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# The Fourth Industrial Revolution: Conceptual paradox or catalyst for achieving the Sustainable Development Goals?

**Significance:**

The topic of the Fourth Industrial Revolution (4IR) became significant in South Africa from 2017, through advocacy, amongst others, by the University of Johannesburg and subsequently through the appointment of the Presidential Commission on 4IR. Preceding industrial revolutions each focused on a single technology; 4IR, however, speaks to a confluence of technologies and a synergy of computing, data, and communications technology, with artificial intelligence rapidly redefining the world of work. Conceptual and geopolitical challenges and potential negative societal implications notwithstanding, we argue that the 4IR paradigm shift is critical to South Africa and to realising the Sustainable Development Goals.

## Introduction

Around 2017, while not new in nomenclature, a strong pitch for the Fourth Industrial Revolution (4IR) developed in South Africa. The University of Johannesburg (UJ) was a key advocate, and 4IR soon became a significant undertaking through various national and regional processes, such as the appointment of the Presidential Commission on 4IR and the role of UJ as a Pan-African epicentre for critical intellectual inquiry. UJ, supported by its Council, committed to over ZAR500 million (UJ Council resolution, March 2019) in 4IR and associated change management processes over a 5-year period. UJ's systemic and systematic approach offered both breadth (a transdisciplinary approach) and depth (progressing the technical discipline of artificial intelligence (AI) specifically). In terms of the latter, UJ hosts the Institute for Intelligent Systems, now a significant partner for both government and industry.

## The conceptual debate

Around the world, and in South Africa, 4IR as a concept is much debated. At the centre of this debate is the fact that previous industrial revolutions had at their core a single revolutionary breakthrough or innovation. The First Industrial Revolution occurred during the late 1700s and early 1800s, and was characterised by the rise of steam-powered machinery and widespread utilisation of the power loom. The Second Industrial Revolution, from the late 1800s to the early 1900s, introduced mass production techniques and the widespread adoption of electricity. The Third Industrial Revolution during the latter half of the 1900s was propelled by advancements in computer and digital technologies.

4IR, on the other hand, is characterised by the convergence of multiple technological breakthroughs, particularly in AI and machine learning. It enables physical, digital, and biological systems to converge, leading to smart factories, integrated workflows and new lifestyles. 4IR is significantly different from past industrial transformations due to the combination of technologies involved, and is expected to have a much wider range and a stronger impact on people's lives than previous industrial revolutions.<sup>1</sup>

AI integration into several industries is already in progress and is anticipated to bring considerable benefits. The technology is expected to drive productivity and efficiency, by augmenting repetitive tasks and processing massive amounts of data. Moreover, new jobs are being created in fields such as data analysis and software engineering for those skilled with AI-based products, services and the product–service continuum. By incorporating AI into specific areas, novel products and services will be developed.

4IR is facilitating rapid technological evolution, which presents a range of open questions in terms of conceptualisation and societal implications. These current developments will surely provide novel solutions to existing problems, or cause disruption – or both. Stakeholders must be prepared to navigate this complex dynamic going forward.

The term 'industrial revolution' is coming under scrutiny, given that the current landscape of technology has shifted, leading to a need for a more nuanced and comprehensive term. The increasing complexity and interconnectedness of technologies requires a broader interpretation than is traditionally offered by the phrase 'industrial revolution'. A more accurate phrase is needed to appropriately reflect the current state of technological advancement.

We argue that there are many indications that the period of significant transformation we are currently experiencing can indeed be termed the 4IR. Emerging technologies like AI, robotics, the Internet of Things, blockchain and quantum computing are revolutionising many aspects of our lives, such as workflows, communication systems, and access to information. Everywhere we look, there are indications that we are experiencing an enormous transformation – ranging from how we interact with one another to how we gain access to information.

Exponential growth in AI technology is largely attributed to advancing computing abilities, bolstered data storage and processing capabilities, and the widespread utilisation of high-speed Internet access. This acceleration in AI development and deployment has been heavily facilitated by technological advances made over the last few decades.

The Internet of Things, connected devices, and cloud computing have democratised AI solutions. This means that businesses, of any size, can now access and deploy AI solutions to automate processes across different



spheres. As a result of these developments, a new wave of innovators is arriving on the scene – and leveraging AI to tackle various economic and societal issues. All these developments do indeed suggest that the term ‘revolution’ is appropriate.

From a geopolitical perspective, 4IR is being driven, primarily by the West, especially the World Economic Forum. This raises the important question of whether this agenda accurately reflects the needs of other regions. However, when one sees increasing technological and AI developments occurring, independently, in China, East Asia, and parts of India, it is possible to conclude that 4IR has a larger global reach than initially thought. This emphasises the significance Africa should play from its unique perspective to keep up with global trends and to redefine 4IR to promote socio-economic inclusivity.

As 4IR has emerged as a major driving force of innovation, technology, and economic growth on the global stage, South Africa has taken note. It is imperative that South Africa capitalises on the advances of 4IR to further its development objectives. Therefore, this topic deserves ongoing discussion as it continues to be of utmost importance in the current landscape.

South Africa is currently confronted with an energy crisis, which requires multiple approaches to be tackled successfully. In this context, 4IR technologies and thought paradigms might well be useful when searching for viable solutions. However, this situation is too complex to be adequately explored in this article.<sup>2</sup>

With escalating global competition, South Africa has strategic opportunities to take the steps needed to bring its development up to date. The implementation of 4IR technologies and advancements can be used to propel the nation to overcome roadblocks that have previously held it back; these include poverty, inequality, and unemployment. The adoption of technological innovation could be key towards accelerating the development needed to improve South Africa’s future. However, automation and AI technologies have undoubtedly created job losses and increased income inequality. The implementation of these systems has also sparked debates about privacy and security concerns as well as raised questions regarding ethics and bias in AI.

In this article, we argue that 4IR is crucial for South Africa. 4IR has instigated a necessary change in perspective and, by fostering innovation, is revitalising optimism and presenting opportunities for rapid advancement. Additionally, we contend that 4IR or similar thinking will be vital in fulfilling the United Nations’ Sustainable Development Goals (SDGs).<sup>3</sup> These 17 goals were established by the United Nations in 2015 to advance sustainable development and tackle pressing global issues, including education, poverty, and health and well-being. Given that 4IR is at the forefront of worldwide innovation, South Africa has the opportunity to leverage technological innovations to attain the SDGs.

At the same time, South Africa has the opportunity to contribute in alternative ways to 4IR’s advancement and to the SDGs. For example, by incorporating African value systems into developing technologies, such as the creation of the operating system Ubuntu (Linux) to ensure that ‘Ubuntu’ principles were incorporated. Ubuntu is a societal value system from the African continent and stands for ‘I am because you are’. Ubuntu, the operating system was founded by Mark Shuttleworth, a South African entrepreneur. The Ubuntu value system and the associated operating system have prolifically progressed open access globally. This brings a unique edge to several SDGs – including SDG 17 (Sustainable Partnerships).<sup>4</sup> The worldwide goal of achieving the 17 SDGs by 2030 seeks to ensure that no one is left behind and there is a brighter and more sustainable future for all. All nations are called upon to advance sustainability and preserve the earth, regardless of wealth and disadvantage.

We recognise that the implementation of 4IR in South Africa has challenges. The country must address the digital divide, the unequal distribution of technology and Internet access. This is a significant challenge for South Africa, as many of its citizens still lack resources such as technology and Internet connectivity, which makes it difficult for them to participate in 4IR. Compounding all of these, South Africa’s digital divide is also a function of extreme social inequality.

Some argue that South Africa, owing to the current energy crisis, should instead pursue 3IR. While we recognise this approach, the 4IR thought paradigm allows individuals to leapfrog in thinking – for example, instead of thinking of only an electricity grid, one can think about a smart grid. The latter, with AI enablement, creates an array of opportunities – innovative business models, policies, technological advancements, a sustainable environment, and others. Furthermore, energy infrastructure is a long-term investment, and if these issues are not considered at the outset, the costs of addressing these at a later stage will be significantly higher.

South Africa must also enhance its education and training to ensure that its citizens have the skills necessary to advance 4IR and reap the benefits thereof. Like the rest of Africa, South Africa has the demographic advantage of a young population; this group is technology-savvy and could be rapidly deployed to form a ‘4IR movement’. Universities are a microcosm of society. Considering this analogy in terms of 4IR, UJ is an exceptional example of what can be achieved; the university’s 2021/22 ranking as number 1 in South Africa by the Times Higher Education (THE) Impact Ranking further demonstrates international acknowledgment.

## Fighting poverty through 4IR

The global community continues to grapple with poverty – an issue that has been further exacerbated by the COVID-19 pandemic. With millions pushed into poverty and economic hardship, solutions are urgently needed. Fortunately, 4IR technologies have tremendous potential for alleviating poverty and improving living standards. It is up to policymakers and stakeholders around the world to identify ways in which 4IR can be harnessed to make a real difference in the fight against poverty.

One of the critical mechanisms of 4IR in helping to end poverty is the gathering and analysis of data. With the increased use of technologies such as big data and AI, vast amounts of information can be collected about poverty levels, living standards, and the distribution of resources. This information can inform policies and initiatives to reduce poverty, making them more effective and targeted. Data analytics must, however, be done at an aggregate level to ensure the highest ethical standards.

Another way that 4IR can contribute to ending poverty is by creating new economic opportunities. The digital economy and e-commerce enabled by 4IR technologies provide new avenues for economic growth and job creation, especially in developing countries where traditional employment opportunities may be limited. The digital economy is particularly well suited to the needs of developing countries, as it is less dependent on physical infrastructure and can provide people with access to global markets and customers. For instance, in 2021, the South African government introduced the ICT special economic (tax) zone incentivising the establishment of businesses in the virtual space.

## Improving education through 4IR

SDG 4 requires that we ensure equitable quality education for all and create lifelong learning opportunities. AI and machine learning can be leveraged to optimise and personalise educational content, customising it according to individual learner needs and parameters.

On the other hand, by using gamification, virtual and augmented reality can make education more engaging, interactive, and enjoyable for learners, helping to foster a lifelong love of learning.<sup>5</sup> Technologies can also provide a more inclusive learning platform or bridge for students who are differently enabled.

Data collection and analysis using educational technologies is an effective way to gain insight into the learning process. This information can then be used to help teachers and administrators make decisions about how to enhance student learning outcomes.

## Solving water-related crises through 4IR

SDG 6 aims to provide universal clean water and access to sanitation. Despite the current efforts of the South African government, work towards achieving this goal needs to accelerate due to the rapidly increasing demand for reliable water sources, and especially in view of climate change.



The water industry is gradually beginning to adopt 4IR technologies. Countries worldwide are exploring ways to introduce these innovations to improve public health and simultaneously increase economic opportunities for their citizens. Implementing such measures will bring many benefits over time.

## Improving health and well-being through 4IR

The health sector has already drawn extensively on 4IR. Early evidence indicates that this has had an immense impact.<sup>6</sup>

4IR can improve access to health care and support the prevention and management of disease. For example, telemedicine and mobile health applications can provide remote consultations and support to people who live in distant areas or have limited access to healthcare facilities. Wearable technology and sensors can also monitor health metrics in real time, allowing for early detection of health issues and prompt intervention. Furthermore, AI advances traditional methods of diagnostics; this complementary approach extends the limited resources available in developing parts of the world.

## Recommendations

Governments, businesses, and civil society organisations must work together to ensure all communities can access affordable, reliable, high-speed Internet connectivity. This includes investing in digital infrastructure and providing digital skills training with particular emphasis on youth and historically disadvantaged communities. By advancing the ICT economic zone initiative, governments can also provide subsidies or other incentives to promote the adoption of new technologies and entrepreneurship.

Additionally, governments can establish regulations and standards that safeguard personal information and prevent cyberattacks. Zero-rating of education opportunities, including around cybersecurity, can be another effective approach.

Governments can also establish partnerships with the private sector, civil society organisations, and academia to drive innovation and promote the development of new and appropriate technologies that further advance the SDGs.

In an overarching manner, and across the three tiers of government, recommendations such as those made in the Presidential Commission's report<sup>7</sup> must also be implemented.

## Conclusion

While we acknowledge the conceptual definitional 'mismatch' of 4IR in the context of industrial revolutions, the confluence of technologies, and particularly AI, is significant today, and requires focused and continued attention. For this reason, we agree with the World Economic Forum and others that this AI-associated confluence deserves 'revolutionary' recognition.

It is crucial that the benefits of 4IR are shared equitably across society and that countries address any negative implications. Going forward, proactive steps must be taken by governments, businesses, civil society, and other stakeholders to fully understand the impact of technology on society.

We must take a multifaceted approach to technology that considers its implications in the broader societal and political context. A more integrated method of technological progress, which draws upon the insights of various disciplines and stakeholders, will foster a sense of collective ownership. What is needed is an innovative framework for developing technology with an ethical underpinning which emphasises fairness, sustainability, and justice.

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## Competing interests

We have no competing interests to declare.

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