Sustainability in Industry 4.0 Business Practice: Insights From a Multinational Technology Company

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Industry 4.0 (I4.0) needs new business practices, which focus on its positive impacts and sustainability. This article presents original empirical research from a multinational engineering company operating in South Africa and the challenges that area managers experience in this organization. It explores the meaning and meaning-making in times of organizational change and transformation within the South African business context. The authors present findings which present the 4IR and sustainability issues in the company and themes which are identified, such as speed, effectivity, and Broad-Based Black Economic Empowerment (BBBEE). However, findings also indicate that emotions and the human touch are key in technologising work environments. The study further denotes that sustainable business practice requires the constant development of skills and knowledge of employees, as well as the systemic integration of the ecological environment and the care for the eco-system.

Keywords: sustainability, environment, water management, future trends, fourth industrial revolution, business practice

INTRODUCTION

Industry 4.0, which is at the core of the fourth industrial revolution, is a digital transformation that is intensifying exponentially. People's lives are being fundamentally reshaped by the digital revolution, and they remain optimistic about the opportunities I4.0 may offer for sustainability (Birkel and Müller, 2021). Organizations are becoming increasingly interested in I4.0 applications for achieving sustainability. As evidenced by literature, organizations can excel in the long run by adopting I4.0 technologies (Margherita and Braccini, 2020).

This article focuses on the positive impacts of I4.0 on business practice with regard to sustainability. It discusses the changes experienced and conducted in the I4.0 workplaces and draws on relevant literature on I4.0 and sustainable business practice. Islam et al. (2022) emphasize that the I4.0 and Sustainable Development Goals (SDGs) are concurrent. Both issues affect countries around the world equally and are interconnected in many different ways. Taking into account the positives of I4.0, they determined that it is an important means of achieving SDGs. The authors present original empirical research from a multinational engineering company striving for sustainable business practice in the context of global, contemporary and future-orientated engineering and water management (Oztemel and Gursev, 2020). The guiding research question that is being responded to in this article is: *What are sustainable business practices in a I4.0 business context in South Africa?*

The study primarily shows which innovative technologies are used to support sustainable business practices and how employees are striving to use the rapid I4.0 changes to increase sustainability through human-technology interaction (Bocken et al., 2014; Chen et al., 2018; Lou, 2018; Ally and Wark, 2019; Hughes et al., 2019; Jia et al., 2019). It further shows how employees see the I4.0 business practices as a constructive and productive way of upgrading skills of the employees toward a broader and deeper understanding of the complex organizational and technological processes.

I4.0 represents a new stage in the organization and control of the industrial value chain. Cyber-physical systems form the basis of I4.0 (for example "smart machines"). They use modern control systems, have embedded software systems and dispose of an internet address to connect and be addressed via the Internet of Things (IoT). In this way, products and means of production get networked and can "communicate," enabling new ways of production, value creation, and real-time optimization. Cyber-physical systems create the capabilities needed for smart factories. These are the same capabilities we know from the Industrial Internet of Things (IIoT), such as remote monitoring or track and trace (Barkai, 2019).

I4.0 has been defined as "a name for the current trend of automation and data exchange in manufacturing technologies, including cyber-physical systems, the IoT, cloud computing and cognitive computing and creating the smart factory" (McClure, 2018). I4.0 is a vision that evolved from an initiative to make the German manufacturing industry more competitive ("Industrie 4.0") to a globally adopted term (i-SCOOP, 2017). I4.0 is the information-intensive transformation of manufacturing (and related industries) in a connected environment of data, people, processes, services, systems, and IoT-enabled industrial assets with the generation, leverage, and utilization of actionable data and information as a way and means to realize smart industry and ecosystems of industrial innovation and collaboration. Thus, I4.0 is a broad vision with clear frameworks and reference architectures, mainly characterized by the bridging of physical industrial assets and digital technologies in so-called cyber-physical systems. A key role is indeed played by the IoT, within the scope of I4.0 IIoT with its many IoT stack components, from IoT platforms to IIoT gateways, devices and much more (Barkai, 2019).

Yet, it is not just IoT, cloud computing (and cloud platforms), big data (advanced data analytics, data lakes, edge intelligence) with (related) artificial intelligence (AI), data analysis, storage and compute power at the edge of networks (edge computing), mobile, data communication/network technologies, changes on the level of, among others, manufacturing execution systems, enterprise resource planning (ERP, becoming i-ERP), programmable logic controllers, sensors and actuators, transducers and innovative data exchange models all play a key role (i-SCOOP, 2017). Additionally, the same technologies, such as Robotic Process Automation, AI (AI engines, machine learning), the meeting of both and so forth that pop up close to all software areas such as enterprise information management, business process management and applications in the sourcing market, are of course showing up in IoT-enabled industrial/manufacturing applications and IoT manufacturing platforms as well (Barkai, 2019).

MEANING-MAKING IN INDUSTRY 4.0 THROUGH SUSTAINABILITY

The literature on industrial processes contains trending concepts such as I4.0 and sustainability. I4.0 has been primarily discussed in the literature from a technological standpoint, neglecting to address sustainability challenges (Ejsmont et al., 2020). Beltrami et al. (2021) emphasize the similarities between I4.0 and sustainability, in particular the effect I4.0 technologies have on sustainability practices and outcomes. I4.0 and sustainability are important concerns for organizations and for the society. The influence of I4.0 should be considered in the context of the three main pillars of sustainability—economic, environmental, and social—for industrial organizations. I4.0 (Drath and Horch, 2014; Shrouf et al., 2014; Erol et al., 2016; Lu, 2017), is starting to revolutionize communities requiring a significant upgrade not just in terms of technology. With the advent of exponential technology and high speed and big data processing capabilities, high levels of digitalisation regarding all kind of processes in companies are also required (Varela et al., 2019). These processes have to become supported by appropriate infrastructures, such as (1) Internet of Things (IoT), which is the connectivity of physical objects such as vehicles, devices, buildings, and electronics, and the networks that allow them to interact, collect and exchange data; (2) Industrial IoT (IIoT) that enables machinery and equipment to transmit real-time information to an application, allowing operators to better understand equipment efficiency and identify preventative maintenance needs; (3) Radio Frequency Identification (RFID), which refers to the use of strong radio waves to "excite" enough current in a small tag to send a radio transmission back. It works over a short range, and only for small amounts of data (RFID tags can be used to detect and record such as temperature, movement, radiation levels, and thus can be very useful in asset monitoring and supply chain management); and (4) cloud computing, which refers to storing and accessing data and programs over the internet instead of the computer's hard drive (Hozdic, 2015; Schlechtendahl et al., 2015; Gilchrist, 2016). Additive manufacturing (Kang et al., 2016) and collaborative robots (Iqbal and Riek, 2019), for instance, are expected to play a crucial role in this direction, but also suitable organizational structures and business models. Together with appropriate production and decision methods and supporting tools these will be necessary to enable a successful ingress on I4.0. Moreover, according to Thoben et al. (2017), the principles of I4.0 are the horizontal and vertical integration of production systems driven by real-time data interchange and flexible manufacturing to enable customized production (Varela et al., 2019). Such data play a crucial role for enabling different kinds of decision making, for instance regarding the prioritization of production orders and tasks optimisation, along with other needs, such as maintenance related to each one's requirements (Lee et al., 2014).

The concept of sustainability has received increasing global attention from the public, academic, and business sectors

(Mhlanga, 2022). The World Commission on Environment Development (World Commissionon Environmentand Development, 1987) defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Putnik and Ávila (2016) reinforce the importance of the theme and even give the character of ubiquity in the word "sustainability." Nidumolu et al. (2009) explained why sustainability is the key driver of innovation, according with their study of sustainability initiatives of 30 large corporations. Almeida et al. (2016) stated that it is common to ignore the interdependence of the sustainability pillars for short periods of time, but history has shown that before long, mankind is reminded of it through some types of alarms or crisis (Varela et al., 2019).

Birkel and Müller (2021) postulate that I4.0 has been studied from the perspectives of supply chain management and triple bottom line sustainability, but neither of these perspectives has yet been adequately combined. Among the areas outlined are the role of small and medium-sized enterprises (SMEs) within I4.0, emerging economies, multi-tier supply chain management, information sharing across the supply chain, and the interaction of ecological and social perspectives with economic benefits, demonstrated in new business models.

Companies that have adopted I4.0 to improve their results also want to be seen as socially responsible. Sustainability is considered the new I4.0 frontier (Martínez-Jurado and Moyano-Fuentes, 2014). Productivity and cost-saving are necessary for the economic survival of organizations. However, these tasks should be achieved in a sustainable way, by mitigating negative environmental and social impacts and contributing to a sustainable society. According to Jabbour et al. (2013), support for environmental management tends to be greater when companies adopt I4.0 practices, which would improve their environmental performance (Jabbour et al., 2012; De Sousa Jabbour et al., 2018). Also, Ng et al. (2015) indicate that I4.0 reduce environmental impact and increase environmental benefits. According to Yang et al. (2011), who explored the relationship between I4.0 practices, environmental management, and business performance, the results of their research propose that lean manufacturing experiences are positively related to environmental management practices. In spite of that, some authors refer to the positive influences of I4.0 in terms of sustainability, in collaboration and good environmental practice (Varela et al., 2019).

Ghobakhloo (2020) found that I4.0 sustainability functions exhibit sophisticated relationships based on their precedence. "Matrice d'Impacts Croises Multiplication Appliquee aun Classement's (MICMAC) analysis showed that economic sustainability is primarily a function of production efficiency and business model innovation, which paves the way for the development of more distant forms of sustainability such as energy sustainability, harmful emissions reduction, and social welfare enhancement."

INDUSTRY 4.0 IN THE SOUTH AFRICAN BUSINESS CONTEXT

In terms of the status and challenges of I4.0 in South Africa, Schutte (2015) listed ten industry sectors in which I4.0 is employed in South Africa. The four major disruptive information technology trends in I4.0 are big data, advanced analytics, human-machine interfaces, and digital-to-physical transfer, which remain potentially applicable to all sectors of industry and not only to manufacturing. For example, Baur and Wee (2015) refer to an African gold mine that, by capturing massive data from its sensors, was able through analytics to diagnose unsuspected fluctuations in oxygen levels during leaching (a key process). Fixing this resulted in a 3.7 per cent increase in yield, worth ZAR 287.5 million (US$ 20 million) annually (Sackey and Bester, 2016).

While pointing to ways to accommodate I4.0, its potential drawbacks in a developing country such as South Africa need also be acknowledged. Full-blown I4.0 will likely have a significant impact on workers' jobs. Other questions relate to whether there will be any scope, willingness, or readiness for skills upgrading to match the demands of I4.0. To see I4.0 as the cause of general unemployment is to look at the problem from the wrong perspective. Properly applied, I4.0 can be used to increase productivity, making firms more competitive and thus preserving some jobs. Perhaps it would strengthen the argument to remember that there was a time when competitive struggles for industrial survival took place within a country's borders. Today, however, the barriers have broken down, threatening local markets being usurped by global firms. Obviously, other industrial countries, notably Germany, Japan, the UK and the USA, would continue producing as efficiently as possible using these smart, automated systems (Sackey and Bester, 2016).

Bogoviz et al. (2019) postulated that the process of formation of I4.0 in developing countries such as South Africa has its peculiarities and is different to the process in developed countries. As compared to developed countries, in which the process of formation of I4.0 was started earlier and aimed at marketing and social results, developing countries face institutional (absence of state policy of formation of I4.0) and financial barriers and seek economic goals. At the same time, the initiative approach to formation of I4.0 in developing countries, within which the initiators of this process are economic subjects (companies), envisages larger flexibility and effectiveness as compared to the directive approach (state initiative), which is applied in developed countries.

Broad-Based Black Economic Empowerment (BBBEE), which pursues promoting economic transformation in order to enable meaningful participation of black people in the economy, is also an important factor to consider in I4.0 (Broad Based Black Economic Empowerment Act 53 of 2003, 2003). The Act defines black people as all previously disadvantaged groups of people—namely Africans, Coloreds, and Indians. It is imperative to note that although other categories of people—e.g., youth, women, people living with disabilities, and people living in rural

areas—are specifically targeted, the legislation requires these beneficiaries to be black, as per the BBBEE's Act's definition (BBBEE Commission, 2017). In addition to this overarching objective, BBBEE in its current design seeks to:

- Achieve a substantial change in the racial composition of ownership and management structures in the skilled occupations of existing and new enterprises;
- Increase the extent to which communities, workers, cooperatives, and other collective enterprises own and manage existing and new enterprises and increase their access to economic activities, infrastructure, and skills training;
- Increase the extent to which black women own and manage existing and new enterprises, and increase access to economic activities, infrastructure, and skills training;
- Promote investment programmes that lead to broad-based and meaningful participation in the economy by black people in order to achieve sustainable development and general prosperity;
- Empower rural and local communities by enabling access to economic activities, land, infrastructure, ownership, and skills; and
- Promote access to finance for black economic empowerment.

Shai et al. (2019) state that since the inception of BBBEE there has been major deliberate shifts in the evolution of BBBEE and its associated instruments to improve its implementation in South Africa. The key major shifts focused on aligning policy, legislation, and regulations to the broader definition of empowerment, moving away from the limited focus on ownership. Their study reveals that the intervention's effectiveness has largely been undermined by various challenges. In the context of the design of the legislation, these include the unintended barriers that regulations have created for small businesses and the limited participation of the private sector in implementing BBBEE. Challenges related to fronting, non-compliance, and corruption, the enrichment of the most politically connected and wealthy blacks at the expense of the targeted groups and the constraints for black-owned qualifying small entities, further highlight the policy incoherence of various organs of the State in implementing BBBEE. As a result of the focus toward broad-based impact, the design of BBBEE inherently speaks to various disciplines. However, in practice this has either led to various interpretations of the legislation's objectives or public entities working in silos, informed and influenced by their disciplines and areas of focus. Considering the scale of BBBEE and the fact that it has been in place for over 16 years, the lack of rigorous evidence on how it is performing against its key objectives is both a design and implementation shortcoming.

RESEARCH METHODS

The research design used in this study is qualitative (Creswell, 2013) and its research paradigm is hermeneutical-phenomenological (Fuster Guillen, 2019). The design and paradigm were used to explore the in-depth subjective experiences of the individuals who participated in this study. The individual subjective experiences are then interpreted through the eyes of the researchers (Eisenhardt, 1989; Ellram, 1996; Clarke and Hogget, 2009; Creswell, 2013; Hassan and Ghauri, 2014).

The organization that participated in this study is a German world-leading, global operating technology organization, which specializes in manufacturing in the context of water management with regard to engineering solutions, power station management, mining, automation, service, and consultancy. The headquarter of the company is based in Germany, and a subsidiary is located in Johannesburg, South Africa. The annual service revenue of the organization is around 2,200 million euro. Important values in the organization are professionalism proactivity, commitment and responsibility and technological success. The organization operates in over 100 countries globally. Two individuals acted as researchers in this project, who are both organizational consultants and who are working in the field of Industrial and Organizational psychology. The research team was gender-mixed.

In this single organizational study, only participants from the South African subsidiary participated. The participants were sourced through purposeful sampling (Shaheen and Pradhan, 2019), based on the criteria of managerial leadership role, position in the organization and lengths within the organization. The participants were English-speaking (8 individuals), Afrikaans-speaking (4 individuals), bilingual (Afrikaans and English, 2 individuals), and German-speaking (1 individual). Altogether 15 male and one female employee participated. The age of participants ranged between 32 and 60 years and they had been working in the organization for between 2 and 23 years, in top, middle and lower management positions. Their areas of expertise were Production and Planning, Engineering, Finance, Technical, Projects, HR, Sales, Warehouse, Service and Operations.

The data were collected through about 60-min-long interviews that consisted of 20 interview questions, such as "What skills and practices are needed in the organization to transform smoothly toward the I4.0?," "What are best practices in Industry 4.0?," "What contributes to a meaningful work environment?," "What will be sustainable in future?" The data were analyzed by means of content analysis that comprised the following five steps: (1) Data were collected and holistically assess regarding the topic at hand, (2) themes were generated, (3) data were coded, (4) the text were categorized into new units, which were then labeled, and (5) meaning inherent in the data was analyzed in more depth (Clarke and Hogget, 2009). Data were recorded and transcribed verbatim.

The usual ethical considerations in organizational research were taken into account, such as confidentiality, anonymity, protection of the participant, the ethical foundation of the study, and the ability of the participant to withdraw from the study at any point in time (Myers, 2019). The study received ethical clearance from the Department of Industrial Psychology and People Management of the University of Johannesburg in Johannesburg, South Africa. Additionally, the organization

provided organizational consent, while each participant gave individual consent to participate in the research.

Data were recorded as audio-recordings and transcribed verbatim. In addition to the interviews, the researchers took field notes. The data will be stored electronically for a period of 5 years in password-encrypted data files. In terms of the quality criteria of this study, researchers ensured that participants could share rich and rigorous data, which could be analyzed and interpreted in an in-depth manner (Johnson et al., 2019). Further, the researchers used intersubjective validation processes (Yin, 2013) and ensured confirmability and transferability (Creswell and Plano Clark, 2011; Creswell, 2013).

In terms of the limitations of the study, it needs to be highlighted that the findings are not generalizable, but rather provide an in-depth contextualized understanding of the research topic at hand (Lincoln and Guba, 1985). As in each and every qualitative study, this study is limited by its qualitative approach which is subjective in nature and which might contain a researcher's bias. Further, it is a general limitation that this study only focuses on one single organization.

FINDINGS

In the following section, research findings will be presented in a qualitative reporting style, responding to the question: *What are sustainable business practices in a I4.0 business context in South Africa?*

Findings refer to the question on different levels and managers refer in their responses to (1) Industry 4.0 sustainable business practices; (2) Positive and constructive ways forward into a sustainable future (speed and technological advancements; skill development); and finally (3) Meaning creation around sustainable business practices.

What Are Industry 4.0 Sustainable Business Practices?

Firstly, **Table 1** provides an overview of the notions of the participants as to what I4.0 sustainable business practices are. The participants mentioned technologisation, job retrenchment, automatisation, artificial intelligence, smart systems, robots, and robotics as being the main drivers of Industry 4.0 practices.

Out of 16 interviewees, 14 highlighted that I4.0 is a process within industry that is based on technologisation. Another 14 interviewees associated I4.0 with job retrenchment. Interestingly, the topic of job loss as an inherent part of I4.0 was viewed as important and as inherent business practice in I4.0 which, obviously is not sustainable for the employees. It was seen, along with the technologisation process, as part of a business practice.

Altogether 11 out of 16 interviewees highlighted that automatisation is an important aspect of I4.0. Further, eight individuals mentioned AI as a huge aspect of I4.0. For another 8 interviewees, Smart Systems play a main role in I4.0. Finally, 6 individuals emphasized that I4.0 was determined by robots and robotics. Several of the participants refer to a number of the topics addressed. Obviously, the new technologisation processes are, in their mind, the driver of innovation and success and need to be

TABLE 1 | Sustainable Industry 4.0 business practices.

Number of participants	What are Industry 4.0 business practices for you?	Interviewees
14	Technologisation processes	P1, P2, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16
14	(Avoidance/minimization of) Job retrenchment	P1, P2, P3, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P16
11	Automatisation	P1, P2, P5, P6, P8, P10, P12, P13, P14, P15, P16
8	Artificial intelligence	P3, P4, P5, P7, P10, P12, P13, P15
8	Smart systems	P1, P5, P10, P12, P13, P14, P15, P16
6	Robots and robotics	P3, P4, P7, P8, P9, P13

driven in a sustainable manner. However, the business practices in I4.0 are viewed by most of the participants as only being sustainable when they are combined with the "human touch" and the knowledge of the individuals involved. Sustainability can therefore only be created through the human impact and knowledge that drives technologicsation.

P5, a 34-year-old, white Afrikaans-speaking manager points out:

> *A person is replaced by robot. It's sad, but it's true and it does happen. Now that person shouldn't feel ashamed because there was really nothing he could do about it. Was the decision made by the company? Hopefully the company sees the value of that person and incorporates him on something else. Or make him the programmer or the end user of that cell, that robot now. Don't lose his expertise, or his knowledge. Use it with new technology. Only this is sustainable for the organisation.*

The human knowledge and input in combination with technology makes the organization sustainable in so far, that managers always need to make the right decision and add knowledge to the technological concept. P2, a white Afrikaans-speaking male interviewee points out the following:

> *In future, we should not forget the human potential. We must master the technology and work in an environmentally friendly way. We must adjust our business practices to the customer and the market and see the bigger picture.*

This manager points out that it is not only the human touch in combination with the technology, but also the contextualization of the work and the consideration of the environment in general as well as the organizational business context, which includes the market and the customers. The important aspect is to also take into account the perspective of the environment, the market and the customers.

FIGURE 1 | Industry 4.0 business practices sustainably.
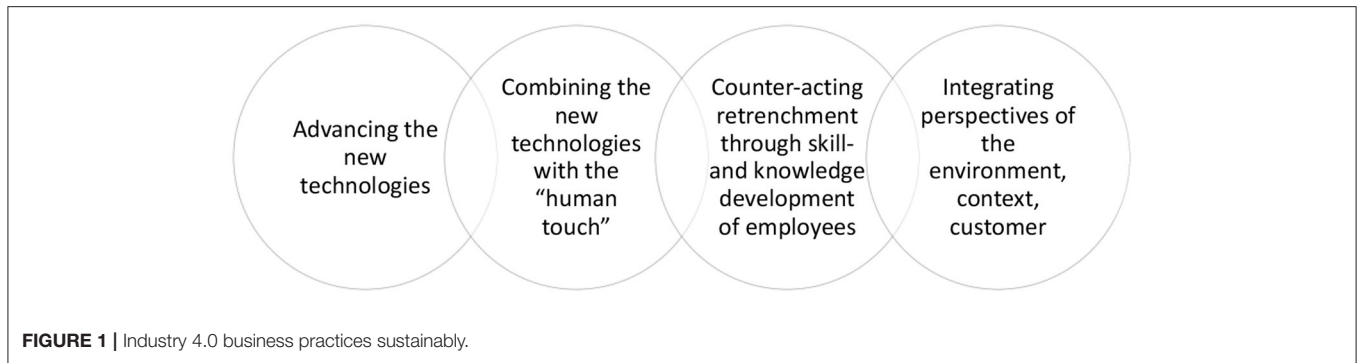
P16 emphasizes the importance of sustainable strategies to deal with job retrenchment due to advanced technologisation and automatisation:

...they've got machines where there are no operators. So that the parts come through on a conveyor belt, the machine picks them up, puts them in, machines them, out the other side …. labour rates have to go more and more and more towards automation. That means obviously less and less people with jobs. …so we have to create new strategies how to deal with job retrenchment… we need to build skills and knowledge and change towards more knowledge so that the company and the employees can sustain the competition.

This participant sees a sustainable business practice in upgrading skills of the employees, knowledge creation and flexibility in employees with regard to job demands to maintain jobs and develop new areas of expertise in which employees can strive and drive Industry 4.0 sustainably.

In summary, as depicted in **Figure 1**, sustainable business practices include the advancing of the new technologies, the combination of technologies with human knowledge, the skills and knowledge development of employees, and finally, the consideration of the context, the environment and the customer.

What Are Positive and Constructive Ways Forward?

Findings show that managers are worried about the ways forward into a future that is I4.0 driven and they highlight that a positive mindset is part of sustainable business practices. Managers refer to three specifically positive and constructive ways forward with regard to I4.0, which need to be taken into consideration for the organization to become pro-active drivers of the I4.0 in the organization (**Figure 2**).

These three themes are presented throughout the data set as influencing I4.0 sustainability in the organization researched.

Pursuing Speed and Technological Advancements in Context

Sustainable practice in I4.0 will only be reached through positively and constructively dealing with new speed and effectivity, based on technological advancements. The speed and effectivity (11 statements) which are reached through machines and technology constitute an important aspect of sustainable, positive and constructive ways forward. Several employees

FIGURE 2 | Three positive ways to become a driver of Industry 4.0.
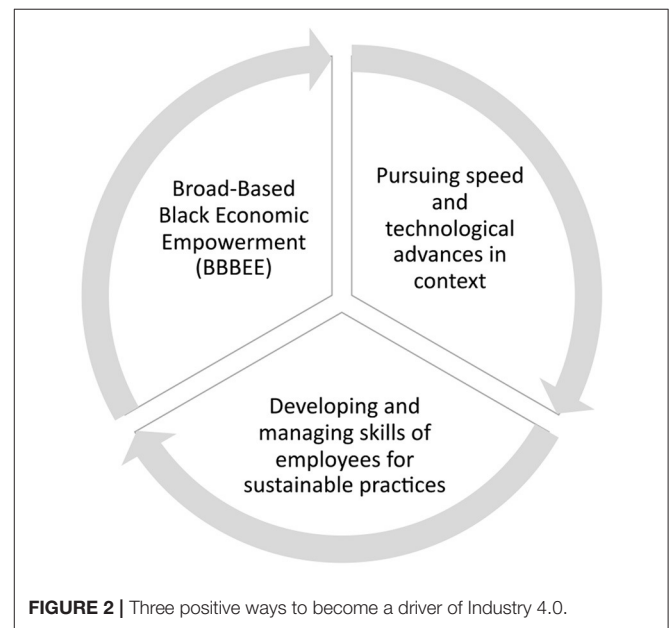
highlight that they have more time for important work aspects when the routine work is dealt with by machines. P2 comments:

I am happy with the new advantages, because when the machine does the routine work, I have more time for something more important or even more leisure time.

Here, the impact of the technological advancement is viewed as positively contributing to a new focus on work and to a more balanced work-life balance which both contribute to sustainability for the organization and the employees. Several of the participants emphasize that the organization does not seem to be "up-to-standard" with regard to I4.0, but that they need to catch up with the advancements to be sustainable in future. In order to reach future sustainability, the organization has to catch up primarily with speed and effectivity with regard to global technological advancements on the one hand, but also has to ensure that the work environment is on the same level of technological advancement with their suppliers and customers on the other hand. That means that the advancement

of technology within the organization is always a balancing act between the needs of the organization to compete on a global level and its restrictions on local levels.

P12 emphasizes, for example, the challenges and what needs to be done:

Even with our new system we wanted to be able to scan all incoming delivery notes and I said it's not possible because our suppliers don't have that technology. So, we just wrote it off, we said we don't start there, we start a step back. I would just like better transparency through the system so you can see exactly there to the end what's on time, what's not on time.

The organization will therefore only work sustainably when taking the advancements on global and local levels into account and balancing them. The advancement in technology comes with an advancement of speed. Technological advances that are perceived as important in keeping the organization's sustainability are indicated in **Table 1**. I4.0 related advances are:

- robot processing
- automated system use
- use of big data
- use 3D-printers/scanners

Obviously, several of the technological advances highlighted by the managers and presented in **Table 1** are not even I4.0-related, but are rather I3.0 technologies, such as:

- use of internet and computers
- cell phone connectivity

The increase in speed and effectivity as well as the decreased bureaucracy are viewed as biggest side effects of the technological advancements, which are seen as major advantages of I4.0. One further aspect that is mentioned by only one manager is that the new technologies bring improved recycling practices for the organization and the environment, which are seen as a contribution to the eco-friendly approach needed in I4.0. Three participants, however, emphasize strongly that the technological advances of I4.0 need to be adjusted to the African context to guarantee the technological and environmental fit (**Table 2**).

In summary, positive aspects of I4.0 are increased speed and effectivity, as well as several advantages which emanate from the development from I3.0 to I4.0. The findings show that participants do not necessarily focus on the sustainability of the new technology, but rather on the effectivity and speed of work and production. The importance of sustainable solutions do not seem to be in focus of the majority of participants yet. The data show that managers and the organization rather seem to be in a transition from I3.0 to I4.0 and this means that for managers to create a sustainable I4.0 organization, the mindset needs to be reviewed with regard to the question what actually is a sustainable I4.0 process and how to transform I3.0 processes into I4.0 contexts.

Developing and Managing Skills of Employees

Managers across the board agree that new skills for a sustainable future practice are needed for I4.0 and that the body of employees

TABLE 2 | Technological advances for sustainable business practices.

Number of participants	Advances	Interviewees
11	Higher work speed / effectivity (24/7)	P2, P4, P5, P6, P7, P8, P12, P13, P14, P15, P16
10	Use of automated warehouse and customer (tracking/performance) systems	P1, P3, P4, P7, P8, P12, P13, P14, P15, P16
9	Use of internet and computers	P1, P2, P3, P4, P5, P6, P8, P12, P16
8	Robot processing	P2, P6, P4, P5, P7, P8, P14, P16
5	Connectivity through use of cell phones	P1. P3. P4, P12, P13
5	Use 3D-printers/scanners	P1, P3, P4, P5, P7
3	Use big data	P3, P4, P15
2	Decreased bureaucracy	P7, P8, P15
3	Adjust technology for Africa	P13, P15, P16
1	Improved recycling	P3

of the organization generally need to upskill to create an organization that is sustainable in future. **Table 2** indicates that altogether 12 individuals mention that new training programmes are needed for employees to firstly cope with the situation and secondly drive the organizational changes.

Further, 11 participants mention that the knowledge of employees needs to be increased in the organization, not only with regard to advanced technological knowledge, but also regarding basic knowledge. Different aspects of knowledge creation are mentioned, such as learning new programmes in general, knowing automated systems, learning SAP skills, developing analytical and engineering skills specifically. P6 points out:

People really need to get more training to getting into this new technology.

P8 emphasizes specific skills:

I believe that employees need to get the chance to get to know automated systems and develop their analytical skills. Also… to work with big data….and learn new programmes.

All employees are aware that training is needed. They state that it is particularly important to train people on and off the job (**Table 3**).

In parallel to training and increasing knowledge and skills in generally and specifically, 9 statements refer to the fact that employees should bring in their experiences, 7 statements refer to the fact that individuals should increase their communication skills, 6 mention that employees should increase their cooperation with the headquarter, that the quality of work needs to be improved and 5 participants feel that participants should adapt to new challenges.

TABLE 3 | Skill development for sustainable practices.

Number of participants	Skill development for the I4.0	Interviewees
12	Training	P1, P2, P6, P4, P5, P8, P9, P11, P12, P14, P15, P16
11	Increase knowledge/skills	P1, P3, P5, P8, P9, P10, P11, P12, P13, P15, P16
8	Learn new programmes	P1, P5, P7, P8, P9, P10., P12, P13
7	Know automised system	P7, P8, P10, P11, P13, P15, P16
7	SAP skills	P1, P3, P4, P9, P10, P12, p13
6	Develop analytical skills	P3, P4, P8, P10, P12, P13
3	Engineering skills	P3, P7, P16
9	Bring in experiences	P1, P3, P5, P10, P11, P12, P14, P15, P16
7	Communication skills	P1, P4, P7, P8, P9, P10, P11
6	Cooperation with headquarter	P1, P3, P4, P12, P14, P16
6	Improve quality of work	P2, P4, P6, P9, P15, P16
5	Adapt to new challenges	P7, P8, P10, P11, P12

TABLE 4 | BBBEE and I4.0 practices.

Number of participants	BEE and I4.0 practices	Interviewees
4	BBBEE does not work at all, does not have effect on unemployment	P4, P5, P9, P10
4	BBBEE does not contribute to I4.0, it is just a political agenda to empower certain people and will break us in the I4.0	P3, P5, P10, P15
3	BBBEE means entitlement, nothing else	P4, P6, P15
3	BBBEE makes us loose quality and professionals	P5, P12, P16
3	I4.0 is good for BBBEE, because it asks to train workers and creates new chances	P1, P13, P16
	BBBEE brings diversity	P1
1	I4.0 brings death to BBBEE	P7
1	I4.0 is paper-less and sustainable, BBBEE is paper-rich and unsustainable	P8

P10, for example, highlights that communication is important and that people need to know how to communicate:

...we do a lot of work in Africa. And there's a lot of communication that needs to be face to face, to build relationships. So that's another thing. To get clients on board. Ja. People need to know how to communicate.

P11 emphasizes that people also need to learn how to adapt to new challenges and be flexible and open-minded to new possibilities and opportunities. PP 11 highlights:

Remember, I think you need to be, have knowledge about everything. Don't just be for the workshop just working with your hands, you should be, you must be able to do, if tomorrow they replace you with the machine, you have to go – and do something else.... You have to be prepared for that.

The skills development is therefore anchored in training and knowledge as well as in intra-, inter- and work-related professional skills.

Broad-Based Black Economic Empowerment (BBBEE)

Finally, employees highlight that the BBBEE policies need to be taken into account when focusing on sustainable, positive, and constructive ways forward in South African multinational organizational contexts. This is the case since in BBBEE processes, the focus of employing staff members is based on the aim to reconcile members of all South African population groups (African, Whites, Indian, and Coloreds) by addressing inequalities of the previous apartheid regime. Thereby the integration of previous disadvantaged population groups in the workplace and the support of them in the businesses is the principle of BBBEE processes on a local and national level. These BBBEE processes, in the mind of the managers, seem to be conflicting with 4I.0 sustainability processes.

Four participants, as indicated in **Table 4**, emphasize that BBBEE is not impactful and does not help with solving the problems of the times, such as unemployment. Another four individuals emphasize that BBBEE does not contribute to I4.0.

P5, as a highly critical voice toward BBBEE, emphasizes:

I don't think it fits at all, to be honest, I really don't think BEE has a big place in this. It's not supposed to be, because it's been now 25 years. Okay, granted, only now the first lot is coming through the system. But you're losing so much other qualities and professionals and because I really do think it's it's actually more a hinder on a company than an asset. I do know we've been BEE status one, whatever, now for last year. I don't think it even once helped us in getting a contract. So, so, but that's only from my perspective.

Three individuals see BBBEE as political entitlement that has nothing to do with professional and industrial work. Another three individuals see BBBEE as being responsible for losing quality of professionals, due to the fact that people are employed based on racial criteria and not based on professional work ability. Three other employees say that I4.0 is good for BBBEE because it brings training and opportunities to workers and thereby supports sustainability at least for members of previously disadvantaged groups.

Finally, one individual states that BBBEE creates diversity, that I4.0 causes the downfall of BBBEE, that I4.0 and BBBEE are contrary with regard to their sustainability approach, since I4.0 is sustainability-orientated and paperless whereas BBBEE is unsustainable and paper-rich. In summary, it can be emphasized that the majority of managers (14 statements) see BBBEE as non-sustainable for a I4.0 work environment due to its ineffectivity, being part of a political agenda and entitlement and creating a loss on quality and professionalism at work.

Number	Meaning at work and business practices	Participants
8	Survive/no retrenchment/care	P1, P4, P7, P8, P9, P10, P11, P15, P16
4	Broaden horizon	P8, P11, P12, P16
4	See the job done	P5, P7, P10, P15
4	Deliver quicker solutions/smarter processes	P10, P12, P14, P16
3	Give my best	P7, P11, P16
3	Train and educate people	P8, P9, P16
2	Protect the environment	P8, P9
2	See new, future possibilities	P13, P14
2	Move company forward	P1, P9

For several employees, BBBEE is incompatible with I4.0. Only 1 person sees BBBEE in a positive way as supporting diversity. However, the I4.0 process is valued as being rather positive in terms of sustainability, bringing with it training, new work demands, and an eco-friendlier approach. P8 highlights:

> We need to have a sustainable approach and we want to go paperless. This is possible with Industry 4.0, but BEE uses a lot of paper and it is not a sustainable approach.

The participants of this study are divided about their ideas on the compatibility of I4.0 and BBBEE, which is, in the South African business context, a critical point of discussion. A majority of participants, however, thinks that BBBEE and I4.0 do not fit or collaborate together well and that BBBEE processes might even be counteractive with regard to drivers of sustainability in the I4.0 context.

Meaning-Making Around the Topics of Sustainable Business Practices?

With regard to a positive future of the organization, managers highlight that the mindset and the meaningfulness of the work they do is mainly important to create a sustainable future.

Eight employees, as depicted in **Table 5**, highlight that within the process of transformation toward a sustainable I4.0, they need to create a meaningful workplace which ensures survival and care (no retrenchment) for the employees. They feel that a workplace is only sustainable when jobs are created and when an organization cares for the wellbeing for the employees.

Further, managers believe that the I4.0 transformation is only sustainable when employees broaden their mind and contribute to stimulating complex thinking and acting systems in the work environment. P8 explains:

> We train in the workplace, correct, for you to better what you are doing. But it also contributes to your personal life because it broadens your horizon; you think beyond a certain point now and not just in work, in your personal life as well, where you used to just go and you take this bottle of water off the shelf. Now you are comparing prices because you know of better.

In this sense, work and the transformation toward I4.0 contributes to changing the mindset of managers and employees toward advancing personally and professionally. Sustainability is reached when people are trained at work and thereby develop personally. Further on, work is meaningful for the employees when they see "the job done" (4 employees), deliver quicker solutions or smarter processes (4 employees), feel that they give their best (3 employees), and can contribute to training and educating others (3 employees). Additionally, two people construct meaning at work by protecting the environment, seeing new and future possibilities and moving the company forward.

In summary, it can be highlighted that meaning-making in the organization is strongly linked to the idea of sustainability with regard to personal and professional development (**Figure 3**).

Meaning-making happens for the managers on different levels, namely on the foundational level for the survival of employees and the organization, and on organizational, inter- and intra-personal levels. **Figure 3** indicates the different levels of meaning-creation for a sustainable business practice.

DISCUSSION

This article considered sustainability and business practices in the context of global, contemporary and future-orientated engineering and water management in a specific company. Managers are of the opinion that sustainability is an important topic in organizations of the I4.0 and that employees lives are reshaped by the digital revolution which offers possibilities for sustainability as described by Birkel and Müller (2021).

Findings partly agree and partly disagree with previous research. Findings indicate that the I4.0 business practices within the organization are defined by technologisation, job retrenchment, automatisation, AI, smart systems, robots, and robotics—thereby referring to I4.0 practices, as in previous research (i-SCOOP, 2017; McClure, 2018). Participants emphasize strongly, however, that sustainability is only researched when there is a strong connection between technology and human connection, which has not necessarily been highlighted in previous research. Although Margherita and Braccini (2020) highlight that organizations can in the long run excel by adopting I4.0 technologies, the organization at hand is still in the transformational phase from the I3.0 to I4.0. Findings show clearly that the aims for the I4.0 and the sustainability of the organization are not yet clearly outlined and structured as, for example in the SDGs (described by Islam et al., 2022). In this organization, managers rather still try to find their feet and define the I4.0 and their sustainability aspects by using a contextualized approach. This approach does not yet seem to be strategically be bound to internationally emphasized SDGs.

Research on I4.0 and sustainability emphasizes smart technology and eco-systemic approaches, in combination with innovation and collaboration as sustainable practices. However, the theoretical and literature-based focus is often on cyber-physical systems, IoT and technology (Barkai, 2019) instead of on the human connection which is predominantly highlighted in this organization.

FIGURE 3 | Meaning-making in sustainable I4.0 business practice.
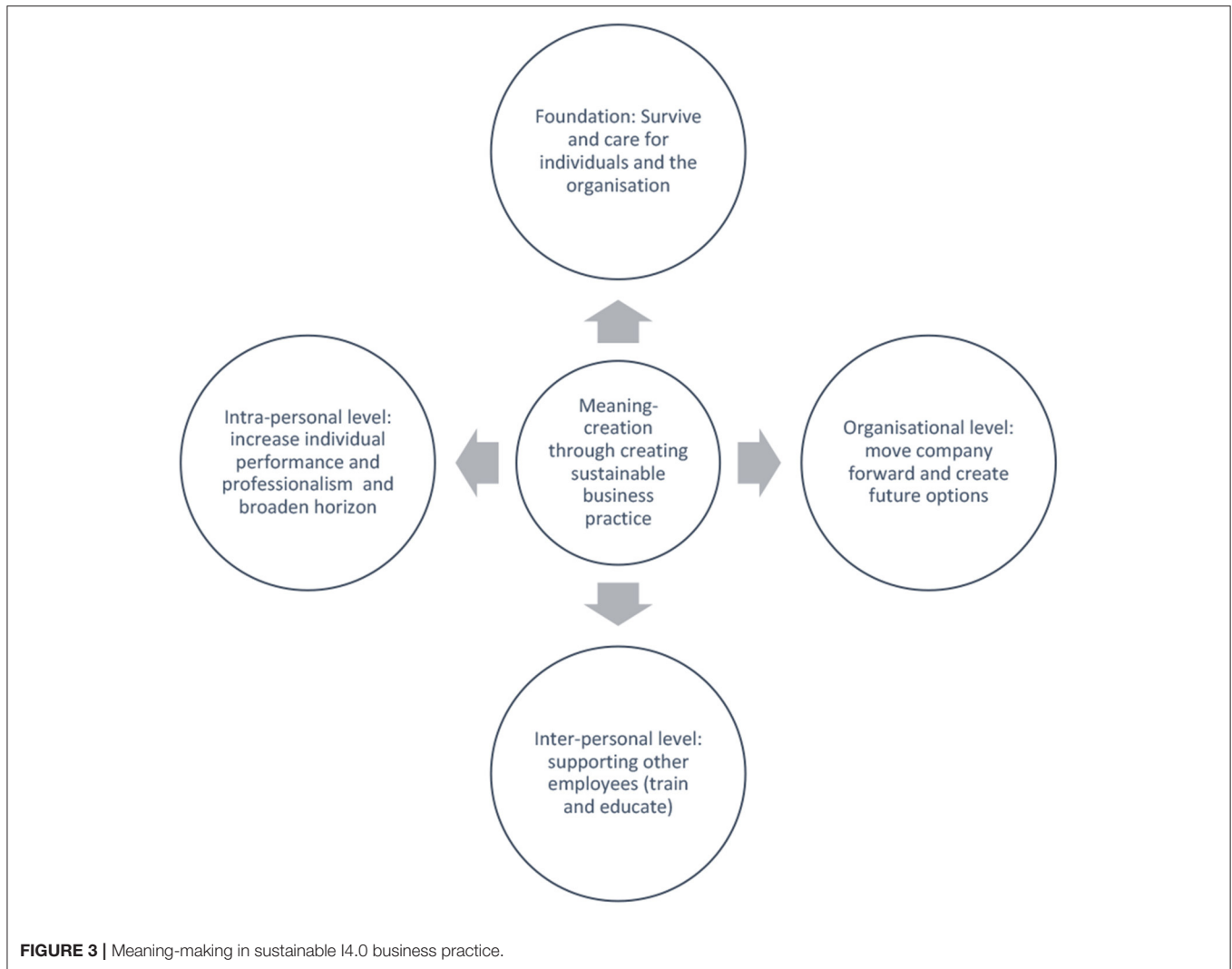
Furthermore, findings indicate that there are three aspects that demonstrate constructive and positive behavior in organizations, namely speed and technological advances, developing and maintaining skills and BBBEE. Schutte (2015) also mentions four disruptive advances, including big data, advanced analytics, human-machine interfaces, and digital-to-physical transfer. The findings further support the perspective of Bogoviz et al. (2019), namely that developing countries might have their peculiarities in incorporating I4.0. This perspective is shared by the participants of this study, who emphasize that a positive and constructive way forward needs to take three aspects into account for transforming the South African industry, or at least segments thereof, such as pursuing speed and technological advances, the development of the skills of employees and sustainable practices and the BBBEE procedures. Participants combine I3.0 and I4.0 technologies, which indicates that they are still in a transitional state. Further, the aspect of a sustainable industry and future does not seem to be a priority for the participants in comparison with the priority focus on effectivity, higher production rates and outcomes. The

adjustment of technology to African contexts and the aspect of sustainability are of less concern than the potential economic benefits and threads.

In the South African context, Broad Based Black Economic Empowerment Act 53 of 2003 (2003) is of major importance in the industry and employment sector. This is also mentioned as a critical aspect for I4.0 in the findings, where the employment based on racial affiliation is seen as a critical aspect to foster I4.0. The data support the view of Shai et al. (2019) regarding the way that BBBEE has been implemented for many years, but that the consequences of BBBEE have not yet been researched rigorously with regard to its evidence, key objectives and design and implementation of shortcomings and contributions. It is highlighted that BBBEE and I4.0 are very complex global and local processes that need further rigorous research with regard to its benefits and contributions, as well as the challenges and how to address it. Therefore, the meaning of work and sustainability need to be taken into account and might need to undergo refinements and redefinitions. According to the

participants, survival and care need to be secured for employees through employment based on BBBEE in combination with improvements in the workplace through I4.0 developments. Business practice appears to be meaningful for the employees when survival and care are secured (particularly for the employees, but also through the protection of the environment). The findings seem to support Ejsmont et al. (2020) partly who emphasize that sustainability challenges are often neglected in the literature. For managers, sustainability is only a topic to a certain degree and with its main focus on the sustainability of work for the employees. However, sustainability with regard to environmental aspects is not of such a strong importance in the data. However, managers point out that sustainability is important to create meaning and a future for employees at work and, at the same time, that I4.0 technologies can be used to create sustainable practices (as in Beltrami et al., 2021). However, this aspect to really use I4.0 technologies to create sustainability is not mentioned extensively in the findings. Managers are more concerned with creating sustainable jobs for the employees by highlighting the human impact than in sustainability that is created through technology. They thereby emphasize Birkel and Müller (2021) idea that ecological and social perspectives with economic benefits need to be demonstrated and applied in new business models which are holistic and complex. The findings do not show that managers strongly care about environmental and energy sustainability and emission reduction (Ghobakhloo, 2020), but rather about socio-economic sustainability in I4.0.

CONCLUSIONS AND RECOMMENDATIONS FOR A FUTURE SUSTAINABLE BUSINESS PRACTICE

This article contributes to building the research literature on sustainability and I4.0 by responding to the research question on *What are sustainable business practices in a I4.0 business context in South Africa*?

Overall, findings show that sustainability in I4.0 business practices is created through the combination of connecting advanced 4IR technology and the human touch. In theory and practice of being innovative and advanced, the human touch and impact often seems to be forgotten. The focus on humanity and human impact whilst driving technological progress might be specific for the South African business context in which human relations play a significant role.

Findings of the study show further that sustainable business practices are ascribed to advanced tehcnologisation processes and the implementation of I4.0 technologies, such as automatization, artificial intelligence, smart systems, robots and robotics. To drive I4.0 sustainably, job retrenchment needs to be addressed through job creation and in particular training and employee skill- and knowledge development. Sustainable perspectives on the individual, the environment, the context and the customer need to be integrated to create a sustainable I4.0 business practice. Further, managers are aware that sustainable practice needs a positive and constructive mindset and this includes three topics that need to be addressed: (1) pursuing speed and

technological advances in context; (2) Developing and managing skills of employees for sustainable practice; and managing BBBEE as a local practice of employment equity within the context of the global drivers of the 4IR and I4.0. Finally, it is a highly important topic that the work and business practice are meaningful. Managers believe that a meaningful business practice is more sustainable than a business practice that does not appear to be meaningful. Business practices are viewed as meaningful when they help to develop the individual, define quick solutions, improve actions of employees, contribute to training and education, protect the environment, and advance the company.

Innovations, efficiency and corporate social responsibility practices define much of the current theoretical I4.0 sustainability agenda. While important, they are insufficient in themselves to deliver the holistic I4.0 changes necessary to achieve long-term social and environmental sustainability. The question can be asked in future: How can organizations encourage corporate innovation that significantly changes the way organizations operate to ensure greater sustainability in I4.0? Sustainable business models (SBMs) consider a wide range of stakeholder interests, including the environment and society. SBMs are important in driving and implementing corporate innovation for sustainability, assist to embed sustainability into business purpose and processes, and serve as a key driver of a competitive I4.0 advantage. Many innovative and applied approaches may contribute to delivering sustainability through business models.

Recommendations for further research include that further studies need to be conducted with regard to the exploration of sustainability in specific socio-cultural contexts. Cross-cultural country comparative studies need to be run to understand the local, cultural, and contextual drivers of the I4.0 business practices within their organizational environment. Further, mixed method studies are needed which explore the breadth of different organizations involved and which apply qualitative methods which cater for the in-depth exploration of subjective experiences of the I4.0 changes toward an even more sustainable business practice. Thereby research needs to differentiate with regard to social, economica, ecological, and environmental business practice and needs to start understanding the forces and drivers which impact form the cultural context.

Organizations such as this multinational company, need to start addressing sustainability within the South African business with special regard to its complex and multi-layered political, legislative, economic (local, regional, and global) forces. They need to be understood and contextually adjusted in terms of the practices. International sustainability practices need to be applied and adjusted to ensure a successfully sustainable I4.0 business practice. Surely, one outstanding aspect is, for the South African context, the development of 4IR skills of employees who do not seem to be prepared for the I4.0 advances. The gap between the practical skills and knowledge needs to be addressed through professionalization processes. International organizations should further start to implement learning processes between their international key players to foster mutual learning and understanding to increase

sustainability on global levels and create meaningful work practices to foster sustainability on all levels. Definitely, the human factor will play a major role in sustainability in future in the South African context while driving technological advances further.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Johannesburg. The patients/participants provided their written informed consent to participate in this study.

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