

Policy options for the Fourth Industrial Revolution in South Africa

Summary

South Africa – through partnerships encompassing the government, business, academia, labour and civil society – has embarked on a process of developing a national strategy and plan of action for harnessing the Fourth Industrial Revolution (4IR) to drive its human and economic development. This policy brief contributes to national efforts by presenting a policy options framework to inform the deliberations of the government and its social partners. It proposes alignment with national norms and values (such as combating unemployment, poverty and inequality) as well as alignment within and between policy domains. The framework puts forward a set of strategic focus areas that inform cross-cutting strategies (such as artificial intelligence [AI] strategies and public-sector innovation plans) as well as initiatives led by specific government departments (for example, research and development strategies led by the Department of Science and Innovation). This policy brief outlines four core strategic focus areas aimed at (1) strengthening adaptive capabilities, (2) leveraging technological change, (3) building skills and technical capabilities, and (4) directing policy towards developmental outcomes. It concludes by reflecting on, and recommending, potential structures

for consultation and co-ordination in developing a national plan of action for harnessing the 4IR.

Introduction

The 4IR has been described as the fourth major industrial era since the initial Industrial Revolution of the 18th century, in which new technologies are fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries.¹ Key technology platforms include AI, robotics, the internet of things, autonomous vehicles, additive manufacturing (also known as 3D printing), quantum computing and nanotechnology. The 4IR is viewed as significant, imminent and global. South Africa's development challenges, particularly those of inequality and uneven development, require 4IR-related strategies that are contextually specific yet informed by global developments. Being prepared for the 4IR means to position institutions in such a way that the 4IR is harnessed for the benefit of human wellbeing and in support of national and international social and economic objectives. It is therefore critical that South African institutions put in place strategic measures to prepare us for building innovation capacity, developing policy, writing legislation and regulations,

joining multilateral and international agreements, and debating the emerging ethics of its advent. The velocity of the 4IR suggests that by the time the policy cycle has turned, the 4IR may already have had an enormous impact – hence the urgency and significance of initiating policy cycles at all levels.

A policy options framework

The purpose of a national 4IR policy framework is to harness the power of new technologies towards the achievement of South Africa’s developmental aspirations. The framework presented here consists of a proposed set of aims, objectives, structures and strategies. A 4IR policy framework has to provide guidance for policy-makers in all spheres to build evidence-informed, responsive and future-oriented policy. Due to the broad and cross-cutting nature of the 4IR, no framework can be exhaustive in its assessment of the potential applications of technologies or its assessment of the human development roles these technologies might play. We therefore need to support the development of functions within policy-making structures to make such determinations independently. Overall, these imperatives point towards the significance of adaptiveness – the capacity of institutions to observe and make sense of external change, including technological change, and effectively incorporate and adapt to such change. Adaptiveness is indeed an imperative that intersects with the full technological and developmental scope of the framework, and should be a consideration in the development of all policy mechanisms and interventions.

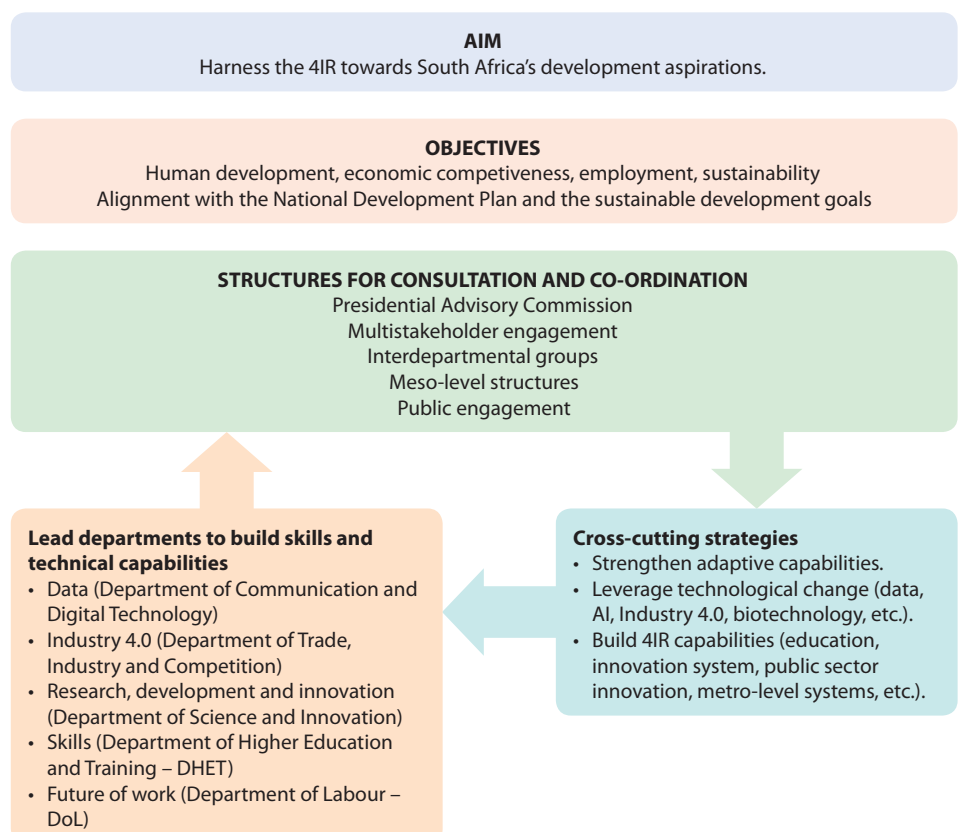
The aims, objectives, strategies and structures of the proposed framework should be informed by five main areas of consideration (see Figure 1). First, the framework defines an overarching aim – to harness the 4IR towards South

Africa’s development aspirations. Second, the objectives need to align with our values (such as combating poverty, unemployment and inequality within a human rights framework) and our national policy frameworks (such as the National Development Plan). Third, cross-cutting approaches (operationalised across government departments and economic sectors) are needed. Fourth, vertical strategies are needed (led by a specific government department and applied to a distinct sector). Fifth, structures for consultation and co-ordination are required to ensure ongoing alignment and provide avenues for public and stakeholder input to the policy process.

Four broad cross-cutting strategies have emerged from the policy discourse and research. The first is the need to strengthen adaptive capabilities. Across all institutions (including government,

business, education and research), increased capacity to make sense of technological change and adapt accordingly is becoming increasingly significant. The second is the generalised imperative to leverage the technological changes that characterise the 4IR. Technological change in most instances presents both opportunities and threats, and the role of policy must be to harness new technologies for the maximisation of opportunity and the mitigation of threats. The third broad domain is that of building capabilities, since capabilities underpin efforts to leverage technological change. These include technological capabilities, research and development capabilities, and education and skills development capabilities. The fourth and final strategy is to ensure that all policy is oriented towards the achievement of developmental outcomes, including economic growth, human development and human freedoms.

Figure 1 Summary of a national 4IR policy options framework



A policy framework should align with national values and developmental goals

To steer the 4IR correctly, policy must be aligned with South Africa's developmental goals, for example as articulated in the National Development Plan and as expressed in the Sustainable Development Goals (SDGs). The National Development Plan expresses goals of economic development and the progressive realisation of human freedoms through the provision of services such as health, education and housing. The SDGs include the imperatives of environmental sustainability, safety and security, and gender equality.

There must also be alignment between departmental policies. Both the process and the outcomes of the strategy have to be transformative and inclusive.

The 4IR raises a number of ethical questions, including questions about data privacy, responsibility for autonomous drones and vehicles, the bio-ethics of genetic modification, and the societal and developmental impacts of social media and internet use on individuals and populations. Each of these issues requires ongoing engagement among stakeholders, and a research response, in order to inform the policy development process in an ethical manner.

A national policy framework should be preceded by, and include, ongoing dialogue over the language of the 4IR and how it might best be framed in the South African public sphere. It may be the case that, as in other countries (such as Germany's concept of Industry 4.0 and Japan's concept of Society 5.0), South Africa coins its own term to describe its contextualised approach to accelerating technological change and utilising technological disruption.

A policy framework should include cross-cutting and vertical strategic focus areas

Strengthen adaptive capabilities

Rapid and accelerating technological change is a central proposition of the 4IR concept. We therefore need mechanisms to improve responsiveness and adaptability, both as a policy objective in a variety of domains (for example labour markets and innovation systems) and as a characteristic of policy mechanisms that have to function effectively in the context of rapidly changing technologies and socioeconomic dynamics. The South African response to the 4IR will require an increased capacity to be responsive to technological change – to sense changes in the global and local technological environments, and to interpret these changes in terms of their relevance to economies, society, institutions and policy.

Leverage technological change

Multiple specific technologies are currently causing widespread disruption (or opening avenues for innovation), for example AI, the industrial internet of things, genetic modification, robotics and 3D printing. Each technology – and each converged application of technologies – presents a distinct set of policy imperatives and opportunities, and hence should form a distinct component of an overall framework. The technological scope of the national policy response will have to change over time, as existing technologies plateau and new ones emerge to cause as yet unimagined disruptions.

While the leveraging of technological change has to encompass the full and dynamic scope of emerging technologies, four examples are presented below – each operationalises the principles of harnessing specific technologies to maximise opportunities and mitigate threats. The illustrative

examples focus on data, AI, Industry 4.0 and biotechnology.

Data policy

Data policy in South Africa is led by the Department of Communication and Digital Technology (DCDT). However, from a strategic point of view, data policy is cross-cutting in that it impacts other strategic areas such as Industry 4.0, AI, biotechnology and capability building. Across this broad scope, several strategic principles may guide data policy. Globally, there is a policy tension between the imperative of open data and the imperative of data privacy. Achieving a balance between these two opposing principles is an important part of an overall approach to data policy. It is also important to look at measures to reduce the cost of data for the poor. If one places the digital divide at the centre of the analysis, the question of data costs for poor people in South African might be the most critical issue in the overall South African response to the 4IR. A national data policy would need to steer the rollout of 5G networks. Network slicing (which splits resources into virtual networks to address use cases with distinct characteristics and data requirements) is an option that merits exploration, taking into account questions of data access and questions of enabling Industry 4.0 in South Africa. South Africa must support data sovereignty and internalise the beneficiation of South African data. Sectoral responses are also required. For example, ongoing review of the impact of the 4IR in the financial sector is needed to safeguard financial stability. Cyber security is increasingly important to national security. South Africa's cyber-security systems may require enhanced AI capabilities. Finally, South Africa's Information Regulator protects data privacy and helps South Africa to meet international privacy standards. This function may in future play a greater role and require expanded capabilities.

Artificial intelligence

Many countries have developed or are developing national AI strategies. A South African AI strategy should be aligned with and integrated with a national 4IR strategy. AI strategy includes the need to build skills and broad-spectrum research, development and innovation (RDI); stimulate investment; set legal and regulatory frameworks; address ethical issues; build public awareness; and seek application that meets developmental aims. At an operational level, the technological fundamentals of machine-learning applications do not have to be developed *de novo* – off-the-shelf machine learning systems are freely or commercially available. South Africa therefore has to strike a balance between building scientific capabilities in the AI domain and building technological capabilities in the domain of AI applications.

Industry 4.0

The concept of Industry 4.0 overlaps with, but is distinct from, the notion of the 4IR. The notion of the 4IR has a broader global socio-political component, while Industry 4.0 has a production focus – specifically on production automation through the use of cyber-physical systems and advanced manufacturing technologies such as autonomous and collaborative robots, simulations, systems integration, the industrial internet of things, additive manufacturing (3D printing) and human-machine interfaces. In South Africa, Industry 4.0 policy is spearheaded by the Department of Trade, Industry and Competition (DTIC), where a dedicated 4IR directorate has been established, and policy formulation is in progress at the time of writing. Industry 4.0 policy would ideally be integrated with data policy, due to its reliance on a permanently connected network of devices and equipment. A policy framework for Industry 4.0 would benefit from a sector-specific focus,

since the manifestation of Industry 4.0 has distinct characteristics in each sector.

Biotechnology

Biotechnology is critical technology within the 4IR, not only in terms of the changes it drives in sectors such as agriculture and healthcare but also in the changes it precipitates in the human body and identity. South Africa's national bio-economy strategy and its genetic modification regulatory framework are important parts of an overall 4IR policy system. A national 4IR framework may have to be used to review this policy and regulatory space, seeking to leverage biotechnology for the public good while also seeking alignment with data policy, Industry 4.0 policy and AI policy, among other areas. Some specific areas for consideration are regulatory costs and data bias. High regulatory costs can prevent new genetic modification technologies, developed within South African universities, from benefiting the public. In the medical sphere, South Africa has a responsibility to counter the consistent bias in global genetic databases which largely excludes African populations even though African populations are the most genetically diverse in the world.

Build 4IR capabilities

Building capabilities is a prerequisite for growing economic competitiveness and effectively applying technologies to meet human development aims. Key areas of capability include (1) the education system, (2) RDI, (3) public-sector innovation and (4) metro-level governance systems.

Education

Education and skills development are central in responding to the 4IR, as skills underpin national performance in terms of innovation, economic competitiveness, and the capacity to utilise and benefit from new technologies. The adaptability

imperative must shape education policy. As such, it is important to strengthen the capacity of tertiary education institutions to engage with employers and understand their current and potential future skills requirements. In addition, the cycle for curriculum change must be shortened to respond to changing technologies. Fresh approaches to education could include new and more flexible modalities. Lifelong learning, self-learning, peer learning and customised learning could be more pronounced. School curricula should steer away from machine-like tasks (memorisation, repetition and routine) towards human traits that machines are unlikely to replicate (empathy, creativity, innovation and social skills). At the same time, new technologies hold potential for greater inclusion in school curricula, for example the inclusion of coding, 3D printing and robotics. The use of technology for education requires increasing connectivity as well as technological upgrading. All technological upgrading requires capability building – the aim is to avoid the installation of laboratories or other facilities without developing the capabilities to operate them. At tertiary education level, curricula could be more multidisciplinary – for example engineering students should engage with social science concepts.

Research, development and innovation

Building RDI capabilities is strategically central. Without strengthening innovation systems and RDI capabilities, South Africa will not be positioned to move towards the technological frontier, enhance competitiveness or harness new technologies towards developmental aims. RDI policy could include increased support directed through existing instruments such as research chairs, centres of excellence, the National Research Foundation, and research programmes within universities and science councils. New instruments and mechanisms may also be

considered, for example the Department of Science and Innovation (DSI), through the Council for Scientific and Industrial Research (CSIR), has established a new World Economic Forum Centre for the 4IR with a focus on applied technology development.

Public-sector innovation

The technologies of the 4IR could be harnessed to strengthen the capacity of government to provide service delivery. This requires building internal government capabilities across a range of technological domains, including the use of AI and data analytics in governance as well as the use of 4IR technologies to deliver services as diverse as health, security, sanitation, housing, environmental protection, economic development and education.

Smart cities and human settlements

A national policy framework could provide guidelines for unique programmes within South Africa's metropolitan areas as well as for non-metropolitan human settlements. A national policy framework could make provision for devolved policy making, while at the same time establishing mechanisms for the managers and strategic actors involved at the city level to interact, develop cohesive programmes and foster mutual learning.

Direct policy towards developmental outcomes

Human development

The 4IR could be steered towards the achievement of South Africa's human development goals. This entails a focus on technology applications that improve human development. No list of such applications can be exhaustive, due to the diversity of technologies and human development needs. Rather, this is a cross-cutting principle that applies to leveraging technological change, building technological capabilities, and building economic competitiveness and employment.

Economic competitiveness

Building capabilities through education and RDI is a prerequisite for national economic competitiveness; however, to harness strengthened capabilities towards economic objectives may require dedicated policy interventions. Industrial and economic development policy options include incentives, small and medium-sized enterprise (SME) programmes, and incubators. Some countries, for example Italy, have introduced a research and development tax incentive for Industry 4.0 start-ups. A tax deduction related to training and skills development is an option. Digital innovation hubs, technology incubators and SME development programmes all have the potential to support new businesses and SMEs. Incubators could be domain specific (for example AI incubator, eCommerce incubator and 3D printing incubator) or converged (for example 3D bioprinting incubator).

The future of work

The International Labour Organization (ILO)² has formulated a consensus position on the future of work that frames it, in terms of values, as a fundamentally human-centric arena. Key elements of this position include foci on human capabilities, the institutions of work, and investment in decent and sustainable work. These focus areas present key tasks for South Africa as it negotiates current and future changes in the world of work.

Assessing the potential for automation-induced job losses, and mitigating their impacts, is an important component of a policy response. This imperative cuts across many policy arenas and government departments, and will have distinct dynamics in different sectors and industries. One general objective is to balance the need for technological upgrading, and therefore economic competitiveness, with the need for decent work and the prevention of unemployment.

A policy framework requires structures for consultation and co-ordination

Any national policy framework would require broad and ongoing social engagement. Germany's Platform Industry 4.0 may provide insights on how to structure such spaces. The policy options put forward for South Africa have the potential to inform socially-engaged debates. The Presidential Advisory Commission on the 4IR has emerged as the strategic centre for policy formation. Related structures could include mechanisms for public engagement, meso-level structures within government and strengthened international partnerships. Within this ambit, it is important to build a space where the DSI, DTIC, DHET, DCDT, DoL and other interested departments can co-ordinate their respective policies and strategies, and align these with the national process. A 4IR framework may include the development of functions focused on facilitating policy alignment (for example the alignment of department-led data policy, Industry 4.0 policy, RDI policy and skills development policy), as well as cross-cutting policy areas such as AI, economic development and human development. The Presidential Advisory Commission will play a leading role in determining how to advance from a general framework to sectoral responses, including the role of stakeholders contributing to specific policies. Ultimately, these efforts are critical to South Africa's future, with the aim of harnessing the 4IR for national development while mitigating South Africa's deep inequalities and digital divides.

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