THE RESHAPING OF CURRICULUM TRANSFORMATION TO ADDRESS THE 21ST-CENTURY SKILL SETS AND EMPLOYMENT PROSPECTS DURING THE FOURTH INDUSTRIAL REVOLUTION ERA: A CASE OF THE SOUTH AFRICA TVET COLLEGES

N. Kana*

P. Letaba*
https://orcid.org/0000-0001-5799-6679

*Department of Engineering and Technology Management
University of Pretoria
Pretoria, South Africa

ABSTRACT
This research explores the employability of Technical and Vocational Education and Training (TVET) college graduates in the Fourth Industrial Revolution (4IR) era in South Africa. It examines the role of TVET lecturers in providing skills that are relevant to the contemporary period. The study uses qualitative research inspired by the interpretivist approach, and a purposive sampling strategy to get the perspectives of TVET lecturers and employers. It was observed that TVET lecturers play a minimal role in the development of the curriculum due to a rigid top-down approach from the Ministry of Higher Education. Companies are forming partnerships with TVET colleges by offering places for in-service training, practicals and internships. The study reveals that South African businesses have adopted 4IR-related technologies, requiring a skilled TVET force that is ready for these transformations. The findings highlight the need for regular curriculum transformation and the importance of TVET education in producing artisans, technologists and technicians that are vital for the South African economy on an ongoing basis.
Keywords: TVET colleges, Fourth industrial revolution, employability, curriculum transformation, industry demand-skills

INTRODUCTION

A mix of education, training and skill development pertaining to many vocational domains is what is known as Technical and Vocational Education and Training (TVET) (Field, Van der Westhuizen, and Osman 2017). It also includes formal, informal, and non-formal learning processes that impart knowledge and skills needed for employment (Stumpf and Niebuhr 2012). In South Africa, TVET colleges provide vocational, occupational and artisan education and training (NACI 2021a, 15). TVET college programs prepare students with specific skills for a

productivity-aligned industry job. Thus, in addition to knowledge about a particular issue, TVETs specialise in providing technical know-how, offering practical skills, and teaching attitudes related to a specific occupation (Fantaye and Hawassa 2019). The importance of TVET colleges has been examined in the literature. Okech (2007) argues that TVETs are important for African countries because they help fight unemployment through the provision of pre-employment vocational training, offer the opportunity for academically less gifted students, produce the much-needed technicians in a country, and reduce poverty through the provision of skills that lead to employment. This explains the importance of TVET colleges in Africa in providing skills for socio-economic and technological development (Fantaye and Hawassa 2019).

TVETs prepare students for the present and future needs of the industry and country through the curriculum (Fantaye and Hawassa 2019). Schleiff et al. (2021) define a curriculum as lessons or content taught to students in a specific programme and can be leaner, problem or subject centred. Wedekind and Mutereko (2016) also define curriculum as the medium in which knowledge is translated, selected and transferred between lecturers and students and also represents the educational intentions of an academic institution and the student's lived experience. A curriculum that follows a learner-centred approach focusses on what students need to learn to be successful post-graduation (Schleiff et al. 2021). In other words, TVET colleges must be responsive to the needs of society in providing graduates who are ready to address the needs of society (Ogude, Nel, and Oosthuizen 2005). Wedekind and Mutereko (2016) caution that curriculum responsiveness is a complex interplay involving many factors rather than just an interplay of employer needs and the curriculum. Okech (2007) observe that TVETs imbibe students with relevant skills that make graduates readily suitable for a job. Consequently, the expectation is that in the contemporary period of the fourth industrial revolution, TVETs will produce students who are knowledgeable about technology, digital connectivity and cyber-physical systems (Maisiri, Darwish, and Van Dyk 2019).

This study explores the extent to which TVET institutions in South Africa are preparing students for work in the fourth industrial revolution era (4IR). The 4IR is an industrial era that has embraced the dynamic convergence of big data, augmented reality, robotics, the internet of things, and artificial intelligence (Maisiri et al. 2019). Therefore, students produced by TVETs in the 4IR era must have digital and technological skills such as data security, programming, data protection and cybersecurity (Akyazi et al. 2020). More so, it is more than just developing the technological competency of students; the 4IR also develops the skills that are required for the future (Maisiri et al. 2019). This is because advanced technology and intelligent machines may be unable to apply the reasoning and empathy employees need to increase productivity

(Maisiri et al. 2019).

The study moves from the premise that skills development is the most important determinant for the successful adoption and implementation of the 4IR in South Africa (Sohimi et al. 2019), demonstrating the significance of TVET colleges in preparing graduates towards work. TVETs are relevant to the 4IR ecosystem as they are the mainstay of developing a skilled workforce (Maisiri et al. 2019). This makes it important to research the extent to which TVET colleges are providing skills for the 4IR.

LITERATURE REVIEW

Industrial revolutions have been happening for the past centuries. Social and economic historians use the concept of the industrial revolution (IR) as a ubiquitous term in describing phases of technological shifts with an influence that has greatly affected society (Klingenberg and Antunes Jr. 2017). This section discusses the historical developments of industrial revolutions until the 4IR. It also extensively discusses the concept of 4IR and the skills required in the 4IR.

Given the centrality of TVETs in providing 4IR skills, this section provides an overview of the TVET landscape in South Africa and discusses the centrality of the curriculum in the delivery of skills, values and attributes to students. Lastly, this section also discusses the concept of curriculum transformation since institutions of leaning must be responsive to industry needs.

Transitions in industrial revolutions

In political science, a revolution is a fundamental and relatively sudden change in political power and political organisation which occurs when the population revolts (Bratton and Walle 1994). Before the arrival of the 4IR, previous industrial revolutions changed the global landscape through innovation (Pereira and Romero 2017).

a)   The first industrial revolution

The first revolution started in England in the 18th century, and the most known invention from that era was the steam engine (Pereira and Romero 2017). The first industrial revolution consisted of the transition of workers who moved from the farm to the factory (McGrower 2011). The end of the 18th century presented an opportune time for individuals to earn a skill from basic engineering to ensure they were able to undertake physical labour (World Bank 2011). This 1IR was replaced by electricity as a form of energy that displaced steam and water to usher in the second industrial revolution.

b)   The second industrial revolution

The second industrial revolution took place approximately a century after the first. A key driver of this revolution was the invention of electricity. The 2IR was characterised by mass production and replacement of steam with electric and chemical energy (Pereira and Romero 2017). Another major invention was electric motors, which led to assembly lines and mass production.

c)   The third industrial revolution

The third industrial revolution started in the second half of the twentieth century. Igniting this revolution was the advancement in the semiconductor industry (Pereira and Romero 2017). The invention of transistors made it possible to digitise and store information easily. This revolution also saw the advent of computers leading to the automation of industries, thus increasing production and efficiency.

Another important invention of the third industrial revolution was the Internet, which resulted in worldwide virtual connection. Pereira and Romero (2017) argue that the first three revolutions contributed to enormous societal changes and increased productivity and efficiency by introducing disruptive technology, be it electricity, the steam engine, microchips or automation.

d)   The Fourth Industrial Revolution

Germany was the first country to introduce "Industrie 4.0", an initiative which has now become an umbrella term to explain advances in the current era of technology, such as big data, artificial intelligence, and machine learning (Hofmann and Rüsch 2017; Vilalta-Perdomo et al. 2022). 4IR has brought production innovations, jobs, and disruptive developments to society (Pereira and Romero 2017). As such, the availability and quality of skills needed in this era is necessary for businesses and countries to gain competitiveness (Maisiri et al. 2019). South Africa is presented with the opportunity to use 4IR to create quality and skilled employment, with higher salaries (Maisiri et al. 2019).

Skills required for the Industry 4.0

The 4IR has far-reaching impacts and consequences in terms of skills and competencies required from a skilled worker or a graduate in general (Mustakin et al. 2021). The World Bank (2014) defines skills as a set of cognitive abilities in a person that include behaviour, attitude and knowledge. The OECD (2018) defines competency as something beyond knowledge acquisition but having attitudes and values that meet complex demands. This means that TVET

colleges must more than just produce graduates who are knowledgeable about engineering but who have attitudes and understanding related to their specific occupation as well as broader sectors of economic and social life (Mustakin et al. 2021).

The demands for a highly skilled workforce in the 4IR compel institutions of learning to teach and familiarise their students with 4IR innovations (Vilalta-Perdomo et al. 2022). The focus is on the ability of people to use digital skills, technologies and knowledge (Oliveira and De Sousa 2022). Therefore, during the 4IR, students must learn affectively, socially, aesthetically, ethically, and culturally from experience (Vilalta-Perdomo et al. 2022). Literature recognises that the 4IR is not just technical and digital know-how, but the emphasis is also made on issues like emotional intelligence leadership, entrepreneurship, and communication, entrepreneurship amongst others (Maisiri et al. 2019). Sometimes 4IR skills are also considered 21st-century skills. Joynes, Rossingla and Amono-Kuofi (2019, 9) define 21st skills as consisting of:

> "creativity, divergent thinking, critical thinking, team working (especially in heterogeneous groups), work autonomy, developed cognitive and interpersonal skills, social and civic competences, responsible national and global citizenship, consciousness of interdependence, acceptance and understanding of diversity, recognition and development of personal attributes, interactive use of tools, communication in mother tongue and foreign languages, mathematical and science competence, digital competence, sense of initiative and entrepreneurship, accountability, leadership, cultural awareness and expression, physical well-being."

Employers have of late been placing emphasis on soft skills for the rapidly changing environment (World Bank 2014). Ogude, Nel, and Oosthuizen (2005) posit that the focus should be on disciplinary practices and the epistemic needs of students. Vilalta-Perdomo et al. (2022) also argue that even if students learn through technology and competency-based learning, it will still be insufficient to achieve the effect expected from education. It is argued that soft skills enable professionals to make decisions in contexts of uncertainty and volatility as robots and artificial intelligence, while useful, is not substitutes for making complex decisions. Joynes et al. (2019, 13) define soft skills as: "a broad set of skills, behaviours, and personal qualities that enable people to effectively navigate their environment, relate well with others, perform well, and achieve their goals."

Additionally, emphasis on skills in the 4IR includes knowledge of climate change. Oliveira and de Souza (2022) argue that 4IR skills from students must include knowledge of global warming, degradation of the environment, and as well as depletion of natural resources. OECD (2018) notes that the 4IR workforce should look beyond just getting a high-paying job and have the knowledge and care of the environment and the planet. This will prepare students

to meet any social challenge and prepare for greener jobs that eradicate poverty (Oliveira and de Sousa 2022).

The onset of 4IR has driven the birth of Education 4.0. Education 4.0 is a pedagogical approach that aligns with the 4IR. It answers the demands of the 4IR (Costan et al. 2021), in which the convergence of science and technology is utilised in augmenting manual processes for improved effectiveness and efficiency. Education 4.0 recently captured the attention of policymakers, driven by the onset of 4IR. According to Fisk (2017), a new vision of learning encourages learners to learn skills through data-driven customisation. The Word Economic Forum (2022) labels Education 4.0 as catalysing and redefining education for quality learning in the new economy. Education 4.0 also speaks to the shift in focus from knowledge to skills and is expressed in discussion and advocacy around a concept often called 21st-century skills.

TVETs colleges overview

In South Africa, TVET is located within the skills development discourse of the formal education and training system. It is a post-school education and training activity between general schooling and higher education, which includes universities and universities of technology. As a component of lifelong learning in the post-school education and training system, TVET traverses secondary, postsecondary and higher education in South Africa. Critically, it incorporates work-based learning and continuing training and professional development.

a)   Transformation of TVET colleges in the 4IR

The TVET system is part of the Department of Higher Education, Science and Innovation (DHESI) and the Skills Development Branch is responsible for monitoring and promoting the national skills development plan. It serves as an interface between the world of work, public and private workplaces and learning institutions, ensuring that skills development aligns with the broader needs of the economy. TVET is a combination of education, training, and skill development for a variety of professions, encompassing formal, non-formal and informal learning methods. The proliferation of curricular innovation in the first three industrial revolutions provides evidence of the need for transformational education curricula in the 4IR epoch (DHET 2019; DHET 2020; Mustakim et al. 2021; Lester 2015).

b)   TVET colleges' role in employability and industry alignment

Stats SA (2021) reports that the South African unemployment rate is at a record high of 34.9 per cent. This has a huge impact on the economically active population, particularly those aged

15–35. Field, Musset and Álvarez-Galván (2014) state that TVET colleges are intended to provide skilled artisans and mitigate skills shortages, however, Mabunda and Flick (2020) argue that the lack of employability skills in TVET colleges adds to the unemployment problem. Yorke (2006) defines employability as a set of achievements which make individuals more likely to secure employment, and Mabunda and Flick (2020) suggest that a holistic view of the factors that influence TVET graduates' job prospects should be adopted to improve their employability.

c)   TVET colleges' position in the national system of innovation

Freeman (1987) describes the national system of innovation (NSI) as the network of public and private-sector institutions whose activities and interactions initiate, import, modify and diffuse new technologies. Several definitions of NSI exist in literature since it was coined in 1987 in an explorative study by Freeman. This approach is called the Triple Helix approach. The interaction of learning institutions, industry and government generates an innovation system that produces the key new sources of novelty and dynamics of the interaction (Cvetković, Joksimović, and Tomić 2017).

Niosi (2002) elaborates that the interrelated institutions have links and consist of flows. Those links are knowledge, financial, human (where people are bearers of tacit knowledge and subject matter experts), regulatory and commercial. These organisations interact with one another directly and indirectly. NACI (2020) states within the academic institutions that make up the triple helix of the NSI, there are TVET colleges. Possibly, the NSI has the ability to recognise TVET outputs.

The South African Policy front on National Qualifications Framework for the 4IR

The South African Qualifications Authority (SAQA) was established to tackle the ill-informed systems of discrimination in the 1970s (SAQA 2022). The Manpower Training Act of 1982 and the Job Reservation Act of 1957 had been designed to exclude Africans from apprenticeship training and to protect jobs from interracial competition (NACI 2021b). As the custodian of the National Qualifications Framework (NQF), SAQA is responsible for its development and implementation, with the overarching vision of having a world-class National qualifications framework that works for the people in South Africa (SAQA Bulletin 2021).

To achieve this, SAQA works closely with other NQF entities such as the DHET, the Department of Basic Education (DBE), and the three Quality Councils (CHE, QCTO, and Umalusi). Research is being conducted to deepen and enrich SAQA's understanding of the 4IR

and its implications in the education and training sector (Tyatya 2019). The introduction of 4IR qualifications and part-qualifications for lifelong learning must be relevant and flexible to the changing needs of the 4IR. In the TVET sector, Tyatya (2019) found that many of the jobs for which TVET students are being prepared will no longer exist in 50 years, and that none of the existing public TVET colleges offer courses related to AI and robotics. He highlights the need for TVET lecturers and students to be prepared for the 4IR through re-skilling accredited programmes.

Curriculum transformation

Research by Mendy and Madiope (2020) involves curriculum makeovers that include technological change, a practical education reacting to unemployment, student support, and the implementation of African pedagogies in line with equivalent changes in the politics of language, history and student participation. These changes must be consistent with the student and educator development.

According to the NACI (2021a) study, there exists a knowledge gap resulting in the need to explore possible strategies for leading changes faced by TVET colleges, focusing on sustainable curriculum change. The outcome of the study was to develop a framework for leading curriculum change in the South African TVET college sector.

PROPOSED CONCEPTUAL FRAMEWORK

Literature review shows the impact of industrial revolutions on the development of education, the workplace and society. It is proposed that the emergence of new capabilities resulting from these revolutions require educational institutions to provide graduates with employability skills, and the creation of innovation pathways to meet industry demands. A conceptual framework is presented based on the literature reviewed which provides two components, namely: the employability skills and curriculum transformation, to build the study's propositions. The importance of this conceptual framework is that it provides a pivot for this research, enabling new skills to be developed in order to adapt to and benefit from the transitions in the industrial sector.

Research propositions

This exploratory study utilises research propositions to capture a more pragmatic approach, as the study is not based on existing models and may therefore provide more meaningful results. Wedekind and Mutereko (2016) state that for vocational or occupational programmes to be effective, they need to remain responsive to issues, such as the needs of employers, shifts in

technology, and the needs of the students and society. Consequently, in the window of opportunity of 4IR, a curriculum that is not responsive to the changes in the macro business environment and the needs of students, becomes obsolete and irrelevant, and therefore the students enrolled in the programme are not deemed to be employable. Literature review entails that Education 4.0 emerges in 4IR and comprises a combination of skill sets and technical and attribute skills.

In order to successfully compete for employment, employability skills are important in the 21st century as they sustain jobs and employment in the industrial global market (Ismail et al. 2021). In order to measure the success of TVET colleges, the graduates must be employed with sustainable jobs and sought-after practical skills. The literature review has defined employability skills as a set of skills and attributes that sustain an individual in their careers and employment through applied knowledge.

The concept of the study is to ascribe 4IR education skills as a means to employability skills required by industry. Holistic efforts to transform the curriculum in TVET colleges enhance the employability of the graduates in the industry. Based on the above, the following propositions were formulated:

P1:   4IR education-inclined curriculum enhances employability skills
P2:   Employable skills are expected outcomes in the transition of TVET colleges in the 4IR
P3:   Industry input in curriculum development and pivoting in TVET colleges enhance student success post-college.

High-level summary of the conceptual framework

The 4IR era will demand a workforce that can develop applications and can interpret its impact on society. The three propositions illustrate how TVET colleges can begin to transform their curriculum to bring relevance and alignment in the fourth industrious era (see Figure 1). A reimagined curriculum will bolster chances of employment. Industry involvement is crucial for the development of the curriculum.

RESEARCH APPROACH

This study adopted an exploratory design which is most appropriate when little information is available on the topic (Van Wyk 2020). It adopted a purposive sampling strategy, and the sample population involved TVET lecturers and employers. From the lecturers, the research was interested in getting their contribution as teachers in preparing students for the 4IR. From
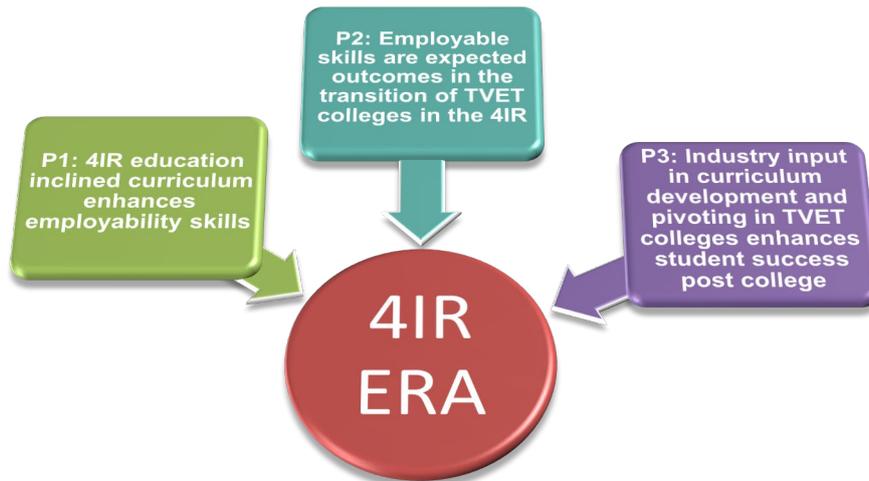
Figure 1: Conceptual framework showcasing the centrality relationship of the propositions

the employers, the researcher was interested in getting their perceptions on the employability of TVET college graduates in the 4IR era. The researcher interviewed six lecturers from four TVET colleges from the Free State, Gauteng, Mpumalanga and Limpopo.

The assumption was that the lecturers are the ones who teach students the technical competencies required in the industry, and they have knowledge of how to prepare their curriculum in line with industry demands. On the employers' part, the research sought companies that were likely to employ engineering students. This study adopted interviews as the primary data collection technique, supplemented by documentary analysis of secondary literature. The data analysis of this qualitative study uses a thematic analysis style. In the results section showcases the major themes identified and unique topics extrapolated were analysed.

RESULTS

This section examines the roles of TVET colleges in 4IR. It assesses the challenges and opportunities TVET colleges face in responding to the needs of industry and employers, including the need for them to develop institutional autonomy and academic freedom in order to design curricula that are responsive to the needs of the labour market. Additionally, the study looks at how employers perceive the readiness of TVET graduates to join the workforce, as well as the challenges they face in adapting to the 4IR.

Top-down approach to curriculum development

This text examines the lack of autonomy and agency at TVET colleges. It is revealed that the Department of Higher Education (DHE) has control over the design of the curriculum and

lecturers have limited influence. The ministry is responsible for curriculum development, leaving the colleges with limited power over their own curriculum. One of the lecturers lamented the centralisation of many things in DHE for example TVET colleges not employing own capacity program developers. In some cases, professors from universities design curricula. The lecturer further notes that sometimes policy development lacks implementation support.

Furthermore, in the interview, the lecturer discusses the contradiction in the TVET landscape between structural constraints and agency, and autonomy versus affordability of programs. The argument is that the lecturers are seen as novices who learn from what is prescribed by DHET and its partners, leading to them being side-lined in curriculum development and deprived of their creativity. Williams (2021) argues that TVET lecturers' knowledge and expertise should be recognized, as they are highly educated with experience working with students. However, there is limited room for instructors to manoeuvre away from this quagmire due to funding constraints, and other role players are involved in the curriculum's development.

The participants were asked if TVET colleges offer opportunities for staff development, to stay up to date with current trends in technology and industry. One of the respondents said: "At our college we are trying to establish robotics as a program which has been initiated by the department and our lecturers going through the induction and everything".

DHESI has been identified as playing a central role in the curriculum dynamics of TVET colleges. It is responsible for setting strategic agendas, reviewing curricula, providing funding, and making decisions about which curricula to teach, and who should be appointed to senior positions. DHESI is also the custodian of the curriculum, and has the final say in the syllabi, assessment guidelines, and instruction documents.

Fragmented stakeholder engagements

The lecturers are not just limited in terms of developing the curriculum as explained above but also in some stakeholder engagements.

One of the participants expressed the predicament of lecturers in TVET colleges, who are marginalised and neglected in important meetings, yet still maintain some importance as they are allowed to hold stakeholder meetings. Hoag (2014) calls this oscillation between abandonment and near care "dereliction". The lecturers are considered experts by their students but revert to naivety when they are overlooked for important meetings. Nevertheless, their stakeholder meetings are crucial for linking students with potential employers and looking for partnerships for in-service training and internships. These partnerships are necessary for the students to gain employment in a country with high unemployment, where university graduates

are often favoured.

Lack of funding

Let's consider the following interview excerpt.

> "Our staff is exposed overseas for example to Aviation Advancements in Singapore. The memorandum has been signed. There are these partnerships with European developed countries. Our staff are exposed to these beautiful developments and when they come back, there is frustration of wanting to implement. And to implement these things require not very cheap resources. Without resources like money there is nothing we can do. The problem is some agencies have hundred million to expose us so that we implement curriculum changes. But without money it is just exposure."

This interview excerpt highlights how limited funding can prevent the staff from incorporating this knowledge into their curriculum. This reveals a kind of liminality, where the staff can experience an expansive view from exposure to advanced economies and institutions, but are held back by the lack of resources.

Resistance to change

Given the dynamics explained above, what impact do they have on the adoption of 4IR-related approaches to learning?

In response, one of the lectures bemouned the difficulties of adapting to change in learning institutions, particularly in regards to the use of technology. It is suggested that education must update its methods to keep up with the rapid developments of the Fourth Industrial Revolution, such as those seen in movies. It is noted that this transition has been made easier since 2020 due to the global pandemic and the resulting lockdowns, which have necessitated the shift to online and blended learning.

Impact of coronavirus on the TVET colleges

The pandemic acted as a catalyst for change even to institutions with management that were obdurate to change. Another lecturer brought further insight into how the pandemic significantly impacted changing learning and strategies at TVET colleges.

The participant stressed the need for educational institutions to be prepared for disasters and anticipate the need to keep up with technology as the 4IR progresses. The lecturer emphasised the importance of digital literacy, cybersecurity awareness, smart online platforms, and strong network infrastructure with regular maintenance as necessary competencies for TVET colleges in the 4IR.

Similarly, another lecturer echoed the need for reliable infrastructure in order for the 4IR

to be adopted effectively. In South Africa, electricity is seen as the key to successful 4IR implementation due to its necessity for ICT infrastructure and data sharing. However, prolonged load-shedding has put the adoption of 4IR under strain due to a lack of energy security.

Industry understanding of 4IR

The previous sub-section went to a greater extent in explaining the coronavirus pandemic as a catalyst for a shift in online learning. In understanding 4IR, some firms understood 4IR as consisting of online meetings and consultations. Company A manager said that:

> "... our company has adopted the standard methods of using 4IR technology such as conducting meetings and hosting webinars virtually. We also have a system in our auditorium that allows for a dual interface between the audience and someone presenting virtually. This also included incorporating 4IR in its programme offering by utilising digital platforms to run workshops. We are introducing learners to coding and robotic using the latest technology. The building is accessed by staff through biometrics and the Centre also upgraded its infrastructure by introducing digitised exhibits, which also include virtual reality."

This organisation is in line with the features of the 4IR described in literature, such as virtual reality, robotics, coding and massive digital technologies, and offers Science Technology Engineering and Mathematics (STEM) exhibitions in energy, automotive, light and optics, and games. Additionally, it provides laboratory space for students to learn physics, chemistry and life sciences. A similar company offers comparable features in line with the 4IR literature. The program manager of Company B noted that 4IR technologies adopted by the company to improve business processes include installing vehicle trackers, counters on printers as well as automation of financial and operating systems.

This study confirms that South African businesses possess the capability to leverage sensor technology, data analytics, Internet of Things (IOT), predictive analytics, virtual reality, and 3D printing to automate logistics, track objects, predict maintenance, and rapidly prototype products (Lorenz, Tessarin, and Morceiro, 2021). Moore (2016, np) also notes that:

> "Large-scale integration of machine-to-machine communication (M2M), Smart technologies, and the Internet of Things, drastically increased the automation of industries through improved communication and self-monitoring, and Smart machines that can analyse and diagnose issues without the need for human intervention."

Other companies go beyond the above in employing drone technology, big data analysis, internet of things devices, and human interfaces of level 4IR technologies such as mobile devices. Company D, which focuses on waste management company reckoned that:

"Yes, we do our waste resource mapping and our data collections and data analysis on an IT level. We're not at the level that we should be, but we'll be implementing many other solutions to have a more data driven business."

The findings from the interview reveal that South African companies have largely embraced the 4IR, and as such, TVET students must be equipped to work in the digital and technology landscape. This includes having skills such as problem-solving, creativity, communication, digital literacy, collaboration and critical thinking. The 4IR is seen as a period where smart, connected and converged cyber, physical and biological systems and smart business models are being used to shape the social, economic and political spheres.

Some companies noted basic computer skills, big data analytics and drone technology, while others, like company D, require:

"A progressive human being is all that's needed to work in company, high learning index is needed due to technology improvements that are constant, trained technicians as long as they can integrate themselves to machine and software-based environment."

The above interview excerpt emphasises the evolvement of technology and that technicians ought to have a high learning index as continuous learning is the modus operandi of working in the 4IR. Additionally, digital literacy in the 4IR is beyond right or wrong, but it is a process of becoming more digitally and technologically literate (Teis and Els 2021). Thus, a person must be willing to undergo lifelong learning as a result of changes brought about by changes in the use and deployment of technology. Similarly, companies E, F, G, H and I, echoed the same sentiments.

It is important to note that DHET had partnered with CISCO, a United States of America based corporation, to enhance 4IR skills. The cabinet executive for DHET explained this partnership:

"CISCO is developing a digital skills training, which has been integrated into the National Certificate (Vocational) [NCV] programme. The new programme stream focuses on Robotics in the NCV: Information Technology and Computer Science programme, which previously focused on programming and systems development only. This stream will cover subjects such as Electronic and Digital concepts for Robotics, Robotics Fundamentals, and Industrial Automation. The curriculum for this programme is currently being quality assured by Umalusi and is envisaged for implementation in 2022." (Teis and Els 2021).

Disciplines such as Electrical Engineering, Mechanical Engineering, Civil Engineering and Electronics Engineering are being prioritised and reconstructed to be in line with 4IR (Teis and Els 2021). In addition, Siemens AG and Council for Scientific and Industrial Research (CSIR)

signed an MOU to provide TVET colleges with critical technical and digital skills to contribute to the employability of students and enhancement of the quality of job profiles (IT Web 2021).

Employability of TVET college graduates

Wedekind and Mutereko (2016) conducted a study on employability of TVET graduates. They found that employability is largely determined by educational outcomes that are responsive to the needs of the industry. Additionally, they observed that TVET graduates were not ready to be absorbed by some companies due to a wide gap between the skills acquired in TVET institutions and the skills required to be competent in the enterprise (Teis and Els 2021). This suggests that the checklist of attributes and skills needed from TVET graduates is sometimes incongruent with each other.

However, company C for example, noted that TVET graduates, have to be trained for a certain period before they are ready for employment.

The technical supervisor for Company E also noted that their company is always looking for opportunities to partner with TVET college. Partnerships can be defined as linkages, collaborations and networking between TVET colleges and industry (Williams 2021). Wedekind and Mutereko (2016) argue that partnerships between industry and TVET colleges are crucial for determining curriculum collaboration ad linking staff and students to their workplaces. In 2021, Nzimande, who is the minister responsible for the TVET colleges, appealed to the industry to:

> "... to rally resources together ... [to] invest in the development of engineering infrastructure at learning institutions (TVETs) and provide good experiential learning opportunities for students who will be pursuing their engineering qualification".

The supervisor of company E highlighted that the company works with various institutions of learning to identify technology-oriented graduates and providing internships. This was also echoed by the manager of Company D, who said that:

> "Our company has a particular strategy targeted at working primarily with TVET colleges to bring innovation in their communities where they are situated, so that they can benefit from advancements registered in the mobile devices industry over time."

For company C, the technical supervisor noted that they were starting to have partnerships with colleges starting in the 2022 financial year. He said:

> "I'm having a meeting this week with one of the colleges that, we can actually integrate with them in terms of getting young people to come and do practicals and all of that stuff at our company."

Company F noted the same sentiments, underlining that the company participates in career guidance expositions in communities in partnership with other stakeholders, to showcase opportunities available in the mobile devices industry in this 4IR era. Additionally, the company establishes partnerships with institutions of higher learnings (e.g., TVETs and universities) to increase access to information to communities as well as connecting learners to available opportunities.

The above interviews demonstrate the existence of partnerships between TVETs and employers and also signal the growing recognition of TVETs as a source of interns and a skilled workforce.

CONCLUSIONS

The study revealed that TVET college lecturers in South Africa play a minimal role in the development of the curriculum because of the rigid top-down approach from the responsible Ministry of Higher Education, Science and Innovation. The top-down approach has a tendency to take much longer, hence it is not responsive. The lecturers bemoaned their omission in developing the curriculum as they were overlooked in favour of industry and other consultants from the industry, which the researchers called pedagogical liminality. The lecturers bemoaned that despite their experience and exposure to professional development overseas, they are not able to transfer their knowledge to students that they teach because of the rigid requirements and prescription of syllabus from the DHET, which the researchers called ontological liminality. The lecturers also highlighted the slow adoption of blended learning from the senior management, who were resistant to change despite the push from younger staff members exposed to Disney-like developments. The lectures also highlighted how the pandemic exposed TVET colleges as they were not ready for the massive disruption that came in 2020. Overall, the lecturers are well aware of 4IR requirements but are also concerned about the availability of infrastructure, network, reliable electricity supply, cybersecurity systems, as well as the training of older staff to become digital natives.

Findings from the industry indicated that South African companies have, to a larger extent, adopted 4IR-related technologies such as IoTs, 3D printing, cloud computing, and big data, amongst others. This necessitates a skilled TVET force that is ready for these kinds of transformations. While some employers think that the TVET graduates are not ready to be absorbed, many companies are forming partnerships with TVET colleges by offering places for in-service training and doing practicals and internships. The discussion of literature also demonstrated that DHET had made partnerships with CISCO to offer 4IR certifications to

TVET students. More so, CSIR, in partnership with Siemens AG, will also provide TVET colleges with critical technical and digital skills to contribute to the employability of students and enhance the quality of their job profiles. However, a big concern is that the big private sector companies and state-owned companies that must absorb TVET graduates have got their own training academies, such as the Denel Technical Academy, Ford Resource and Engagement Centre, Mercedes-Benz SA Learning Academy, Monyetla Work Readiness Programme and the Nuclear Skills Development Centre at the Nuclear Energy Corporation of South Africa (Necsa 2021).

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