be included in an entirely fresh model, it could assist the educational sector in providing services to these sets of customers in an affordable, low-cost manner. However, the application of

disruptive innovation into an existing educational system would not bring about any change to the model and will instead be used to support its operation.

Most importantly, disruption of HEIs would be better managed at a national level and not at the individual universities, in silos, as this will merely become another challenge to individual universities (Christensen et al. 2011). Part of the argument was that conventional universities are mainly focused on business models focused on research, teaching and learning and preparing students for careers; these models are problematic and may not result in channelling resources into what is necessary, thereby removing priorities from research and teaching. In its place, online learning models would thus only facilitate teaching and learning, rather than research, in a manner tailored towards learner progress from a career development perspective, in a cost effective way. Moreover, these innovations allow online learning at different locations, and times, which will afford learners the opportunities to access more affordable education, especially those who have been previously disadvantaged.

Methodology

This study intended to determine higher education institutions' readiness for the 4IR in the entrepreneurial universities, focusing on South Africa. We adopted qualitative methodology through extensive analysis of existing literature to help identify and select literatures related to the Fourth Industrial Revolution and the future of entrepreneurial university (e.g. Opute et al. 2020). To achieve that, we searched online databases; Scopus, Science Direct and Google Scholar, books and online publications using strings relevant to the study's theme relating to disruptive innovation and the entrepreneurial university. Our strategy was to systematically collect robust evidence on the central question for the study, to identify, chose and evaluate the relevant literature to our study (e.g. St. John & McNeal, 2017; Munn, Peters, Stern, Tufanaru, McArthur & Aromataris, 2018), to conduct an appraisal, synthesize and draw conclusions. We conducted a systematic analysis of the literature and selected pieces pertinent to the research question about disruptive innovation and entrepreneurial universities; these pieces of literature were then synthesized (e.g. Cronin, Ryan & Coughlan 2008; St. John & McNeal, 2017). To ensure that we can capture themes appropriately, we adopted a back and forth review process of the various materials selected for the study to ensure we could capture relevant information appropriately (e.g. Straus & Corbin, 1998). In line with the study's central theme and aim, data construct were in the form of hypothetical perceptions and conceptualization (Snyder 2019). Based on the data we assembled and our systematic review, we were able to draw inference and suggestion on the critical role Entrepreneurial University tend to play in economic development through knowledge-creation and innovation in relation to the aim of the study and also the Way forward for the Entrepreneurial University in the 4IR Dispensation.

Our initial search in the databases generated a total of (n=115,210) from the various sources relating to the broad area of disruptive innovation and education, the search string was further refined, and we were able to exclude a total of (n=114, 886), thus making a total of (n=324) suitable for evaluation. Finally, further (n=205) were not considered for assessment due to some criteria ranging from the date of publication and not closely related to the study's objective, Thus (n=119) were found to be closely associated with the aim of our study.

Table 1: Summary of related studies in literature

| s/no | Author(s) and Year | Title | Journal Name | Method Used | Findings |
|------|--|--|---|---|---|
| 1 | Alessandrini, Klose, & Pepper (2013) | University Entrepreneurship in South Africa: Developments in Technology Transfer Practices | <i>Innovation: Management, Policy & Practice</i> | Survey Questionnaire and Structured face-to-face Interview | Some institutions are under resourced, thus affecting their ability to support their technology transfer |
| 2 | Blackmore & Kandiko (2012) | Change: Processes and Resources.” In <i>Strategic Curriculum Change, Global Trends in Universities</i> , eds | Abingdon: Routledge | Case Study | Development of concepts, processes and tools that can be applied to curriculum change |
| 3 | Butler-Adam (2018) | The Fourth Industrial Revolution and Education | <i>South African Journal of Science</i> | Speech / Online Publication | Change in curriculum, teaching and learning and the need for lecturers to upskill their knowledge to operate, support and maintain new technology |
| 4 | Christensen, Horn, Caldera & Soares (2011) | Disrupting College Innovation Can Deliver Quality and Affordability to Postsecondary Education | http://www.americanprogress.org | Building of inductive theory and testing deductively | Policy recommendation on how to remove obstructions to disruptive innovation and collaboration between innovators and Higher Institutions, and application of the appropriate model |
| 5 | Ilie (2010) | The role of entrepreneurship education in the current global economy recovery process | <i>Euromentor Journal – Studies about Education</i> | Conceptual paper (Qualitative Review) | Identified problems faced by entrepreneurs to be training and suggestions on the importance of introducing entrepreneurship at all levels of higher education. |
| 6 | Kayembe & Nel (2019). | Challenges and Opportunities for Education in the Fourth Industrial Revolution. | <i>African Journal of Public Affairs</i> | Desktop research using conceptual analysis | Iterate challenged being faced by South Africa Higher Institutions in the adoption of 4IR as Lack of skills, funds and infrastructure |
| 7 | Pattnaik & Panday (2014). | University Spinoffs: What, Why and How? | <i>Technology Innovation Management Review</i> | Literature review | Proposed multi-stage holistic model |
| 8 | Penprase (2018) | The Fourth Industrial Revolution and Higher Education.” In: Gleason, N. editor. | <i>Higher Education in the Era of the Fourth Industrial Revolution</i> | Book Chapter | Developed outline and structure of the 4IR, developed catalogue of some important evolving technologies that could assist in adopting 4IR and some societal implications. |

Table Cont'd

| | | | | | |
|----|---------------------------------|---|--|--|---|
| 9 | Powell, Olivier & Yuan (2015) | “Handling disruptive Innovations in HE: lessons from two contrasting case studies. | <i>Research in Learning Technology</i> | Case study using the theory of disruptive innovation | Disruptive innovation lens will help institutions to understand varieties of innovation and how to respond to disruption |
| 10 | Thabo Mbeki Foundation (2019) | Education in the Age of the 21st Century, Responding to the Challenges and Opportunities of the 4 th Industrial revolution | <i>Working Group Briefing Note, 2019</i> | Combination of both desktop and survey questionnaire | Unskilled teachers/lecturers and lack of infrastructure to support digitization |
| 11 | Valavanidis (2020) | Universities as Innovation Drivers for Major Disruptive Technological Transformations and Economic Development | <i>Scientific Reviews</i> | Literature Review | Presented challenges faced by world leading universities in the advent of digitization in the USA, UK, Germany, China, India and France |
| 12 | Waghid, Waghid & Waghid (2019). | The fourth industrial revolution reconsidered: On advancing cosmopolitan education | <i>South African Journal of Higher Education</i> | Conceptual paper | Higher Institutions teaching and learning should be focused on the cosmopolitan human condition, how teachers and students conform to universal goals of education in which it was acquired |
| 13 | Wood (2011) | A Process Model of Academic Entrepreneurship | <i>Business Horizons</i> | Desktop/Literature review | Development of Multi-Stage model of academic entrepreneurship |
| 14 | Yuan & Powell (2013). | MOOCs and disruptive innovation: implications for higher education eLearning | <i>eLearning Papers</i> | Use of Theory | Developed model that can be used for the development of innovation and implementation of strategy |

Entrepreneurship University

The role of universities in knowledge creation and entrepreneurship is becoming more important than ever before, necessitating continued interest in promoting a more entrepreneurial university globally (Rorwana and Tengeh 2015). As such, there is growing pressure on HEIs to become more entrepreneurial and innovative, thereby taking the lead in contributing positively to the economy while also remaining competitive (Gibb and Hannon 2005), with South Africa gradually pushing towards achieving this through universities across the country. This is corroborated by Ilie (2010), who posited that HEIs play a crucial role in promoting economic growth, the failure of which will impact the employability of students in the new economy. Although it is argued that economic growth is hinged on technology and innovation, when available policies and strategies are not correctly applied in a coordinated manner, it could be a challenge for South Africa to embrace the necessary digital transformation required in the 4IR dispensation (Rorwana 2016).

In helping to propagate this initiative, entrepreneurship universities, where new skills can be taught, gain significance. According to Tshikovhi and Shambare (2015, 152), "Attention should be given to the role education can play in developing the next generation of innovations and entrepreneurs can create jobs and inspire others to succeed". This can invariably only be achieved through curriculum redesign that makes allowances for the future of work while taking the anticipated disruption that could accompany 4IR advancement. As noted by Wood (2011), academic institutions are supposed to be the citadel of digital technology idea generation, development and transfer that would be a catalyst to entrepreneurial activities towards sustainability and competitiveness. This intention usually begins with students during the course of their study or with tutors and collaboration amongst academic institutions and industry technology transfer (Wood 2011).

Universities and Disruptive Innovation

Beginning from the 21st century, there has been an increase in disruptive technologies in all aspects of life (Valavanidis 2020), ranging from digitization, Robotics, 3D printing and unprecedented big data application. The astronomical way in which these technologies are growing has posed many challenges in a manner that has affected the way activities are carried out, with HEIs no exception (Valavanidis 2020), since they are equally faced with numerous innovation challenges brought about by 4IR and disruptive innovation that could hinder knowledge advancement. This, despite technological advancement being required by HEIs in leveraging opportunities to become competitive both locally and globally.

According to Valavanidis (2020), most HEIs in the United States of America, the United Kingdom, Germany, China, India, and France have developed strategies that will allow them to advance knowledge in disruptive technologies while collaborating with organizations to accomplish their stated goals. Valavanidis explains that, compared to most universities in some developed countries, HEIs in the USA operate a decentralized monitoring authority, precisely because there is not a body that provides annual funding for running their operations, rather, they operate independently, to the point where they have the liberty to develop their curriculum, research and innovation, as well as learning and development, and how they collaborate with the industry. Furthermore, approximately half of the educational institutions act as economic drivers and technological innovators within their domain (Valavanidis 2020).

Thus, most research and development (R&D) initiatives are jointly sponsored by academic institutions and the industry (Valavanidis 2020). In addition, another strong initiative by USA academic institutions is the support of new ventures for students able to develop innovative ideas and products. Egusa (2017) mentioned that universities in the USA provide the necessary funding for student start-ups instead of obtaining funds from outside sources. This is also evident in South Africa, where some universities have initiated the "process of unleashing innovations through start-up accelerators for their students." (Diphoko 2018, 1-3). Examples include LaunchLab by Stellenbosch University, University of Cape Town's Solution Space and Witwatersrand University's Tshimolong.

Concerning HEIs, disruptive innovation is explained by Powel, Olivier and Yuan (2017, 3) as, "Those that develop new business models to exploit the potential of emerging technologies to serve new types of students, or existing students that current provision does not serve well". Arising from this, it is anticipated that disruptive innovation poses many challenges to current HEI processes and procedures in an unprecedented manner. Although South African HEIs welcome the disruption 4IR could bring to the education system, the most pertinent question that needs to be answered relates to their preparedness levels for the future. This is important because, in order for Higher education to be ready and competitive, they must embrace curriculum change that considers relevant skills to enable future jobs.

The Fourth Industrial Revolution (4IR) and the Entrepreneurial University

4IR will impact all facets of life and education globally (Penprase 2018). According to the World Economic Forum (WEF 2017a,b), 4IR will impact and "Shape the future of education, gender and work". However, despite the rate at which it is anticipated to disrupt higher education, most academic institutions, unfortunately, do not appear to be adequately prepared for the impending disruption (WEF 2017a). For HEIs to prepare students for the work of the future, the introduction of digital technology becomes an important aspect of the curriculum (WEF 2017b).

The industrial revolution is not new, it first started with the introduction of machines, specifically steam engines, in the First Industrial Revolution (1IR), the Second Industrial Revolution (2IR) saw a continuation of the previous revolution leading to developments in

steel, electricity and chemicals, while the Third Industrial Revolution (3IR) further developed technology in the area of energy (nuclear power), as well as manufacturing, computing and electronics; these previous revolutions made impact not only economic growth but also the promotion of economic growth through socio-economic transformation (Weightman 2007). Although these provide a platform for discussion on the impact of 4IR on higher education globally (Penprase 2018), it is also mentioned that how 4IR will affect every facet of life is not yet clear. However, it is certain to bring unprecedented change in an astronomical way. As such, it is essential that HEIs are adequately prepared to key into the rapidly evolving technologies associated with 4IR to enhance educational delivery (Penprase 2018).

Part of the areas that require immediate attention is curriculum development, which ought to take full consideration of emerging technologies and skills, such as Data Science, Artificial Intelligence (AI), Robotics, and Genomics. Endy (2016) and Penprase (2018) posited that when developing curriculums, due consideration should be given to the incorporation of 4IR STEM courses, including “Science - biology, chemistry and physics,” affording high priority to computer science courses to assist in providing a minimal understanding and use of technology within 4IR. For example, Cyert (2017) iterated that Stanford University’s biology curriculum was redesigned to include synthetic biology and molecular design; this new curriculum encourages students to develop solutions that will enable “Real world pathogens such as Lyme Disease and HIV using authentic data from scientific literature” (Cyert 2017, as quoted in Penprase 2018, 218), this also includes numerous courses in engineering biology, bioengineering, and green chemistry, which will help prepare students in acquiring the requisite skills needed in this era of 4IR disruption.

Moreover, institutions should begin to redesign their curriculums through an interdisciplinary approach in new technological advancement to better prepare students for future work (Penprase 2018). This is corroborated by Butler-Adam (2018), who mentioned that some of the consequences of 4IR disruption of the educational sector entail curriculum design and teaching and learning and not necessarily the application of robots for lecture delivery. He further stressed that cross-boundary collaboration amongst departments and faculties is an important factor to consider in the 4IR era; this could be the design of curricula to enhance collaborative learning, where students learn about the implication of 4IR to their area of study. Furthermore, it is necessary that “students studying the basic and applied sciences need to understand the political and social nature of the world in which they live, and, in turn, students who study the humanities and social sciences need to understand at least the foundations on which AI is based and how it operates.” (Butler-Adam 2018, 1). Therefore, when developing the HEIs plan, due consideration should be given to the achievement of the 3IR, based on a blended approach of online and physical lecture delivery with online video conferencing technologies. This is important to enabling more conducive learning for students in an integrated way.

According to a Massachusetts Institute of Technology (MIT 2013) report on an institute-wide task force on the future of MIT education, the importance of combining both online and classroom learning at the undergraduate level was stressed in making learning more flexible. A typical example is the electrical engineering introductory course, which is delivered online, except for the practical aspects that are done at the laboratory; the advantage of this mode of delivery is that it is less stressful for the students, as well as improving assignment completion and testing (Roll 2017). Although the first three industrial revolutions have had a significant effect on socio-economic activities, the educational sector and the development of different innovative curriculum, it is nevertheless anticipated that the full impact of the 4IR may not be achieved very soon in the educational sector (Penprase 2018).

The rate at which 4IR technologies are advancing highlights the need to be proactive in the way activities can be better dealt with than in the previous industrial revolution. It was further iterated by Penprase (2018) that how 4IR driven technologies would impact socio-economic and environmental activities will require a rethink of the educational curriculum so it may be more responsive to economic needs. In anticipation of student desires to meet the changing demand of requisite skills that will make them competitive in the 4IR dispensation, academic institutions must develop and teach a relevant curriculum, thereby making them more responsible for society's economic and environmental needs.

South Africa Universities and Disruptive Innovation

Schwab (2016, 12) stated that 4IR is “characterized by a much more ubiquitous and mobile internet, by smaller and more powerful sensors that have become cheaper, and by artificial intelligence (AI) and machine learning.”. Technology advancement due to 4IR is occurring in a manner that will enhance growth and development, coupled with a new discovery in all aspects of life, including the educational system (Kayembe and Nel 2019). In reality, this revolution is technology-driven. The application of these digital initiatives tends to help governments, industry, economy, society, and academic institutions undergo astronomical transformation coupled with disruptions to processes. Part of the changes brought about by this revolution, according to Kayembe and Nel (2019, 82), include “Ideas such as virtual worlds, smart cities, big data, Internet of Things (IoT), and AI have taken centre stage in driving development”.

However, a significant concern is whether South African HEIs can respond to the impending disruptions from 4IR? These institutions can harness the opportunity that may come with 4IR to adequately prepare students for the future through curriculum redesign that embraces new technologies and innovation. As Khathu (2019) mentioned in his report on 4IR and the South African education system, South Africa academic institutions need a radical change to respond adequately to the proliferation of 4IR. Moreover, to adequately prepare, the following challenges must be appropriately addressed, for example, courses relating to computer skills must be taught in all faculties at universities, telecommunication infrastructure must be built to enable access to reliable and fast internet

access, courses related to data science and software development should also be taught. At the same time, there is the further necessity of upskilling lecturer experience in these areas.

Rodny-gumede (2019) argued in her report that for South African HEIs to succeed in the 4IR, innovative talent should be embraced; however, unfortunately, most HEIs in the country do not encourage innovative and creative thinkers. It was further iterated that this assertion was supported by Tshildzi Marwala and Boxing of the University of Johannesburg, who argued that, “Most developed and underdeveloped countries lack innovate talent”, and as such, higher education “should not only focus on training knowledge-based skilled persons but have a good look at cultivating innovative talent” (Sighted in Rodny-Gumede, 2019: Online), which can be achieved through interdisciplinary degrees and professional qualifications. By studying some international university curriculums, achieving this is possible to better understand how this was developed, taking 4IR requirements and future work into consideration (Rodny-gumede 2019). The 4IR, according to Schwab (2016, 12), is explained as “occurring simultaneously are waves of a further breakthrough in areas ranging from gene sequencing to nanotechnology, from renewables to quantum computing, it is the fusion of these technologies and their interaction across the physical, digital and biological domain that makes it fundamentally different from the previous revolutions”.

It is held by Waghid, Waghid and Waghid (2019) that despite the use of the internet by HEIs in South Africa, some academics are unfortunately still ‘left behind’ in the use of technology in their area of activities; this assertion is evident in the manner in which academic institutions have responded to the previous revolution on how to prepare students for the skills required to meet demand (Waghid et al. 2019). It is anticipated that most skills being taught by HEIs, according to the Future of Jobs report (2016), will no longer be relevant in the 4IR dispensation, and this has continued to put institutions under intense pressure in remaining relevant in providing those skills required in preparing students to acquire proficiencies in areas where digital skills are necessary (Waghid et al. 2019). Therefore, in anticipation of the disruption 4IR could bring to higher education, the South African government has developed a policy to assist academic institutions in having adequate internet access through the National Development Plan (2011). To help address these challenges, the education ministry has mandated academic institutions to incorporate subjects and delivery modes that embrace digital technology.

Kupe (2019) argued that part of the academic institution’s responsibilities is to contribute to not only global socio-economic development but that of South Africa in particular and that in order to achieve this drive, “There is need to underpin teaching and learning strategies that create well educated, socially conscious citizens who are equipped with skills for their era, in this case, the 4IR.” (Kupe 2019, 1). The 4IR has come to stay and will definitely impact society, including academic institutions, both positively and negatively; therefore, all stakeholders must begin to prepare adequately for this disruption. Despite all these challenges, academics must be fully prepared to embrace these unprecedented changes and prepare for whatever transpires (Makhanya 2019, cited in Ravhudzulo 2019, 1).

Conclusions

According to this study, there is no question that the Entrepreneurial University plays a critical role to play in economic development through knowledge creation and innovation. They are actively involved in developing the next generation of innovators and entrepreneurs in a way that results in job creation and employability. This also involves establishing channels for generating digital technology ideas, development, and transfer to promote entrepreneurial activities through product development and spin-off companies. The 4IR is taking place in an astronomical manner, thus impacting every aspect of life, including that of the entrepreneurial university, and this poses many challenges to academic operations and competitiveness, preventing the leveraging of opportunities that could accompany 4IR.

To address these issues, academic institutions must fundamentally alter their curricula to integrate future job-related skills. Although South African HEIs welcome this disruption, 4IR could result in disruptions to the academic institution system. Nevertheless, it is important to incorporate courses relating to computer skills. At the same time, while telecommunications infrastructure must be enhanced to enable fast internet access, and courses relating to data science and software development should also be taught, with upskilling lecturer experience to include the application of digital technologies into the academic system. Collaboration between academic institutions and the industry is vital in developing curricula that will prepare students for the workforce of the future.

A major concern regarding some challenges that may arise from implementing digital education across institutions is that it could be a disadvantage to society's less privileged. To address this shortcoming, policies conducive to the uptake of 4IR initiatives across a broad spectrum of life should be considered, not just in education but through collaboration with all government, industry and non-governmental organizations. These should include developing strategies that will consider the human element of life, necessitating stakeholder dialogue, especially with researchers in various institutions. Curriculums must be designed with due consideration of the dynamic nature and rate at which 4IR is unfolding. This should incorporate activities that will prepare students for future work and immediate employment after graduation. Moreover, combining the strength of conventional modes of learning and e-learning for effective delivery and competitiveness would also result in more flexible education.

Limitations and Future Research Direction

This study is limited in scope since it examined only South African HEIs in order to ascertain the diverse problems confronting higher education institutions and their preparation for 4IR in entrepreneurial universities. Additionally, this paper was a systematic analysis of the current literature to identify and select literature related to the Fourth Industrial Revolution and the future of entrepreneurial university; thus, no empirical study was considered. Future research should concentrate on conducting empirical studies to bolster our results and buttress HEIs preparedness for 4IR in South Africa.

Way forward for the Entrepreneurial University in the 4IR Dispensation

According to a report by the Thabo Mbeki foundation (2019, 182), “Education is one sector that will not be left behind” in the manner in which 4IR will cause disruption. Globally, higher education is fast integrating digital technology into the education system to enhance competitiveness. African’s continent, especially South Africa’s entrepreneurial universities, will face numerous challenges due to the anticipated advanced technology that accompanies the 4IR and disruptive innovation (Thabo Mbeki Foundation 2019).

Furthermore, the study iterated that some priorities that government, universities and other stakeholders should focus on should include, but not be limited to, providing a conducive environment for 4IR implementation and adoption should hinge on policy and practices to support education, at present, most policies do not adequately support 4IR implementation, to achieve this there must be political will on the part of the government. In addition, there is a lack of requisite infrastructure that could enable the implementation of 4IR in most HEIs, for example, adequate internet and other connectivity infrastructures. Furthermore, inadequate funding is provided for education that could be used to advance 4IR, thus, to cultivate digital education and for South Africa to compete globally, the necessary funding must be provided to help foster innovation on an ongoing basis. Further to this, incorporating a 4IR curriculum into teaching and learning is no longer negotiable; this also includes the required hardware and software to enable student skills development for the 4IR. Lastly, lecturers should be encouraged to develop knowledge in those technologies that could enhance digital learning; this can be achieved through consultation with the government to identify opportunities and challenges that should help advance or limit the smooth implementation and adoption of 4IR in the education system.

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