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The future of work in Africa in the era of 4IR – The South African perspective

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ABSTRACT

Although the correlation between technology and the changing labor landscape has been the subject of much research, there are growing concerns regarding the rise of automation and its impact on the job market. Research focus has been on jobs that are most likely to be affected by automation in the era of the fourth industrial revolution (4IR). Very little, if any research has examined universities' readiness to meet the current and future 4IR curriculum demand needs, and their capabilities to produce graduates or skill sets that support the current and future labor market and technology changes. This insight paper explores South African universities' 4IR readiness against the backdrop of general industry 4IR adoption. An interpretive interview with three leading 4IR education training and industrial automation company directors offers insight into industry 4IR adoption in Africa, as seen against the available skills sets and/or labor force readiness. This paper has implications for curriculum redesign and planning.

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Introduction

Automation, which has been on the scene for almost five centuries, is an integral part of the industrial revolution. Studies that have been investigating the industrial revolution since the 1960s, against the backdrop of digital evolution, reveal that automation is firmly entrenched, and now more than ever, it is accelerating to permeate every aspect of the goods and service industries (Carpenter, 2019; SAP SE, 2018). Hence, the recent resurgence of studies questioning the future of work in the era of the fourth industrial revolution (4IR) (Bughin, Manyika, & Woetzel, 2017; Chopra-McGowan & Reddy, 2020).

Almost inevitably, the future of work presents a causality challenge between academic institutions and the labor market. However, the challenge has received limited attention, with the exception of Chopra-McGowan and Reddy's (2020) attempt to address what would be required to reskill entire industries, and Bughin et al.'s (2017) take on the automation renaissance of jobs. Chopra-McGowan and Reddy's (2020) study provides insight into the type of content, financial investment and format of learning that would be required, while Bughin et al. (2017) focus on jobs that would be created and lost

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because of automation. Although the two mentioned studies provide a great platform for this paper through their acknowledgement of the need for academic reform, they in part, neglected the issue of academic readiness in terms of people and advanced technologies, and the financial resources that would be required to produce the skills necessary to feed the future of work. Whilst automation is an undeniable force in the future of work, the people, technology, skills, equipment, and advanced technologies required to prepare for it are an unattainable idea for most academic institutions, especially those in Africa where economic, social and political turmoil prevail.

Drawing on the qualitative interpretative semi-structured interview of three purposively selected experts from two top global automation industry frontiers, this insight paper gives a potent voice to the causality challenge, and calls for the necessary moral obligations of academia, government and industry to engage in the efforts required to address the challenge. Their insight offers a perspective on industries' 4IR adoption in Africa (especially South Africa), against the academic skills sets and/or labor force readiness. The advantage of purposive sampling is that it provides the necessary information required for this paper; however, it is not representative of the entire population (Saunders, Lewis, & Thornhill, 2019; Yin, 2018).

Two of the three experts have more than 35 years' experience, and the other has over 42 years' experience, all in the information technology (IT), enterprise systems and automation industry. The experts were amongst the guest speakers at the 1st and 2nd African Operations Management Conference in 2017 and 2019, respectively. Following the conferences, face-to-face and virtual contacts were held with them regarding the subject matter. Their respective roles and responsibilities span the world, including Africa, Asia, and Europe. For the better part of their careers, the three experts have overseen major projects as the head, director, or chief executive officer (CEO), at various levels from strategic, tactical and operational levels in South Africa, whilst also covering many African countries. Their experience across the different levels of management provides a bird's-eye view of the future of work in Africa in the era of 4IR, as they have been involved with planning on long-term (strategic), medium-term (tactical), and short-term (operational) bases (Bocij, Greasley, & Hickie, 2015) in South Africa and the entire African continent.

To prevent confusion regarding the varying references to 4IR, this insight paper starts by introducing 4IR, which is also known as the Information Age, the Age of Entanglement, the Internet of Systems, Industrial Internet of Things, Industry + in China, the Fourth Economy and the Age of the Robots (Carpenter, 2019; Mkansi, 2017). Although defined differently, the latter studies commonly present similar interpretations of 4IR. Mkansi (2017, p. 218) presents 4IR as the "convergence of physical objects (things) and digital worlds (virtual representation that is embedded with sensory, actuator and smart devices) such as the cloud, smart phones, radio-frequency identification devices (RFID), necessary and required to control the entire value chain". Carpenter (2019) emphasizes data as the fuel behind the digital economy, and the proliferation of cheap sensors and smart devices that underpin the concept of cyber-physical systems, and that remodel industry towards the digital economy.

The next section provides descriptive insight into digitalization and the future of work. This is followed by an interpretative account of how the future of work is an academic and economic challenge in Africa. Thereafter, the interaction between universities and the

economy is discussed, which sets the tone for the future of 4IR from a triple helix perspective, followed by concluding remarks.

Digitalization and the Future of Work

Recent studies have provided insight into how automation in the 4IR era will reconfigure the labor market. These studies have revealed the increasing number of jobs and/or skills sets that are most likely to decline, and/or will be replaced by machines, either in the immediate term or the next decade (Arntz, Gregory, & Zierahn, 2016; Bughin et al., 2017; Gownder et al., 2018; Kosslyn, 2019; PwC, 2017; Truswell, 2019).

Kosslyn (2019) examined the aspects of stable or surviving jobs that are most likely to be automated. In his analysis, repetitive jobs and routine jobs, such as radiologists and physicians, are more likely to have limited roles, whilst jobs such as truck driving, cashiers, and warehouse picking and packing, will be entirely replaced by machines. Furthermore, Gownder et al. (2018) estimate that jobs in the financial services could be more vulnerable to automation in the short term, in comparison to transportation jobs that could be more vulnerable in the longer term. In particular, the jobs of blue-collar workers are more likely to be vulnerable to automation in the next decade (PwC, 2017).

PwC (2017) and Truswell (2019) explored the impact of automation by gender and concluded that women are most likely to be affected from 2019 onwards, and into the 2020s, especially in terms of the administrative and secretarial jobs in which they make up 80% of the workforce. Automation will impact jobs that mainly comprise men, such as construction work and truck driving, slightly later, more in the 2020s to 2030s. Arntz et al. (2016) provided a thorough analysis of the tasks of over 200,000 employees across 29 countries, and their related potential vulnerability to automation.

Although the impact of automation in the 4IR has been well established, very little attention has been given to academic institutions' readiness to meet the current and future 4IR curriculum demand needs, and on its capabilities to produce the graduates or skill sets that support the current and future labor market and technology changes. Yet, automation has massive implications for investments in education, and the skills necessary to foster flexibility and the rapid adaptation of technology-driven changes to different career or exit paths (Bughin et al., 2017; World Bank, 2016). Bughin et al. (2017) reinforce how automation challenges the current education system, workforce training, skills building, and business approaches, and equally note the need for changes to the secondary, college and university curricula. The World Bank (2016) noted with concern the slow response of the education system towards automation.

The Future of Work: An Academic and Economic Challenge in Africa

The significance of understanding the future of work in the 4IR era remains an academic and economic challenge. This insight paper posits that the findings of the reviewed studies (Frey & Osborne, 2016; PwC, 2017) raise several important questions for African universities and industries if compared to the developed world. For example, although PwC's (2017) findings suggest that educated workers with graduate degrees, or above, are less likely to be affected by automation, Frey and Osborne (2016) examined the susceptibility of jobs to automation, and concluded that wages and education bear no

correlation to the probability of occupations being automated. The latter findings have several implications for universities, in that a paradigm shift is required to realign and redesign curricula, equipment, and lecturers' knowledge to career paths that are less likely to be susceptible to computerization.

The career paths most susceptible to computerization is best illustrated through the lens of Figure 1, which highlights the evolution of automation since the birth of the industrial revolution. Of particular interest, the figure paints a canvass of the changing landscape of repetitive tasks vis-à-vis high-value tasks as automation evolves. The moderating factor between repetitive tasks and high-value tasks is automation. Using the economic logic of demand and supply, it is safe to conclude that Figure 1 depicts an emerging "law of automation", and that is, at higher automation, industries for goods and services will less likely demand skills for repetitive tasks. Hence, from a supply perspective, at higher automation, industries and universities will be required to increase the supply of high-value skills for high-value tasks.

In this regard, how can African universities redesign a curriculum that is relevant today and will remain future-proof? How can African universities prepare students to thrive in times of rapid technology changes, disruptions and uncertainty, especially considering that 47% of jobs are already at risk of automation (Frey & Osborne, 2016). Even though the 47% risk is reflective of the situation in the US, Bughin et al.'s (2017) global perspective suggests that 50% of work activities have the technical potential of being automated. SAP SE (a German multinational software corporation) (2018) supports Bughin et al. (2017) by highlighting the rate of automation in the twentieth century as compared to previous eras (see Figure 1). Their assertion heightens the economic challenges of Africa, and the potential automation impact in terms of the education system, equipment, and the workforce required to cope with current challenges and future 4IR demands.

In Africa, there is already a high unemployment rate (Iraki, 2018; Van Broekhuizen, 2016), lack of infrastructure (Oduwole, 2018; Mkansi, de Leeuw, & Amosun, 2020),

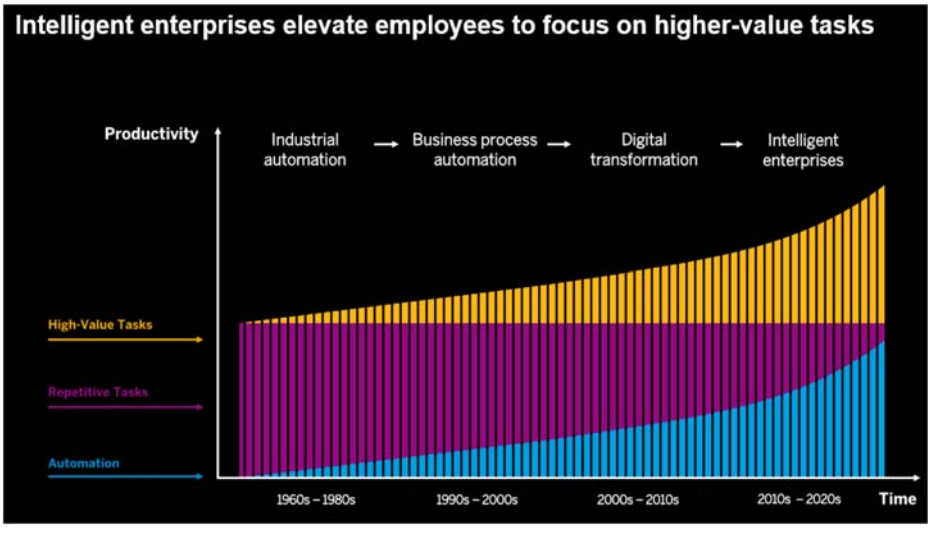

Figure 1. Intelligent enterprises elevate employees to focus on higher-value task (SAP SE, 2018).

education that is highly dependent on aid (Asongu & Tchamyou, 2015; Cai, Zheng, Hu, Pray, & Shao, 2018; Knack, Rogers, & Eubank, 2010), and limited equipment to support the critical skills in demand in the 4IR (Xing, Marwala, & Marwala, 2018). One of the practitioners interviewed offers the following perspective in this regard:

> In South Africa, we refer to ourselves as an industrialized country, but we have still got very many labor problems. Our current unemployment rate is bordering on 30%, and if you look at the youth unemployment it is even worse … If you analyze the availability of people, curriculum, equipment, whatever needed or necessary to do it, it is mostly unavailable … As far as lecturers, teachers, and also equipment is concerned; our resources are dated. If I look at the 50 plus TVET Colleges, only 10% have the latest equipment. As a matter of fact, experience inside the mechatronics laboratories show that academic institutions have got dated training equipment lagging way behind current Industry 4.0 requirements. The colleges are not capacitated, which means that students are graduating out of those institutions with their diplomas or whatever, and they are not adequately exposed to what they will find in the industry.

Further, the wave of automation appears to be affecting the majority of key resources that drive the growth of domestic products in Africa. Africa's operations, supply chain, and the majority of its key economic activities depend on agriculture, forestry, fishing, mining and drilling (oil, gas, minerals), and the built environment (Mkansi, de Villers, & Amadi-Echendu, 2020; World Resource Institute, 2017). An analysis of the leading studies in automation highlights the major impacts in the aforementioned key areas. Kosslyn (2019), PwC (2017), and Millington (2017) rank key aspects of the built environment, such as transportation and construction, as the top three job categories most susceptible to automation. Bughin et al.'s (2017) analysis found agriculture to be one of the key areas of potential job dislocation from automation, with up to 30% of jobs already in decline. Frey and Osborne's (2013) distribution of Bureau of Labor Statistics (BLS) occupational employment ranks farming, fishing, and forestry jobs amongst the top five categories of the probability of computerization.

Although the jobs at risk vary from one African country to another, a generally high percentage of automation occurs, in the range of 60% (Seychelles), 65% (Nigeria), 67% (South Africa), and the highest, 85%, for Ethiopia (Frey & Osborne, 2013; Frey & Osborne, 2017; Millington, 2017; World Bank, 2016).

This paper is more concerned that the challenge extends far beyond the equipment and curriculum, to the lecturers and/or teachers who are expected to be the major repository of knowledge. In designing a 4IR curriculum, the lecturers/ facilitators need access to state-of-the-art technology, and should be able to steer students towards the relevant practices. However:

> In looking at the current demographic of facilitators and lecturers, they are not your tech-savvy people, they are easily disrupted, and mostly their students are better exposed and educated in technology and digitalization. During my travels into Africa, mostly to countries bordering South Africa, like Angola, Mozambique, Zambia, Lesotho, Botswana, and Swaziland, I have experienced similar challenges in the education systems. Further north, in the SADC region, the same situation applies. The difference between South Africa and rest of SADC is that, from the training point of view, 80% of the time South Africa fund their own education and developing programs, whilst the rest is still dependent on foreign aid, funds, grants, etc. So that makes difficult, and it also make the implementation and rollout of projects very long-winded.

This insight paper is also concerned with the resource scarcity in South Africa, namely, that of the people, curriculum, and availability of advanced technologies at various universities, against industry 4IR adoption rate and skills needs. It challenges universities, government, and industries to consider how business and academia can work together towards aligning their 4IR adoption and readiness strategies for mutual benefit.

The Interactions between Universities and the Economy

The effects of automation and 4IR on the labor market involves an understanding of the universities' readiness and capabilities, as well as the economic interactions at play across different geographical contexts (Bughin et al., 2017; Herweijer, Combes, Johnson, & McCargow, 2018; Ndemo & Weiss, 2017; PwC, 2017). Put differently, the needs of the 4IR labor market are highly dependent on the labor diet from universities and training centers. Academic institutions (universities) are, in turn, dependent on the prevailing economic conditions in the country. In this context, academic institutions are the brewing pot of knowledge and skills, and serve as the lifeblood that generates 4IR skills in the country. Hence, the economic conditions of the country serve as fertile ground for the universities' capabilities (i.e., people, curriculum, equipment, and availability of advanced technologies) that are necessary to breed the necessary skills for the country.

Bughin et al. (2017) cement the key role of government in ensuring that countries and universities realize the full potential of automation, such as artificial intelligence (AI) and robotics, as well as investing in e-training, education and retraining. Likewise, an examination of Africa's emerging digital transformation and future shows that the success of digital technologies is highly dependent on the multiplicity of relationships between the economic, political, social, organizational, and cultural landscapes (Ndemo & Weiss, 2017; World Bank, 2016). Herweijer et al. (2018), similarly, discussed the links between 4IR, skills, and economic conditions, and they amplified the importance of 4IR in skills development, and social and economic returns.

Whilst automation is undoubtedly linked to increases in productivity, which has many benefits for economic growth in terms of new products, and faster lead times; the people or skills aspects, if not dealt with, can become an obstacle to progress. Hence, the need to understand the interactions between universities and the economy.

The below quote from the interview with one of the participating directors for IT, enterprise systems, and automation industry provides a practical illustration of the challenge:

> In order to get first-hand experience of the adoption rate of smart factories in South Africa, I went on a tour to visit all smart factories in the country. The perception still is that the digitalization era is still coming, but the train has already left the station. We need to start running. For instance, there is a smart factory in the Eastern Cape province that produce alloy wheels for the automotive industry. In the complete production chain from casting, to the machining, to the spray painting, and packaging, they produce 12 thousand wheels a day, without a single person touching it. But, they are experiencing a problem in that the German machine builder are retracting after six months, leaving the full responsibility of operations and maintenance to the local company. It seems they were trying to leap frog, but proper knowledge and experience transfer did not occur. The business model in the instance is sound because that factory produces only about 10% for local consumption and the rest is for export. With the Rand / Euro exchange rate it is a very lucrative way of

> doing business. The misalignment in this case is that the company did not capacitate the people in time. The high risk for that is that downtime equals loss of production, loss of revenue, and ultimately loss of orders.

In this context, what is so different about 4IR, 3IR, and 2IR that makes this insight paper paramount for African universities and governments? Obviously, disruptions of the workforce or labor market is not a new phenomenon. For example, the Luddite protests in the nineteenth century were against mechanization of the textile industry in Britain (PwC, 2017). Further, there have been several technological advancements, such as fixed-location industrial robots, muscle replacements, such as limbs for athletics and animals, and self-check cashiers (PwC, 2017).

The first major alarming issue that rises to the forefront of the concerns related to automation in 4IR is its ability to replace the human mind and move independently, which, in turn, renders certain human services and job offerings redundant (Carpenter, 2019; PwC, 2017). Carpenter (2019) states that automation is fueled by the ubiquity of data and technology that are combinatorial across the entire spectrum of human activities (i.e., hyperconnectivity, supercomputing, big data, internet of things, blockchain, and open application program interfaces or APIs), which, in turn, disrupt the creation of economic value and, ultimately, new business and working models. In his assessment, the confluence of the latter technologies leads to intelligent automation, the platform revolution, liquid workforce, and the omnichannel customer experience and engagement. For example, powerful graphic processing units (GPUs) (i.e., Nvidia) give rise to autonomous transport and robots; algorithms and AI, such as Siri and those used by telecommunications companies, respond to customers' inquiries, and provide predictive diagnoses and quality in the automotive industry, and so forth.

Lastly, several analyses of the long-term impacts of automation emphasize a wave of capabilities that are expected to substitute a large number of careers, more so, blue-collar jobs, which will leave the majority of people vulnerable to potential job losses (and thus in need of retraining), with the exception of those jobs that demand human interactions, such as housekeepers and hairdressers (Bughin et al., 2017; Millington, 2017; PwC, 2017). Most white-collar jobs, such as top management, managing directors and chief executives, managers, software developers, data analysts and scientist, sales and human resources, are amongst the career paths with projected stability in many industries during the 4IR era. Hence, specialists in AI and machine learning, big data, digital transformations, process automation, and many other key specialists, represent a growth trajectory (Millington, 2017; PwC, 2017; World Economic Forum, 2018).

The latter growth trajectory can be best understood by observing the trends that are set to positively and negatively influence business growth towards 2022, as listed in Figure 2 (World Economic Forum, 2018). As seen in Figure 2, technology, education and economy make up the three trends that have the highest influence on business and the labor market. Hence, older societies (i.e., older position of academia), and government policies (economy) are four and three times more likely to negatively influence business growth, respectively, and ultimately the labor market. Although technology is six times more likely to positively influence business growth (labor market), and economic factors such as national growth, affluence, and the expansion of the middle class are three

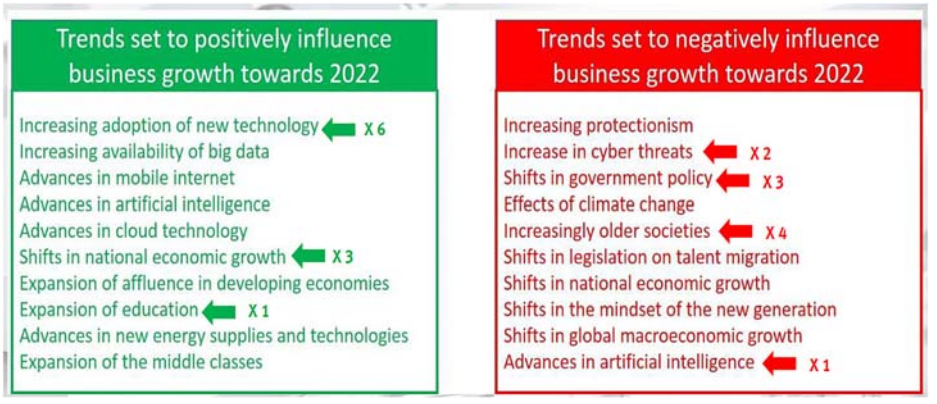

Figure 2. Trends set to positively and negatively influence business growth (World Economic Forum, 2018).

times most likely to exert influence on the business market, the role of education remains undisputed.

An alarming observation for academics should be why educational factors are less represented on the trends set in terms of their influence on business and the labor market. Hence, governments should deliberate on what can be done to align with technology and education in ways that positively, rather than negatively, influence the labor and business market. The latter calls for a need to reflect on the role of academia and government in terms of people, content, and resources, considering 4IR and automation for the future of work.

Whilst the possibility of retraining and reskilling is a mediating factor, the financial burden of retraining is a rather complex matter. It also holds negative connotations for universities that already have limited financial resources, especially for those that are dependent on aid, as well as for industries that face steep competition and governments with ailing economies.

Considering the powerful force of the 4IR globally, how can industry, academia and government co-create a versatile curriculum able to cater for current 4IR demands without compromising future needs? Another question that needs consideration is: How will automation differently affect the developing world and developed world, especially industries and universities' curriculum, equipment, availability of advanced technologies and people between now and the 2030s? The next section attempts to outline a feasible road map.

Future 4IR Perspective: Triple Helix Approach

The reality is that the majority of African countries are trailing the world in terms of 4IR adoption. However, the fortunate perspective on this is that the continent has a window period which allows it to learn and be able to adapt as a result of the failures and successes of developed nations. This is mainly because most developing nations are playing catch-up, while the more developed countries are more susceptible to automation (Bughin et al., 2017; Millington, 2017). The voice of one of the experts in this study similarly notes that:

> The positive is that our industry is still in the 3rd industrial revolution, because the uptake is not being that fast. I can think of about five companies which I have visited that already have the latest stuff. But the rest, I mean thousand, they are still lagging because they cannot invest, they don't have the orders and whatever the case it is, it is a catch 22 situation.

Therefore, this begs the question: Where does the slow adoption or uptake of 4IR by universities and industries place African students in the global arena? This question is especially relevant, since the local market is struggling to offer job opportunities to graduates, and this compels them to compete for jobs in the global market. At worst, almost 375 million people across the globe (14% of the workforce) will likely be subject to transitioning towards new occupations and skill sets (Bughin et al., 2017). Seen in this light, how do universities and graduates with second and third revolution knowledge transition in the current unconducive economies characterized by dated equipment, curriculum, and facilitatory knowledge? In his view, the practitioner thinks that:

> In South Africa we are experiencing a recession and a negative growth rate. It is a challenge because currently around 7% of graduates that eventually go through the whole 12 years school, and then three to five years university actually get into a job. We need to first sort the economy out, making sure that the supply and demand is more balanced. Because the supply is totally over-supplied right now, demand is nowhere. The idea is to grow the economy to the point where it will absorb more, and what is sad is that all the programs that government is attempting, with no real success, cost the tax payer. An example is the YES program for youth employment which creates a tax burden. Individuals, but also companies, are battling to make ends meet. In 2019 on the West Coast at Saldanha, 900 people were laid off, and for 900 people, you will probably find there is at least 6–8 dependents per person, now you can see the knock-on effect. If the economy cannot be turned around, we can produce the best graduates that will either be jobless, or they are going to leave the country.

Curriculum Landscape and Skills to Address the Economic Paradigm Shift

There is absolutely no doubt that STEM skills, namely, science, technology, engineering, and mathematics, should be a priority if Africa hopes to capture value from the global shift to a digital economy. Millington (2017) and Frey et al. (2016) both reiterate the role of education in offsetting the risk and impact of automation on labor and wealth distribution.

The challenge is that the current education system is already grappling to close the gap between theory and practice and has been severely criticized for the lack of correlation between education level and job performance (Chamorro-Premuzic & Frankiewicz, 2019; Schmidt & Hunter, 1998). Chamorro-Premuzic and Frankiewicz (2019) and Gustein and Sviokla (2018) point to intelligent and critical soft skills, such as the ability to learn, reason, and listen, and good communication and logical thinking skills, as a good complement for the changing employment paradigm shift. This is mainly because most employers and the automation era require a higher level of emotional intelligence (EQ), which encompasses resilience, problem-solving, collaboration, empathy and integrity, which are less likely to be automated (Chamorro-Premuzic & Frankiewicz, 2019; RBC, 2019). The above-mentioned EQ skills are reported to be invaluable and are attributes rarely nurtured by universities. Put differently, STEM and EQ skills are critical in the automation era and provide future-proof employability, regardless of changes in the labor market.

Africa will never be able to compete with the likes of the USA, UK, China and India in terms of automation, unless business and education collaborate and succeed together, especially, when it comes to originating and building AI capabilities. However, that does not mean that South Africa and the entire African continent should only become a consumer or adopter of foreign intellectual property (IP) and technology in this area. A good complement to this perspective is provided by Chamorro-Premuzic and Frankiewicz (2019) who emphasize the opportunities that automation presents to universities to close the learning gap, and, simultaneously, to restore their relevance.

The curriculum needs to be repositioned ahead of the revolution, rather than just playing catch-up. The opportunities are available to develop unique capabilities and algorithms in fields such as mining, agriculture and healthcare, to address challenges that are pertinent to South Africa by leveraging data sets that are unique to South Africa and the rest of the continent. However, the required economic paradigm shift is not just related to STEM skills; wherever the country stands with regards to technological determinism, there is no doubt that AI, in its many flavors, will change how work gets done and society operates.

South Africa will also need a cohort of academic leaders who have the savvy and courage to drive the desired change. This means leaders who embody a global outlook, ethics, design, communication and execution capabilities, such as those at the head of UNISA's ambition in driving automation in Africa (the Department of Operations Management and the Department of Mechanical and Industrial Engineering), SAIMC, Africa Automation Fair, and university-industry alliances, such as SAP skills Africa, and the Festo industry 4.0 curriculum. As Amaeshi and Idemudia (2015) indicate, the latter business-society relationship (and/or industry-academic alliances) orientation would be particularly beneficial and have a greater hold in Africa, but only if it is rooted in the values of ubuntu.

This is embodied in the words of one of the leading automation practitioners:

> The National Development Plan (NDP) in South Africa requires the graduation of 30 000 artisans per year by 2030. The current pool of prospective incumbents will not be able to achieve this goal. The only way is to introduce the STEM curriculum in the Basic Education System. Furthermore, a major public awareness campaign is needed to promote technical occupations as a viable option versus the popular accountant, lawyer and admin streams.

South Africa's Readiness in Fast-tracking Skills in Automation

An anemic economy, high unemployment and militant labor movements, lack of skills, lack of scale, and lack of confidence all mitigate against the investments required to build globally competitive automated factories. The low-road scenario is that unless African universities, industries, and governments work together to meet the challenges, the economy will eventually de-industrialize in the face of global competition.

However, there are a few strategies that African universities can embark on to avert this and swim against the tide of the anemic economic, limited AI-skilled human resources, and under-resourced equipment challenges. Firstly, AI and automation leaders, such as SAP and Festo, are taking the lead in skills development in some African countries to create an awareness of the gap related to AI and machine learning skills. Industries' appetite in skills development presents an opportunity for universities to build alliances or dual

offerings for most of the qualification programmes that are most likely to be impacted by automation. This is a view that was endorsed by President Cyril Ramaphosa in his state of the nation address in 2020 (State of the Nation Address, 2020). As stated below by one of the participating IT and automation directors:

> There is a locally developed program in South Africa that addresses AI skills, applications, and strategy formulation. These programs need to be scaled, by once again including such programs in the Basic Education curriculum.

Secondly, there is a need for STEM and EQ skills to be integrated and amplified in the Africa Union Agenda 2063 for coherent, committed and sustained momentum across education, standards and professional bodies (especially engineering), the private sector and government. It is a national effort that up to now has been sorely lacking in coordination and leadership. South Africa trails far behind the other BRICS economies (Brazil, Russia, India, and China) and Europe with their AI ambitions, but there is still a chance for the country to take the lead in Africa. The participating perspective is that:

> In Africa we have unique opportunities to leap frog, i.e., adopt tried and tested technologies and processes. The world sees Africa with its growing young demographic as the next growth area. Africa needs to be prudent in its acceptance of FDI and must change from a consumer to a producer continent. This will start when value is added to natural resources on the continent.

Lastly, the Manufacturing Enterprise Solutions Association (MESA) must take the advisory lead to the Minister of Education in order to help guide the sector in gearing up for automation. Awareness, such as that raised by the African Operations Management Conference, SAP skills Africa, Festo's Industry 4.0, the Africa Automation Fair, the Society for Operations Management in Africa, and education (in terms of the curriculum offered by the Department Operations Management and the Department of Mechanical and Industrial Engineering), are necessary to showcase the art of the possible.

This insight paper presents the triple helix challenge in South Africa of the people, curriculum, equipment, and availability of advanced technologies at various universities, against industries' 4IR adoption rate and skills needs. The paper challenges universities and industries to consider how business and academia can work together towards aligning their 4IR adoption and readiness strategies for mutual benefit.

Conclusion

This paper explores academic institutions' readiness for fostering and producing the high-value skills necessary to address the future of work demands amid limited resources and capabilities. The future of work demands is a challenge posed by the rise in automation and 4IR, which, unlike any previous industrial revolution era, is changing the labor market landscape. In this regard, automation is presenting a "chicken and egg" causality dilemma between academic institutions and the labor market. The latter conception of the dilemma is because the future of work (high-value skills) are hatched by academic institutions, while the academic institutions that lay the high-value graduates and/or skills, in turn, require high-value skills, advanced technologies, and curriculum redesign. Such high-value skills and the technological resources entailed are lacking, and a paradigm

shift is required from academic institutions, government and industry to meet the demands of the future of work.

Therefore, to address and adjust to the changing labor landscape, insight regarding academic institutions' readiness in terms of people, content, and the advanced technologies necessary to redesign the curriculum and produce graduates with high-value skills is required. Hence, this paper, with input from industry experts, offers a reflective form of introspection and critical review of academic institutions' readiness to produce high-value skills (or graduates) in response to industries' future work demands.

A major theme emerging from the insight is that, to avert and swim against the tide of the anemic economic, limited AI-skilled human resources and under-resourced technology, academic institutions must adopt a triple helix approach (an approach where a cohort of academic, industry and government leaders that have the knowledge and courage to drive the desirable change work together). It is through the triple helix approach that the high-value skills, limited capabilities, and resources can be addressed by academic institutions in South Africa (and the entire African continent).

This insight paper and view of future work as a causality dilemma have implications for academic institutions (theory) and industry/ or labor market (practice). In theory, this insight paper re-positions academic institutions and the labor market (future of work) as a causality challenge. The challenge is implied by Chopra-McGowan and Reddy's (2020) attempt to address what will be required to reskill entire industries, and Bughin et al.'s (2017) take on the automation renaissance of jobs. However, they in part, neglected the issue of academic readiness in terms of the people, advanced technologies, and financial resources necessary to feed the future of work.

This insight paper brings the causality challenge center stage, and make more explicit the question of academic institutions' readiness for the 4IR, which might encourage scholars to explore further the causality and implication thereof. In practice, this paper links high-value skills (future of work demands) and academic institutions' readiness (supply) as the two sides of the same coin. The link encourages industry (practice) to view the future of work as a strategic need that requires a partnership with government (policy-makers) and academic institutions (theory).

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