
Assessment of Knowledge Society Development in South Africa

June 2017

African Leadership in ICT (ALICT)

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Introduction

The Global E-Schools and Communities Initiative (Gesci), in collaboration with the African Union Commission (AUC) and other partners, developed an African Leaders in ICT (ALICT) capacity-building programme. The first phase of the programme ran from 2012-2013, focusing on leadership capacity-building in twelve countries (Botswana, Ethiopia, Kenya, Malawi, Mauritius, Mozambique, Namibia, Rwanda, South Africa, Tanzania, Uganda, and Zambia). A second phase of the programme ran between 2014 and 2016 and included four countries (Ghana, Ivory Coast, Morocco, and Senegal). ALICT has built the capacities of 487 mid and senior government leaders in 16 Anglophone and Francophone African countries, as well as officials from the AUC between 2012 to 2015. The Francophone version of the ALICT Programme is referred to as *the Leadership Africain pour les TIC et le développement de la société du savoir (LATIC)*.

The course presented a multi-stakeholder approach for awareness-raising and capacity-building of African leaders around issues of Knowledge Society (KS), Information, Communication Technologies (ICT), Education, and Science Technology and Innovation (STI) in support of the AUC Action Plan and the EU-AU P8. Courses comprised of contextualized, modular content, founded upon country research and reflecting the identified needs of country governments.

The programme is currently under review to integrate leadership for sustainable development components in line with international frameworks and AU continental strategies for achieving 2030 sustainable development goals and objectives. The focus is on a continent-wide expansion of the programme through a wider access model.

Aims and Objectives of the study

To inform future development of the ALICT programme, it is important to understand where the participating countries are at in terms of developing a KS. Thus, Gesci commissioned Neil Butcher and Associates to prepare updates on the status of the KS in the 16 participating countries. Specifically, the focus was to update the situational and needs analysis of each country to keep abreast of developments since 2013 regarding the KS and its pillars of Education, STI, and ICT.

The specific objectives of the study were to:

- Update briefs of country KS pillars for the ALICT-LATIC Database.
- Update the ALICT KS country study database of the KS pillar status in each country, which involved:
 - Desk review of country KS documentation, identifying essential policies, strategies, plans, and papers on KS;
 - Review of KS pillar documentation sets related to Education, ICT, and STI; and
 - Identification of major actors, stakeholders, and partners and their role in KS pillar development.

Methodology

The report methodology involved a desk review of various government policy and strategy documents. Additionally, documents from development partners, research and academic papers, news articles, websites, and publications from various organizations were consulted. Further, data from the 2013 report were included where relevant. A framework for the country reports was

prepared, outlining what the various sections would cover. This was done to ensure uniformity in the type of information collected. The major areas and themes covered included policies and plans in ICT, Education, and STI. Additionally, socio-economic background information and indicators were reviewed to obtain an understanding of the context of each country. After receiving approval from Gesci for this framework, draft reports were prepared for each of the 16 countries. The reports were sent to Gesci for review and, based on feedback received, the reports were then finalized.

Overview of theoretical model

Modern economies are transforming from agricultural and industrial economies to information and knowledge-based economies. Such rapid transformation has had significant impact on social, economic, political, and cultural development across the world. For such development and growth, ICT is seen as both a driver and an enabler towards establishing and developing the various sectors in an economy that contribute to stronger, more developed, and richer societies. Africa is on a journey of transformation towards information and knowledge societies. During any such transformational journey, the leaders of a society and policy makers are likely to undergo a paradigm shift that involves developing their capacity and providing tools and direction for accepting relevant changes in mindset.

Dahlman (2011) defines a KS as a society that values the creation, dissemination, and effective use of knowledge, and has the institutions, infrastructure, norms, social interactions, and culture that support this.¹ UNESCO (2005) describes a KS as one that is nurtured by its diversity and its capacities. It further argues that, in the increasingly knowledge-based world, it is critical to embrace knowledge and innovation-related policies to spur competitiveness, growth, and improvements in welfare.²

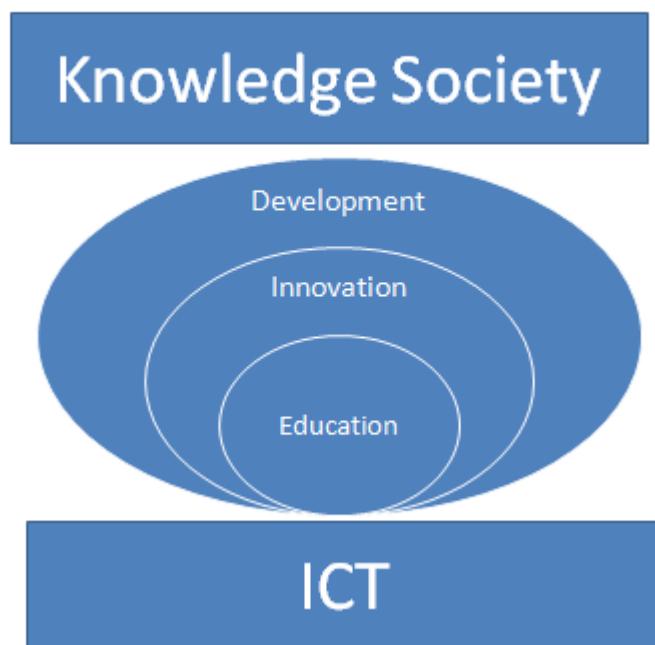
Gesci believes that ICT, education, and innovation are the critical pillars and key elements for development towards a knowledge-based future. Butcher (2010) visually captured the inter-relationship between the three pillars as follows:

¹ Dahlman, C. J. (2011). What is the Knowledge Economy and Society and How Can it Help Jamaica? Retrieved July 17, 2017 from

http://www.knowledgesocietyfoundation.com/images/Dahlman_C_2011_What_is_the_Knowledge_Economy_and_Society - How_can_it_help_Jamaica,_Jam_KE_C_Conf,_Ssn_1-2.pdf

² UNESCO. (2005). Towards Knowledge Societies. Retrieved July 17, 2017 from
<http://unesdoc.unesco.org/images/0014/001418/141843e.pdf>

Figure 1 Framework for reflecting on ICT, Education, Innovation and Development Support of a Knowledge Society³



The innovation pillar incorporates the fields of Science, Technology, and Innovation (STI) in a single pillar. The education and innovation pillars are presented as interrelated drivers for development. The ICT pillar is the enabler for Education and Innovation dynamics that will drive Development towards the Knowledge Society.⁴

ICT is regarded as an engine for growth and a tool for empowerment, which has profound implications for education change and socio-economic development. UNESCO (2007) defines ICT as

Forms of technology that are used to transmit, process, store, create, display, share or exchange information by electronic means. This broad definition of ICT includes technologies such as radio, television, video, DVD, telephone (both fixed line and mobile phones), satellite systems, and computer and network hardware and software, as well as the equipment and services associated with these technologies, such as videoconferencing, e-mail and blogs.⁵

ICT is considered a critical tool in preparing students with the skills required for the global workplace. Thus, technology integration is becoming a key element in almost every plan for the restructuring and re-engineering of education systems.⁶ This enables continuous adaptation to a

³ Neil Butcher and Associates. (2011). Thematic Paper: ICT, Education, Development, and the Knowledge Society. Gesci. Retrieved July 17, 2017 from http://gesci.org/fileadmin/user_upload/4_ICT_in_STEM_Education_Files/ICT_Education_Development_and_the_Knowledge_Society_1_1.pdf

⁴ Hooker, M. (2011). African Leadership in ICT and Knowledge Societies: Issues, Tensions and Opportunities for Learning for Gesci. Retrieved July 17, 2017 from http://gesci.org/fileadmin/user_upload/1_African_Leadership_in_ICT_and_Knowledge_Society_Development_Files/2013_-african-leadership-knowledge-societies-issues-tensions-opportunities-learning.pdf

⁵ UNESCO Bangkok. (2007). The UNESCO ICT in Education Programme. p.1. Retrieved July 17, 2017 from <http://unesdoc.unesco.org/images/0015/001567/156769e.pdf>

⁶ Scheffler, F.L., and Logan, J.P. (1999). Computer Technology in Schools: What Teachers Should Know and Be Able to Do. Journal of Research on Computing in Education, Vol 31, Issue 3. Available from <http://www.tandfonline.com/doi/abs/10.1080/08886504.1999.10782257>

work world of continuous technological innovations and makes it easier for students to access knowledge.

Challenges of ICT within Africa often relate to lack of human and financial resources, which translate into inadequate and insufficient skills supply, irrelevant or incomplete regulatory frameworks, including policies and legislation, and inadequate infrastructure and communication platforms.⁷ To embrace a KS, Gesci believes that there is a requirement to ensure that leaders develop skills to make informed policy and investment decisions to support socio-economic development effectively. This encompasses building both leadership ICT skills and ICT management skills.

Lifelong learning is regarded as a requirement to keep pace with the constantly changing global job markets and technologies. Education contributes to all other sectors by providing required skills and knowledge for economic development. Thus, it is not limited to formal education in traditional structures, but encompasses the broader societal learning necessary for development. Preparation for lifelong learning involves an emphasis, in primary and secondary schools, on learning general skills and competencies (communication, mathematics and science skills, new literacy skills, problem-solving and interpersonal skills, and self-directed learning skills to learn other subjects) and at tertiary level on capacity-building in science and technology, discipline-specific skills, research, and development.⁸ Additionally, there is a need for postgraduate programmes to build specific research capacity to handle knowledge-innovation process development – to meet needs and demands for national and regional competitiveness and growth. Education plays critical roles in imparting learning skills.⁹

Innovation is described as a process of creation, exchange, evolution, and application of knowledge to produce new goods. It involves adapting, adopting, or using knowledge to produce new goods and services in local contexts or to advance society in general.¹⁰ The UN Economic Commission for Africa (UNECA) (2010) regards innovation and change as fundamental when developing a KS to drive economic growth and advancement. It has been argued that the basic ingredient for nurturing the innovation dynamic is setting up systems to enable cross-fertilization of ideas between the fields of Science, Engineering, Technology, and Innovation (SETI).¹¹

Overview of the ALICT-LATIC programme

The ALICT Programme is conceptualized to model a methodology and multi-stakeholder approach for capacity building and awareness raising of African leaders on the issues of the KS, ICT, Education, and STI.¹² The programme is based on the premise that investments in ICT, Education, and STI contribute to socio-economic development and a shift towards the development of a KS.

The programme's focus is to build absorptive capacity of current and potential future African leaders to acquire, assimilate, transform, and exploit the benefits of knowledge. It aims to foster dynamic

⁷ Hooker, M. (2011). African Leadership in ICT and Knowledge Societies: Issues, Tensions and Opportunities for Learning for Gesci. Op cit

⁸ Neil Butcher and Associates. (2011). Thematic Paper: ICT, Education, Development, and the Knowledge Society. Op cit

⁹ Hooker, M. African Leadership in ICT and Knowledge Societies: Issues, Tensions and Opportunities for Learning for Gesci. Op cit

¹⁰ Hooker, M. (2010). Concept note: Building Leadership Capacity for ICT and Knowledge Societies in Africa. Gesci. Retrieved July 17, 2017, from http://gesci.org/fileadmin/user_upload/1_African_Leadership_in_ICT_and_Knowledge_Society_Development_Files/2012_-ConceptNoteALICITFinal.pdf

¹¹ Hooker, M. (2011). African Leadership in ICT and Knowledge Societies: Issues, Tensions and Opportunities for Learning for Gesci. Op cit

¹² ibid

organizational capability through knowledge sharing, collaboration, and exposure to technology. It is hoped that, through participation in the ALICT-LATIC course, future African leaders will demonstrate knowledge, skills, and attitudes that promote their role as change agents. These are expected to translate into positive benefits for their respective countries in pursuit of inclusive knowledge societies.

The core concepts of the programme are as follows:

- Capacity Building: The ALICT capacity-building model aims to build and enhance the knowledge, skills, and attitudes of future leaders to manage transformation and change, manage institutional pluralism, enhance coordination, foster communication, and ensure that data and information are shared and used in planning, resource mobilization, implementation, and evaluation processes.
- Knowledge Society: The ALICT model focuses on the role all facets of ICT play in building the absorptive capacities of current and potential future African leaders to acquire, assimilate, transform, and exploit the benefits of ICT and knowledge to produce a dynamic organizational capability through peer knowledge sharing and exposure to technology. The ALICT approach to KS development focuses on the interconnection between leadership, policy development, and future-proof planning and how they contribute to KS development through Education, STI, and ICT.
- Leadership: A prerequisite for leadership development for knowledge societies is policy coherence between the three pillars (ICT, Education, and STI) that form the basis of any KS. For future African leaders to be able to steer their countries towards that goal, it is essential for them to not only be well versed in management, leadership, project formulation and project management skills, but also to acquire comprehensive knowledge about the interrelationship of the three KS pillars (Education, STI and ICT) and then be able to apply that knowledge in the African context.
- Policy Coherence: Policy coherence is the development and implementation of conjointly supportive policy actions across all sectors of the economy and society and, more specifically across government departments and agencies. Policy coherence pursues the creation of synergies across policies that advance the achievement of shared and agreed objectives. Within national governments, policy coherence issues arise between different types of public policies, between different levels of government, between different stakeholders, and at an international level.
- Futures Thinking: Futures Thinking was first theorized by Jim Dator (Bezold, 2009). Among its many uses within complex and rapidly shifting economic and social systems is its relevance to policy development and implementation. Futures Thinking requires the revisit of plans and policies at regular intervals to take into consideration any new signals that appear in the environment that may affect a sector or number of sectors.¹³

Considering Sustainable Development Goals

The 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development officially came into force in January 2016. These new goals apply to all countries when mobilizing efforts to end all forms of poverty, fight inequalities, and tackle climate change over the next 15 years.

¹³ Taken verbatim from African Leadership in ICT Model Document 2013 - The Future of African Leadership is here. Retrieved July 17, 2017, from http://gesci.org/fileadmin/user_upload/1_African_Leadership_in_ICT_and_Knowledge_Society_Development_Files/ALICT_Model_final_Juho.pdf

They recognize that ending poverty must go hand-in-hand with strategies that build economic growth and addresses a range of social needs including education, health, social protection, and job opportunities, while tackling climate change and environmental protection.¹⁴

While the SDGs are not legally binding, governments are expected to take ownership of, and establish national frameworks to achieve, the 17 Goals: no poverty; zero hunger; quality education; gender equality; clean water and sanitation; affordable and clean energy; decent work and economic growth; industry, innovation and infrastructure; reduced inequalities; sustainable cities and communities; responsible consumption and production; climate action; life below water; life on land; peace, justice, and strong institutions; and partnerships for the goals.

Primary responsibility for follow-up and review of progress made in implementing the SDGs rests with countries. Implementation and success of the SDGs depends on countries' own sustainable development policies, plans, and programmes. However, regional follow-up and review will be based on national-level analyses and contribute to follow-up and review at the global level.¹⁵

Whilst implementation of SDGs is still in early phases, it provides an opportunity to frame the ALICT programme as a mechanism for countries to address SDGs, due to the programme's cross-cutting nature. Specifically, KS development relies on the progress made in many of the SDGs.

¹⁴ United Nations. (no date) Sustainable Development Goals – 17 Goals to Transform our World. Retrieved July 17, 2017 from <http://www.un.org/sustainabledevelopment/development-agenda/>

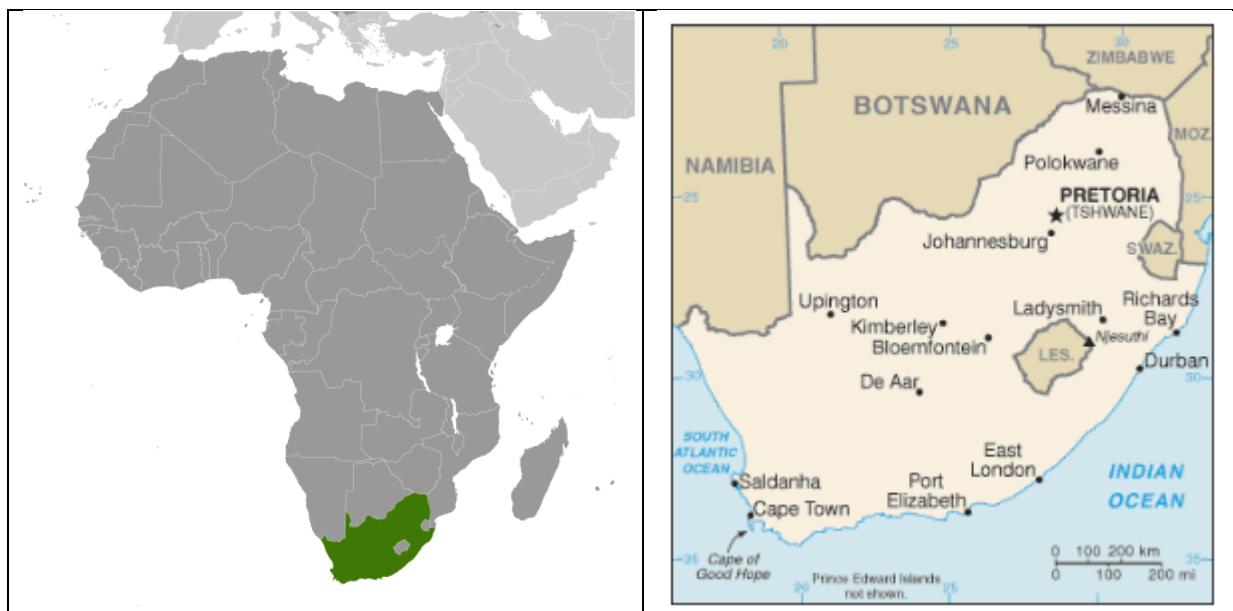
¹⁵ Ibid

Knowledge Society Development in South Africa

1 Introduction

South Africa is located at the tip of the Southern Africa Region and is part of the Sothern African Development Community (SADC). The currency is the Rand (ZAR). It has a surface area of 1,221,037 square kilometers.¹⁶

Figure 2 Map of South Africa¹⁷



The administrative capital city of South Africa is Pretoria which had 2.92 million inhabitants in October 2013.¹⁸ Cape Town is the legislative capital with 3.74 million inhabitants¹⁹ (2013) while Bloemfontein is the judicial capital with 747 thousand inhabitants²⁰ in the 2011 census. South Africa has eleven official languages, namely: Afrikaans, English, isiNdebele, isiXhosa, isiZulu, Sesotho sa Leboa, Sesotho, Setswana, siSwati, Tshivenda, and Xitsonga.

The population, according to Statistics South Africa, is 55.91 million. Approximately fifty-one per cent (28.53 million) of the population is female. About 30.1% of the population is aged younger than 15 years and approximately 8% (4.47 million) is 60 years or older. Of those younger than 15 years, approximately 23% (3.66 million) live in KwaZulu-Natal and 20.4% (3.43 million) live in Gauteng.²¹

¹⁶ Central Intelligence Agency – The World Factbook. (2017). South Africa. Retrieved February 23, 2017 from <https://www.cia.gov/library/publications/resources/the-world-factbook/geos/sf.html>

¹⁷ Ibid

¹⁸ City population. (2011). Tshwane Metropolitan area/Pretoria. Retrieved February 3, 2017 from <http://www.citypopulation.de/php/southafrica-cityoftshwane.php>

¹⁹ City population. (2011). Cape Town Metropolitan area. Retrieved February 3, 2017 from <http://www.citypopulation.de/php/southafrica-cityofcapetown.php>

²⁰ City population. (2011). Mangaung Metropolitan area/Bloemfontein. Retrieved February 3, 2017 from <http://www.citypopulation.de/php/southafrica-mangaung.php>

²¹ Statistics South Africa. (2016). Mid-year population estimates. Retrieved February 3, 2017 from <http://www.statssa.gov.za/publications/P0302/P03022016.pdf>

The population density in 2015 was estimated at 45.35 per square kilometre.²² The country's diverse population in 2016 comprised 45.11 million black African, 4.9 million coloured, 4.52 million white, and 1.39 Indian/Asian people.²³

Migration is an important demographic process in shaping the age structure and distribution of the provincial population, with the Eastern Cape and Limpopo provinces experiencing the largest out-migration. The province of Gauteng accommodates the largest share of the South African population. Approximately 13.5 million people (24.1%) live in this province. KwaZulu-Natal is the province with the second largest population, with 11.1 million people (19.8%) living in this province. With a population of approximately 1.19 million people (2.1%), Northern Cape remains the province with the smallest share of the South African population.²⁴

Life expectancy is continuing to increase, possibly related to marginal gains in survival rates among infants and children under five post HIV interventions in 2005 at birth. Life expectancy for 2016 is estimated at 59.7 years for males and 65.4 years for females. The infant mortality rate for 2016 is estimated at 33.7 per 1,000 live births while the under-five mortality rate is estimated at 44.4 child deaths per 1,000 live births. The estimated overall HIV prevalence rate is 12.7% of the total population. The total number of people living with HIV is estimated at 7.03 million in 2016. For adults aged 15–49 years, an estimated 18.9% of the population is HIV positive.²⁵

According to the UNESCO Institute for Statistics, 96.6% of South Africans over 15 years of age can read and write, but a larger percentage of men (95.83%) than women (93.43%) are literate.²⁶ The South African voters' roll now stands at over 26.33 million registered people.²⁷

The GDP for 2015 was \$314,572 billion. South Africa is also classified as an upper-middle income economy by the World Bank.²⁸ The economy of South Africa is ranked 32nd by the World Bank's GDP list for 2015 making it the third African country on the list, after Nigeria and Egypt.²⁹

In 2016, South Africa ranked 6 out of 54 African countries on the Mo Ibrahim Index which offers a comprehensive assessment of governance that informs and empowers citizens, civil society, parliaments and governments as a tool of measuring progress in governance.³⁰

The Global Competitiveness Index (GCI, 2016-17) which assesses the ability of countries to provide high levels of prosperity to their citizens through measuring the set of institutions, policies, and factors that set the sustainable current and medium-term levels of economic prosperity ranks South Africa 47 out of 138 countries with a score of 4.5.³¹ The index points to inefficient government

²² The World Bank. (2015). Population, total. Retrieved February 3, 2017 from <http://data.worldbank.org/indicator/EN.POP.DNST?locations=ZA>

²³ Statistics South Africa. (2016). Mid-year population estimates. Retrieved February 3, 2017 from <http://www.statssa.gov.za/publications/P0302/P03022016.pdf>

²⁴ Ibid

²⁵ Ibid

²⁶ UNESCO Institute for Statistics. (2015). Retrieved February 3, 2017 from <http://uis.unesco.org/en/country/ZA>

²⁷ Independent Electoral Commission of South Africa. (2016). Retrieved February 6, 2017 from <http://www.elections.org.za/content/Voters-Roll/Registration-statistics/>

²⁸ The World Bank. (2015). GDP, total. Retrieved February 3, 2017 from <http://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=ZA>

²⁹ The World Bank, World Development Indicators database, 1 February 2017. Retrieved February 3, 2017 from <http://databank.worldbank.org/data/download/GDP.pdf>

³⁰ Mo Ibrahim Foundation. (2016). Ibrahim Index of African Governance. Retrieved May 30, 2017 from <http://iiag.online/>

³¹ World Economic Forum. (2016). Global Competitiveness Index – South Africa. Retrieved May 30, 2017 from <http://reports.weforum.org/global-competitiveness-index/country-profiles/#economy=ZAF>

bureaucracy, restrictive labour relations and an inadequately educated workforce as primary limiting factors.

The World Bank's "Ease of doing business" index, a measure of the relative ease for starting a running a local business, for 2017 ranks South Africa as 74 out of 190. Starting a business, enforcing contracts and trading across borders are still constraints.³²

According to the Heritage Foundation report, South Africa's economic freedom score is 62.3 making it the 81st freest economy out of the 178 ranked countries and rated as "moderately free". South Africa is ranked 6th out of 46 countries in the Sub-Saharan Africa region, and its overall score is above the world average of 60.7. According to the Heritage Foundation, the persistent uncertainties surrounding key government policies are hindering private investment and expansion of a production base. Rising public debt, inefficient state-owned enterprises, and spending pressures contribute to increasing fiscal vulnerability and undermine the macroeconomic stability of the country.³³

South Africa has an abundant supply of natural resources; well-developed financial, legal, communications, energy, and transport sectors; and a stock exchange that is Africa's largest and among the top 20 in the world. Even though the country's modern infrastructure supports a relatively efficient distribution of goods to major urban centres throughout the region, unstable electricity supplies hamper growth. Eskom, the state-run power company, is building three new power stations and is installing new power demand management programmes to improve power grid reliability.³⁴

South Africa faces structural constraints that limit economic growth, such as skills shortages and frequent work stoppages due to strike action. The government faces growing pressure from urban constituencies to improve the delivery of basic services to low-income areas and to increase job growth.³⁵

The unemployment rate stood at 25.5% in the third quarter of 2015, with the number of South Africans categorised as long-term unemployed 5.7% higher than in 2014.³⁶ South Africa has the highest rate of unemployment among Commonwealth countries. The situation is worsened by a gender gap in the work force, in which there is an especially low number of women in the fast-growing areas of science, technology, engineering and mathematics.³⁷

The National Development Plan 2030 (NDP) is South Africa's roadmap to eliminate poverty and reduce inequality by 2030. This vision for South Africa in 2030 is divided into thirteen specific goals. These are:

- 1) Health care for all;
- 2) Safety and freedom from fear;
- 3) Economy and employment;
- 4) A skilled workforce;
- 5) Economic infrastructure;

³² The World Bank. (2016). Doing Business. Retrieved March 10, 2017 from <http://www.doingbusiness.org/rankings>

³³ The Heritage Foundation. (2017). South Africa. Retrieved May 30, 2017 from <http://www.heritage.org/index/pdf/2017/countries/southafrica.pdf>

³⁴ Central Intelligence Agency – The World Factbook. (2017). Op cit

³⁵ Ibid

³⁶ National Treasury. (2016.) National Budget Review. Retrieved February 3, 2017 from <http://www.treasury.gov.za/documents/national%20budget/2016/review/chapter%202.pdf>

³⁷ Commonwealth of learning. (2016). Using ICT skills development to address the skills shortage. Retrieved on March 1, 2017 at <https://www.col.org/news/col-blog/using-ict-skills-development-address-skills-shortage>

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- 6) Vibrant rural communities;
 - 7) Sustainable human settlements;
 - 8) Accountable local government;
 - 9) A healthy natural environment;
 - 10) South Africa's place in the world;
 - 11) Efficient public service;
 - 12) Inclusive social protection; and
 - 13) Nation building and social cohesion.³⁸

South Africa is contributor to global climate change due to its energy-intensive, fossil-fuel powered economy, and is also highly vulnerable to the impacts of climate change. The South African government believes that climate change is a threat to the advances made in meeting South Africa's own development goals and the Millennium Development Goals.³⁹

The government acknowledges that should multi-lateral international action not effectively limit the average global temperature increase to below at least 2°C above pre-industrial levels, the potential impacts on South Africa in the medium-to long-term are significant and potentially catastrophic. The temperature is predicted to rise by 1°C to 2°C on the South African coast, and around 2°C to 3°C in the interior by mid-century. By 2100 warming is projected to reach around 3 to 4°C along the coast, and 6 to 7°C in the interior.⁴⁰

South Africa is a water scarce country and this climate change would mean that parts of the country will be much drier; there will be an overall decrease in water availability significantly affecting human health, agriculture and the environment in general. This would also lead to the increased occurrence and severity of veld and forest fires; and an increase in extreme weather events such as floods and droughts. Sea-level rise will negatively impact coastal infrastructure; and mass extinctions of endemic plant and animal species will greatly reduce South Africa's biodiversity.⁴¹

Coastal human settlements are the most vulnerable to an increase in sea-level rise due to climate change. Coastal areas provide habitation, work, and recreation to approximately 40% of South Africa's people. These areas attract large numbers of local and international tourists.⁴²

Socio-economically, South Africa is vulnerable to the impacts of climate change because a large proportion of the population live in impoverished circumstances, where informal settlements are susceptible to extreme weather events, and housing in these areas does not provide sufficient protection against rain, wind and cold. Since much of South Africa experiences low and variable rainfall, access to safe drinking water is a problem in some communities, and this will cause the spread of disease. Water shortages could pose a problem in the future, and this may be worsened by climate change.⁴³

Agriculture and fisheries play a significant role in food security and provide employment to a large percentage of the population. Both agriculture and fisheries face climate change related threats, and

³⁸ The National Planning Commission. (2011). National Development Plan: 2030. Retrieved February 10, 2017 from http://www.gov.za/sites/www.gov.za/files/devplan_2.pdf

³⁹ Government of South Africa. (2011). National Climate Change Response White Paper. Retrieved February 10, 2017 from <http://www.climateresponse.co.za/home/gp/1>

⁴⁰ Ibid

⁴¹ Ibid

⁴² Ibid

⁴³ Griffin, J. (2012). The Impact of Climate Change on South Africa. Retrieved May 30, 2017 from https://www.climateemergencyinstitute.com/cc_s_africa_griffin.html

this will have socio-economic impacts. Small scale farmers and subsistence farmers are most vulnerable to the effects of water shortages and droughts.⁴⁴

South Africa is facing increasing political instability. President Jacob Zuma is facing rising popular discontent, even amongst the ruling African National Congress's (ANC) historic support base formed by the tripartite alliance (including the ANC, trade union Cosatu, and the South African Communist Party), in the face of continued allegations of corruption against Zuma and his government. Declining ANC support coincides with the rising number of protests and demonstrations, most of them related to governance challenges. In 2017, the president decided to enact a massive cabinet reshuffle, prompting calls for his resignation.⁴⁵

In 2017, Zuma fired respected Finance Minister, Pravin Gordhan, who had been committed to eradicating corruption and keeping government spending to a minimum. This led to a five percent plunge in the value of the rand, and prompted two credit agencies to downgrade South Africa's credit rating to junk status. This is causing a loss of consumer and business confidence in South Africa.⁴⁶

South Africa has placed military units to assist police operations along the border of Lesotho, Zimbabwe, and Mozambique to control smuggling, poaching, and illegal migration.⁴⁷

⁴⁴ Ibid

⁴⁵ BMI Research. (2017). Political Risk Analysis - Quick View: May Day Jeers Highlight Rising Pushback Against Zuma - JULY 2017. Retrieved June 14, 2017 from <http://www.africamonitor-newsletter.com/political-risk-analysis-quick-view-may-day-jeers-highlight-rising-pushback-against-zuma-july-2017>

⁴⁶ World Finance. (2017). Political instability sends South Africa into recession for the second time in eight years. Retrieved June 14, 2017 from <https://www.worldfinance.com/featured/political-instability-sends-south-africa-into-recession-for-the-second-time-in-eight-years>

⁴⁷ Central Intelligence Agency – The World Factbook. (2017). South Africa. Op cit

2 Information and Communication Technology (ICT)

2.1 ICT Policy Frameworks

The National Development Plan: 2030 states that “by 2030, ICT will underpin the development of a dynamic and connected information society and a vibrant knowledge economy that is more inclusive and prosperous”.⁴⁸

In 2016, the South African government approved the Department of Telecommunications and Postal Services’ National Integrated Information and Communication Technologies (ICT) Policy White Paper, describing it as an integrated and holistic policy that covers the ICT and postal sectors and sets out the framework of how government wants to provide access to modern communications infrastructure and services to facilitate the entry of new players and meaningful participation of all citizens, including those in rural areas. The White Paper will assist the South African government to achieve the goals of the NDP to use ICT to facilitate faster shared economic growth, improve service delivery and radically transform society. The policy creates a baseline measure of local ICT statistics, reducing the reliance on international studies.⁴⁹

This White Paper includes approaches to governance of the internet at an international and national level and policies on managing and administering the internet in line with the vision set in the United Nations World Summit on the Information Society (WSIS). Universal service and access policies are aimed at ensuring that all South Africans have access to ICT services, and the Department claims that achieving this will require both competitive private sector investment and targeted public sector intervention. The White Paper recognises that fair competition has a role in facilitating universal service and access, and to limiting the digital divide through addressing market inefficiencies, promoting investment in the ICT sector and facilitating innovation. The policy sets out a framework for cooperation with other regulators like the Competition Commission. The policy retains the principles of convergence and technological neutrality to ensure consistent regulation of all networks irrespective of the type of services they carry or whether they are owned and operated by telecommunications, broadcasting or other services.⁵⁰

Regulation and governance of the ICT sector is currently spread across different entities, resulting in overlaps and duplication of roles, and a lack of coordination between different entities. The policy outlines the different roles and mandates of the various role-players. All policy making functions are consolidated and assigned to government. All regulatory responsibilities are assigned to the regulator. This regulator oversees and promotes internet governance, licensing and regulation of networks, services, and other scarce ICT-related resources. The policy proposes that a new economic regulator of ICT be established.⁵¹

The Department of Communications (DoC), according to the Strategic Plan for the for 2016/17 to 2019/20, is responsible for developing policy and legislative frameworks for communications, media and audio-visual content across all platforms. The policy and regulatory decision is regarded as important in shaping and determining the future of the South African communications, media and

⁴⁸ The National Planning Commission. (2011). National Development Plan: 2030. Op cit

⁴⁹ Fin24.com. (2016). Department puts ICT White Paper in context. Retrieved March 2, 2017 from <http://www.fin24.com/Tech/News/department-puts-ict-white-paper-in-context-20161002>

⁵⁰ Ibid

⁵¹ Ibid

content media ecosystem that provides developmental content necessary to sustain its constitutional democracy.⁵²

The DoC is preparing amendments to the following legislation:

- Broadcasting Amendment Bill: The objective of the amendments is to address the governance matters in relation to the board.
- Independent Communications Authority of South Africa (ICASA) Amendment Bill: The objective is to amend the appointment procedures to ensure operational efficiency and performance.
- Media Development and Diversity Agency (MDDA) Amendment Bill: The objective of the amendment is to align the Act to the name of the Minister of Communications and the department and review the entity's ten-year-old mandate in the digital environment.
- Film and Publication Board (FPB) Amendment Act: The objective of the amendment is to align the Act and strengthen the capacity of the FPB to perform its functions.⁵³

Gillwald (2014) argues that it is the lack of institutional capacity to reform monopoly and duopoly markets adequately and to regulate them effectively, that has undermined many of the reform initiatives within the communications sector in South Africa. A fundamental policy review is needed to produce a national e-strategy, as proposed in the National Development Plan. While the ICT sector might provide direct opportunities for manufacturing, service provision and job creation, its significant contribution to economic development is to improve communication and information flow for increased productivity and efficiency.⁵⁴

In 2014, South Africa had the most cyber-attacks of any country in Africa. In 2015, the Department of Justice tabled the Cybercrimes and Cybersecurity Bill,⁵⁵ detailing a wide range of crimes and penalties for these crimes, but this has received criticism because South Africa faces a lack of cyber-capacity skills. Cyber-related responsibilities are decentralised to several government departments, which has been criticised as likely leading to inefficiencies and duplication of effort.⁵⁶ In 2016, this bill was updated, and passed into law in February 2017, and created several new offences for unlawful cyber activity and additional obligations for certain institutions, such as financial institutions.⁵⁷

2.2ICT Infrastructure

Telecommunications is one of the fastest growing sectors of South Africa's economy, driven by explosive growth in mobile telephony and broadband connectivity. With a network that is 99.9% digital and includes the latest in fixed-line, wireless and satellite communication, the country has the best developed and most modern telecoms network in Africa. South Africa's has a relatively low rate of fixed-line telephony, with around 4.131-million fixed-line connections and only 1.409-million fixed broadband subscriptions in 2015 and 51% of individuals using the internet.⁵⁸ Fixed-line telephony is

⁵² Department of Communications (2016). Revised Strategic Plan Medium Term 2015/16-2019/20. Retrieved February 10, 2017 from <http://www.doc.gov.za/sites/www.doc.gov.za/files/docs/resourcecentre/2016%20DoC%20SP%20web.pdf>

⁵³ Ibid

⁵⁴ Gillwald, A. (2014). Beyond the Policy Debates: ICT and the National Development Plan. Retrieved June 12, 2017 from <http://hsf.org.za/resource-centre/focus/focus-66/AGillwald.pdf/download>

⁵⁵ Department of Justice. (2015). Cybercrimes and Cybersecurity Bill Draft for Public Comment. Retrieved February 10, 2017 from <http://www.justice.gov.za/legislation/invitations/CyberCrimesBill2015.pdf>

⁵⁶ Fin24tech (2015). What SA is doing to tackle cyber crime. Retrieved February 10, 2017 from <http://www.fin24.com/Tech/Opinion/What-SA-is-doing-to-tackle-cyber-crime-20151104>

⁵⁷ Republic of South Africa. (2017). Cybercrimes and Cybersecurity Bill. Retrieved 2 June 2017 from http://www.gov.za/sites/www.gov.za/files/b6-2017_cybercrimes_170221_a.pdf

⁵⁸ International Telecommunications Union. (2015.) Retrieved February 21, 2017 from <http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>

dominated by the first National Telecoms Operator, Telkom, which is listed on the Johannesburg Stock Exchange but is majority owned (around 40%) by the Department of Communications.

According to the International Telecommunications Union (ITU), 59.47% of South Africans have active mobile broadband subscriptions, and 51.92% of South Africans use the internet. Only 23.35% of households have a computer, but 50.58% have access to the internet.⁵⁹ Mobile phone use in South Africa surged by 822% in the years from 2000 to 2013, according to the Institute of Race Relations (IRR). The number of cellular subscriptions increased from 8.3 million in 2000 to 76.8 million 2013, or by 822%. Over the same period, the number of fixed-line telephone connections fell by 22%.⁶⁰

The World Economic Forum (WEF) *Global Information Technology Report 2016*, uses the Networked Readiness Index (NRI) to measure the degree of preparation of a nation to participate in, and benefit from, ICT developments. A total of 139 economies participated in 2016. South Africa's Networked Readiness Index for 2016 is 65, ten positions higher than 2015, although the total list of countries measured has decreased from 143 to 139.⁶¹ South Africa made large improvements in the overall NRI rankings, almost entirely driven by improvements in infrastructure and affordability. South Africa's digital transformation is mostly business driven, performing best in business usage (32nd), followed by individual usage (77th), followed by government usage (105th). South Africa's innovation and business environment is rated significantly worse and, shows strong signs of deterioration, especially regarding technology and venture capital availability, government procurement of the latest technologies, and procedures to start a business. Mobile tariffs have more than halved and broadband tariffs dropped slightly, reducing barriers to adoption also in terms of affordability. In order for impact to start materializing, it is believed that significantly more buy-in from government will be needed across all areas of vision, promotion, and efficient use.⁶²

Table 1 Summary of ICT access in South Africa from Census and Research ICT Africa ICT survey data⁶³

	Census		RIA	
	2006	2011	2007	2012
Households with fixed line	18.5%	14.5%	18.2%	18.0%
Households with computer	15.6%	21.4%	14.8%	24.5%
Households with radio	76.5%	67.5%	77.7%	62.3%
Households with television	65.5%	74.5%	71.1%	78.2%
Households with internet		35.2%	4.8% (household) 15.0% (individual)	19.7% (household) 33.7% (individual)
Cellphone ownership (household)	72.7%	88.9%	62.1%	84.2%

⁵⁹ International Telecommunications Union. (2016). ITU Development Index 2016 <http://www.itu.int/net4/ITU-D/idi/2016/#idi2016countrycard-tab&ZAF>

⁶⁰ Brand South Africa. (2015). More South Africans log on via mobile. Retrieved February 23, 2017 from <https://www.brandsouthafrica.com/south-africa-fast-facts/news-facts/cellphones-090815>

⁶¹ World Economic Forum. (2016). The Global Information Technology Report 2016. Retrieved February 10, 2017 from <http://online.wsj.com/public/resources/documents/GITR2016.pdf>

⁶² Ibid

⁶³ Gillwald, A., Moyo, M. and Stork, C. (2012). Understanding what is happening in ICT in South Africa. Retrieved 27 February 2017 from https://www.researchictafrica.net/publications/Evidence_for_ICT_Policy_Action/Policy_Paper_7_-Understanding_what_is_happening_in_ICT_in_South_Africa.pdf

Until 2009, South Africa had amongst the highest international bandwidth prices in the world, because the bandwidth was via satellite and a single undersea cable, South Atlantic 3 (SAT-3), whose sole South African owner was Telkom. South Africa received services from four new submarine cable systems, causing prices to drop significantly. The privately held, open-access SEACOM cable was the first competing cable to land, in 2009. SEACOM is 17,000 km long and with a capacity of 4.2 tbps. In 2012, the SEACOM cable was the only cable servicing the eastern seaboard of the continent and links South Africa, Mozambique, Madagascar, Tanzania, and Kenya with India and Europe. The Eastern Africa Submarine Cable System (EASSy) landed in South Africa in 2010 and is 10,000 km long with a capacity of 4.72 tbps. The MainOne cable landed in 2010, and the West Africa Cable System (WACS) became operational in late-2011. WACS is 17 200 km long, with an initial capacity of 500 gbps, upgradable to a mammoth 5.12 tbps. The African Coast to Europe (ACE) cable came online in South Africa in 2012, with a capacity of 5.12 tbps and a length of 17 000 km (ACE, 2013). The landing of these cables has led to an improvement in international bandwidth capacity, both in terms of quality and pricing (via competitive sales to all carriers).⁶⁴

SA Connect, the ambitious national broadband programme, was set up in 2013. The plan was to deliver fast and affordable internet to the 90% of South Africa by 2020,⁶⁵ but failed to start because the tender specifications for the network service provider were so onerous no one qualified and Telkom, the Cabinet's preferred bidder, did not submit a bid in 2016.⁶⁶

Broadband is an essential digital and has the potential to create job opportunities and open new markets that will allow businesses to grow. Given the strategic importance of broadband, the DoC, committed to delivering 100% broadband penetration and creating a million jobs by 2020. The department is aware of the inter-connectedness of broadband and the licensing of radio frequency spectrum, which is a scarce natural resource. The Broadband Strategy and Implementation Plan outlines fibre connectivity across the country to district level. According to the Ministry of Telecommunications and Postal Services, government is planning several supply and demand-side broadband interventions in South Africa to address the gap between those who have access to digital services and those who do not. An infrastructure gap-analysis study has indicated that there is a gap between the high-capacity backbone and access to network infrastructure. This gap is biggest in rural areas where the most marginalised communities live. There are also some urban areas with high population densities that remain unserved. However, the real gap is in the last-mile or "local loop" infrastructure. There is considerable duplication and potential under-exploitation of infrastructure in metropolitan areas because these areas were commercially attractive to service providers. To address this gap government had found it necessary to consider a range of interventions on both the demand and supply-side of broadband. Supply side interventions to encourage investment and rollout of infrastructure include:

- support for public/private investment initiatives;
- increased competition;
- expansion of core and access networks;
- enablement of infrastructure sharing;
- promotion of coordinated build programmes; and
- allocation of prime spectrum to support universal access.

⁶⁴ Ibid

⁶⁵ IT Web (2016). Cwele talks up SA's ICT ranking. Retrieved February 10, 2017 from http://www.itweb.co.za/index.php?option=com_content&view=article&id=157129:Cwele-talks-up-SA-s-ICT-ranking&catid=260

⁶⁶ IT Web (2016). Confusion looms in wake of cancelled SA Connect tender. Retrieved February 10, 2017 from http://www.itweb.co.za/index.php?option=com_content&view=article&id=157911:Confusion-looms-in-wake-of-cancelled-SA-Connect-tender&catid=147

To complement the supply chain, government determined a number of demand-side interventions. These seek to stimulate the uptake and usage of broadband services and products:

- increased affordability of services and devices;
- aggregation of government demand to enhance procurement;
- alignment of regulatory framework;
- development of ICT skills and e-literacy;
- development of local content, applications; and
- stimulation of niche manufacturing.

Government's intention is to invest in broadband infrastructure through aggregation of public sector demand and smart procurement of high capacity networks.⁶⁷

2.3 ICT4D Initiatives

South Africa faces significant human capital development challenges impacting on the building of an Inclusive Information Society which manifests itself through the shortage of ICT skills at all levels. There are several ICT4D initiatives run by both government as well as the private sector. Examples of some of these initiatives are highlighted below.

The field of ICT4D remains poorly defined in South Africa. In response to a growing need within industry and academia, the University of Cape Town created in 2008 a research centre to investigate the use of ICT in a developing world context. The Centre in ICT4D that serves as a focal point for researchers who wish to create ICT that address problems in the African continent and other developing regions. At present, this centre is the only multi-disciplinary group based in Africa working in ICT for Development. It is a multi-disciplinary centre that seeks to create new technologies for the developing world, as well as study the impacts of existing technology, and provide academic leadership and shape this field so that it best serves those peoples and regions yet to fully engage with digital technology. In addition, it offers masters or doctorate degrees in ICT4D.⁶⁸

The following initiatives focus mainly on training and skills development, and are run by government and the private sector, sometimes in collaboration with each other.

The DoC launched the iKamva National e-Skills Institute (iNeSI) to improve citizens' access to online education resources in 2014. The intention is to benefit the total population by harnessing ICT for equitable prosperity and global competitiveness, and focuses primarily on four components:

- evidence-based research;
- teaching and learning;
- innovation; and
- a monitoring and evaluation framework.⁶⁹

Included in the teaching and learning component is the intention to identify the gaps, shortages and mismatches in course content in relation to the demand for ICT-related skills and competencies across organizational boundaries. The aim is to fill current and future e-skills gaps through embedding e-skills in the curriculum. It is done through consultation with iNeSI's stakeholders through research and policy development.⁷⁰

⁶⁷ Government Communication and Information System. (2016). South African Yearbook 2015/2015. Retrieved March 3, 2017 from <http://www.gcis.gov.za/sites/www.gcis.gov.za/files/docs/resourcecentre/Science%20Technology2015.pdf>

⁶⁸ University of Cape Town. (no date). ICT for Development Centre. www.ict4d.org.za

⁶⁹ Ikamva National eSkills Institute. (no date). About iNeSI. Retrieved February 21, 2017 from http://inesi.org.za/about-inesi/what_is_inesi.php

⁷⁰ ibid

The Media, Information and Communication Technologies Sector Education Training Authority (MICT SETA) is responsible for skills development in the ICT sector. While the SETA does work with employers, it is also focusing on increasing rural presence and development to provide skilled resources in outlying areas. Intensifying skills development programmes in the rural areas and encouraging the uptake of ICT programmes and the use of ICTs is a strategic priority for the SETA. Directed programmes and collaboration with incubators such as Bandwidth Barn, the Innovation Hub, SmartXchange and the Johannesburg Centre for Software Engineering (JCSE) will be critical in addressing rural skills development demands.⁷¹

The MICT SETA works with further education and training (FET) institutions and is working on building their capacity for them to run programmes to further address rural and urban areas skills demands. The SETA is also focusing on cooperation with higher education institutions in the provision of broader management and business skills, and co-funding MBAs and other high-level industry requisite skills. The MICT SETA is partnering with the industry professional bodies to promote continued Professional Development, and is involved in assisting with the development of new ventures through provision of funding and mentoring of new ventures to supply entrepreneurial skills.⁷²

In 2016, the Department of Telecommunications and Postal Services signed a contract on capacity building, ICT talent training and joint innovation on ICT with Huawei. This contract was expected to help enhance the department's strategies to implement their programmes, including the rollout of broadband and lowering the cost to communicate. Another programme that was expected benefit is the e-Strategy that will provide a framework of how the country will include the youth, women, people with disabilities and small and medium sized business in the ICT sector. The ICT talent training component of the agreement is expected to promote ICT literacy and awareness South Africa. Huawei committed to providing training opportunities to 1,000 young South Africans over five years. This training will take place in China and includes:

- telecommunication network security and optimisation,
- telecommunication administration,
- new technology of satellite navigation,
- next generation network construction, and
- cloud computing and big data network construction.⁷³

CTU Training Solutions is a private sector initiative, contributing to skills growth by engaging with vendors like Microsoft, Cisco, Red Hat and others, focusing on delivering a whole range of solutions from face-to-face to blended cloud training. CTU's market has grown from South Africa to running successful interventions on the African continent.⁷⁴

CompTIA is working with the Media, Information and Communication Technologies Sector Education Training Authority (MICT-SETA) and mapping content to the local standards; meaning the CompTIA objectives are covered in the local NQF 4 and 5 qualifications. In order to assist with career guidance and generate interest in IT, CompTIA is working closely with schools in SA to encourage learners'

⁷¹ Media, Information and Communication Technologies Sector Education Training Authority. (2012). Strategic Plan: 2012-2016. Retrieved June 14, 2017 from https://www.mict.org.za/downloads/MICT_Strat_Plan_02_July_2012_Final_new_logo.pdf

⁷² Ibid

⁷³ South African Government. (2016). Minister Siyabonga Cwele: Signing ceremony with Huawei on ICT skills development and technology sharing agreement. Retrieved February 28, 2017 from <http://www.gov.za/speeches/minister-siyabonga-cwele-signing-ceremony-huawei-ict-skills-development-and-technology>

⁷⁴ TrainingWeb. (2016). Emerging trends call for new ICT skills. Retrieved February 27, 2017 at <http://www.trainingweb.co.za/news/training/2592-emerging-trends-call-for-new-ict-skills>

involvement in the CompTIA IT fundamentals programme as a stepping stone or bridging course into more advanced IT courses when they graduate from school. To help address the skills gap CompTIA provides a free skills gap assessment that highlights the gaps and shows where CompTIA's foundational skills can address the gaps that exist. CompTIA Skills Assessment has been used at more than 200 organizations across Africa and other regions. CompTIA is in discussions with the DBE to address ICT skills at school level.⁷⁵

Oracle University is helping to tackle South Africa's skills shortage by working alongside public education and skills development bodies to deliver Oracle technology learning to the youth and the unemployed.⁷⁶

The Institute of Information Technology Professionals South Africa (IITPSA) is addressing skills shortages and skills development, specifically in ICT, in South Africa. IITPSA has established a Students Special Interest Group (SIG) at the Vaal University of Technology (Ekurhuleni Campus) where ICT students are mentored and guided by members of the Institute and its Gauteng Chapter Committee, as potential new entrants to the ICT profession. Developmental areas that have been tackled include life skills, career opportunities and entrepreneurship.⁷⁷

The initiatives below provincial and national government initiatives with a focus on ICT services and connectivity for citizens.

The Gauteng Provincial Government published its ICT Development Strategy Draft. Through this strategy, the province has endorsed and funded three large-scale initiatives, namely the Gauteng online schools programme, the e-Government programme (e-Government Blueprint) and the G-Link broadband infrastructure project. There are other e-government initiatives that have been implemented at departmental level. While there has been an attempt to initiate an e-Health system, this has been unsuccessful.⁷⁸

The current costs of communications in South Africa are high compared to other countries of similar economic setting, create a barrier for businesses, in particular Small, Medium and Micro-sized Enterprises (SMMEs), and citizens to participate in the knowledge economy. Through the ICT Development Strategy, the Gauteng Provincial Government is aiming to enable government service delivery, strengthen economic development; create a productive and competitive economy by removing barriers to entry and lowering the cost of doing business; and encourage innovation, research and development to strengthen the knowledge economy.⁷⁹

The DoC launched the ICT Rural Development Strategy in 2012 to address the problems and challenges identified in utilising ICTs for rural development, and support the mandate of the Department of Rural Development and Land Reform. The strategy's objective is to ensure economic development in the rural areas plays a critical role to ensure sustainability of all projects. For ICT services to take effect in rural areas there is a need to provide television and radio coverage, and connectivity to public institutions such as schools, clinics, postal services and community radio services in all rural areas.⁸⁰

⁷⁵ Ibid

⁷⁶ Ibid

⁷⁷ Institute for Information Technology Professionals. (no date). Skills Development. Retrieved February 28, 2017 from <https://www.iitpsa.org.za/skills-development/>

⁷⁸ Gauteng Province. (2012) Gauteng ICT Development Strategy Draft. Retrieved June 14, 2017 from <http://www.ecodev.gpg.gov.za/policies/Documents/Gauteng%20ICT%20Strategy.pdf>

⁷⁹ Ibid

⁸⁰ South African Local Government Association. (2012). ICT Rural Development Strategy. Retrieved June 14, 2017 from <http://lgiict.org.za/document/ict-rural-development-strategy>

2.4 Key Actors and Players

Actor/Player	Role and Area of Development
Department of Communications (DOC)	Leads all country-wide ICT initiatives
Independent Communications Authority of South Africa (ICASA)	An independent regulatory body of the government, established in 2000, that regulates the telecommunications and broadcasting sectors in the public interest
Telkom	First national landline and wireless phone, internet and network organization
MTN, Vodacom, Cell C, Telkom Mobile	South African cellular network providers
Ikamva National eSkills Institute	South African government initiative, under the Department of Communications, to reduce the lack of e-skills in the country
ICT for Development Centre, University of Cape Town	Multi-disciplinary centre that seeks to create new technologies for the developing world

2.5 Challenges in ICT Development

Universal service and access policies are aimed at ensuring that all South Africans have access to ICT services this will require both competitive private sector investment and targeted public sector intervention. Market inefficiencies still need to be addressed, because, although South Africa has the best developed and most modern telecoms network in Africa, only half the population uses the internet. SA Connect, the national broadband programme, failed to start because the tender specifications for the network service provider were so onerous no one qualified.

A further challenge in the ICT sector is that regulation and governance of the sector is spread across different entities, resulting in overlaps and duplication of roles, and a lack of coordination between different entities, that has undermined many of the reform initiatives within the communications sector in South Africa.

Despite South Africa's improvements in the overall NRI rankings, South Africa's digital transformation is mostly business driven, and lagging behind in government usage, where the most development needs to take place. A further challenge is that South Africa's innovation and business environment is rated significantly worse, especially regarding technology and venture capital availability, government procurement of the latest technologies, and procedures to start a business.

South Africa also faces significant human capital development challenges through the shortage of ICT skills at all levels, impacting on the development of a Knowledge Society. The adoption of cloud technologies, coupled with new trends such as the Internet of things (IOT), big data and mobility, is leading to a huge shortage of IT professionals with the correct mix of skills that organizations need to architect, deploy, build and manage software and other technology assets.⁸¹

⁸¹ TrainingWeb. (2016). Emerging trends call for new ICT skills. Op cit

3 Education

Education is a priority area for the South African government, and is reflected by South Africa having one of the highest rates of public investment in basic education in the world. The 2017/18 overall budget allocation for the Department of Basic Education (DBE) is R23.4 billion, an increase of 5.1% from 2016/17.⁸²

The national department of education shares a concurrent role with the provincial departments for basic schooling and ECD, but it is the responsibility of each provincial department to finance and manage its schools directly. Council of Education Ministers (CEM), consisting of the Minister of Basic Education, the Minister of Higher Education and Training and the nine provincial members of the executive councils for education, meets regularly to discuss the promotion of national education policy, share information and views on all aspects of education in South Africa, and coordinate action on matters of mutual interest.⁸³

The NDP 2030 has the following vision for the education system:

In 2030, South Africa enjoys an education system with:

- *High-quality, universal early childhood education.*
- *Quality school education, with globally competitive literacy and numeracy standards.*
- *Further and higher education and training that allows people to fulfil their potential.*
- *An expanding higher-education sector that boosts incomes and productivity, and shifts South Africa towards a knowledge-based economy.*
- *A wider system of innovation that links universities, science councils and independent research and development institutions with priority areas of the economy*⁸⁴

Basic Education

In 2010, the DBE released *Action Plan to 2014: Towards the Realisation of Schooling 2025*, a report outlining the priority areas that needed to be addressed. The plan's overall aim was to improve learner performance by overcoming the weaknesses in the education system. This was to be done particularly by improving access to education, providing safe buildings, providing learning and teaching materials promptly and by increasing educator numbers and improving their skills. This is in recognition that there are many shortfalls in the system, preventing the country from achieving its goals. Some of the areas within education that require special attention include early childhood development (ECD) and Grade R expansion; educator training and development; timely provision of learning and teaching support materials (LTSM); and school infrastructure at all levels.⁸⁵

South Africa's Medium Term Strategic Framework (2014 to 2019) identifies the following sub-outcomes to achieve quality basic education:

- *Improve quality of teaching and learning through development, supply and effective utilisation of teachers*
- *Improve quality of teaching and learning by providing infrastructure and learning materials*

⁸² Department of Basic Education. (2017). 2017/18 Basic Education Budget Vote Speech delivered by the Minister of Basic Education, Mrs Angie Motshekga, MP, at the National Council of Provinces (NCOP), Cape Town on 07 June 2017. Retrieved June 13, 2017, from <http://www.education.gov.za/Newsroom/Speeches/tabid/950/ctl/Details/mid/6106/ItemID/4392/Default.aspx>

⁸³ The South African Government. (no date). Education. Retrieved February 28, 2017 from <http://www.gov.za/about-sa/education>

⁸⁴ The National Planning Commission. (2011). National Development Plan: 2030. Op cit

⁸⁵ Department of Basic Education. (2015). Action Plan to 2019 Towards the Realisation of Schooling 2030. Retrieved February 8, 2017, 2017, from <http://www.education.gov.za/Portals/0/Documents/Publications/Action%20Plan%202019.pdf?ver=2015-11-11-162424-417>

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- *Regular annual national assessments to track improvement in the quality of teaching and learning*
 - *Improved Grade R and planning for extension of early childhood development*
 - *A credible, outcomes-focused planning and accountability system – building state capacity to intervene and support quality education*
 - *Partnerships for a strong education system.*⁸⁶

In 2015, the Department of Basic Education released *Action Plan to 2019: Towards the Realisation of Schooling 2030*. The sector plan encapsulates the DBE's response to the priorities, targets and programmes articulated in the National Development Plan, 2030; and provides a detailed five-year plan and fifteen year targets and programmes for the whole Basic Education Sector. The plan has 27 goals, with five priority goals, namely:

- Improve the access of children to quality Early Childhood Development (ECD) below Grade 1
- Improve the professionalism, teaching skills, subject knowledge and computer literacy of teachers throughout their entire careers;
- Ensure that every learner has access to the minimum set of textbooks and workbooks required according to national policy;
- Ensure that the basic annual management processes take place across all schools in the country in a way that contributes towards a functional school environment; and
- Improve the frequency and quality of the monitoring and support services provided to schools by district offices, partly through better use of e-Education.⁸⁷

According to the South African Schools Act (1996), schooling is compulsory for children aged 7-15 or attendance in Grades 1 to 9, whichever comes first. School life spans 13 years or grades, from grade 0, otherwise known as grade R or 'reception year', through to grade 12, the year of matriculation. The basic education has six phases, namely:

- Before General Education (GED) band (Grade 00 and 000) – not universally applied;
- Foundation phase incorporates grades R to 3. Grade R or 0 can be attended at a pre-school facility.
- Intermediate phase incorporates grades 4 to 6;
- Senior phase incorporates grades 7 to 9;
- Further education and training (FET) incorporates grades 10 to 12.⁸⁸

In South Africa in 2014, there were 30,500 established public and registered independent education institutions. Of these, 25,741 were ordinary schools and 4,759 were other education institutions – namely, ECD centres and special schools. The figure of 25,741 for ordinary schools comprised the following:

- 14,927 primary schools, with 6,655,171 learners and 201,673 educators;
- 6,068 secondary schools, with 3,910,643 learners and 143,990 educators; and
- 746 combined and intermediate schools, with 2,089,622 learners and 79,427 educators.

Of the 13,068,855 learners and students enrolled in all sectors of the basic education system in 2014, 12,117,015 (92.7%) were in ordinary public schools and 538,421 (4.1%) were in ordinary independent schools. Of the learners in other institutions, 295,942 (2.3%) were in ECD centres and 117,477 (0.9%) were in special schools. In summary, there were 13,068,855 learners and students in

⁸⁶ Ibid

⁸⁷ Ibid

⁸⁸ Republic of South Africa. (1996). South African Schools Act (84 of 1996). Retrieved February 8, 2017 from <http://www.gov.za/sites/www.gov.za/files/Act84of1996.pdf>

the basic education system, who attended 30,500 education institutions and were served by 448,105 educators.⁸⁹

In the DBE's drive to strengthen and support curriculum implementation in South African schools, textbooks and other educational resources are crucial factors in ensuring improved educational performance. A Ministerial Committee for Learner Teacher Support Material (LTSMS)⁹⁰ was constituted in February 2010. In general, the LTSMS Committee focused on recommendations that would ensure good quality material being made available to all schools as a starting point. Other issues such as good combinations of material in classrooms and supporting teacher development regarding LTSMS are expected to develop over time through sustained focus. The recommendations by the committee included:

- *National Catalogue*: The Committee recommends a national LTSMS catalogue, per grade and subject, be developed. This should comprise of no more than 8 comparable items.
- *Centralised Ordering*: The Committee recommends a system of nationally centralised ordering of LTSMS, drawing on school-based choice of LTSMS with key building blocks such as providing sufficient information for decision-making and decentralised delivery and tracking systems.⁹¹

Higher Education

The Department of Higher Education and Training's (DHET) Strategic Plan 2015/16 to 2019/20 had the goal that by 2013 the headcount enrolments should reach 1.6 million in public universities, 2.5 million in Technical and Vocational Education and Training (TVET) colleges and 1.0 million in community colleges as per the National Development Plan.⁹² Currently, South Africa has 26 public universities. These consist of eleven general academic universities; six universities of technology and nine comprehensive universities that combine the functions of both traditional universities and universities of technology. In 2014, there were 969,154 students enrolled in public higher education institutions in South Africa.⁹³

As of 25 September 2015, there were also 124 Private Higher Education Institutions and 96 registered and provisionally registered private higher education institutions.⁹⁴

With regards to public universities, Universities of Technology had 16,491 enrolments in 2014, comprehensive universities had 130,669 enrolments, traditional universities had 348,503, while UNISA (a distance learning institution) had 328,491 enrolments.⁹⁵ The staff complement across all public institutions comprised 50,090 permanent staff and 90,022 temporary staff in 2014.⁹⁶ Funding allocated to universities in 2014/15 was 2.46% of the state budget and 0.74% of GDP.

⁸⁹ Department of Basic Education. (2016). Education Statistics in South Africa 2014. Retrieved February 8, 2017 from <http://www.education.gov.za/Portals/0/Documents/Publications/Education%20Statistics%202014.pdf?ver=2016-05-13-144159-067>

⁹⁰ Department of Basic Education. (2010). Report of the Ministerial Committee for LTSMS Report. Retrieved February 3, 2017 from http://www.education.gov.za/Portals/0/Documents/Reports/Final_Report_of_the_Ministerial_Committee_for_LTSM_15_July_2010.pdf?ver=2010-12-10-090302-027

⁹¹ Ibid

⁹² Department of Higher Education and Training. (2015). Strategic Plan for the Fiscal Years 2015/16-2019/20 <http://www.dhet.gov.za/Strategic%20Plans/Strategic%20Plans/Department%20of%20Higher%20Education%20and%20Training%20Strategic%20Plan%202015-16%20-%202019-20.pdf>

⁹³ Council on Higher Education South Africa. (2016). Vital Stats on Higher Education 2014. Retrieved February 8, 2017 from <http://www.che.ac.za/sites/default/files/publications/VitalStats2014%20-%20webversion.pdf>

⁹⁴ Council on Higher Education South Africa. (no date). 2013 Higher Education Data: Overview. Retrieved February 8, 2017 from http://www.che.ac.za/focus_areas/higher_education_data/2013/overview

⁹⁵ Council on Higher Education South Africa. (2016). Vital Stats on Higher Education 2014. Op cit

⁹⁶ Ibid

The expansion and growth of the public TVET College sector remains a strategic priority of the Department of Higher Education and Training. In 2014, there was a total of 50 institutions, 10,842 lecturers and 702,383 students in Public TVET Colleges. On average, there were 217 lecturers and 14,048 students per institution. Most students (almost 370,000) enrolled in public TVET Colleges were in the 20–24 age group, followed by those in the 25–29 age group. Enrolment generally declines after students reach 25 years of age.⁹⁷

In 2014, there were 291 private colleges registered with the DHET. Out of 284 private colleges in 2014, there was a total of 1,622 lecturers and 78,995 students in private colleges. Gauteng contributed the largest proportion of both lecturers 620 (38%) and students 34,611 (44%), and North West contributed the smallest proportion of lecturers (13) and 239 students.

The administration of the Adult Education and Training (AET) Act, 2000 (Act No. 52 of 2000) and the Continuing Education and Training Act, 2006 (Act No. 16 of 2006) was transferred to the Minister of Higher Education and Training in 2009. The Public Adult Learning Centres provide formal, general education and training programmes to adult learners and out-of-school youth who have not completed Grade 9 in terms of the school sector, although some Adult Learning Centres do offer informal skills training programmes. Most of the short courses or informal programmes are usually offered by the Private Adult Education and Training Centres. There were 275,268 learners enrolled in both public and private AET centres, there was an increase of 17,445 learners, from 257,823 in 2013 to 275,268 in 2014. In 2014, there was a total of 1,828 institutions, 15,447 educators and 262,680 learners in Public AET centres. On average, there were 17 educators and 144 learners per institution. KwaZulu-Natal contributed the largest proportion of institutions and educators, while Gauteng had the largest proportion of learners, 96,282. Northern Cape contributed the smallest proportion of institutions, educators and learners.⁹⁸

3.1 ICT in Education

It is envisioned that through Operation Phakisa in ICT in the education sector, learners will leave the schooling system as ethical, discerning, and responsible users of information, and be ICT capable to make meaningful contributions to society. President Jacob Zuma said this programme is a most effective way of implementing the objectives outlined in the NDP.

The Operation Phakisa ICT in Education lab worked towards finding ways to accelerate ICT provisioning to all schools, but more importantly, the lab worked with the understanding that devices alone cannot improve learning.

Operation Phakisa ICT marks an overdue turning point in government's quest to transform teaching and learning through the appropriate use of ICTs as envisioned by the 2004 White Paper on E-education. Basic Education will work closely with departments such as Telecommunications and Postal Services, Communications, Higher Education and training and government entities, and regulatory bodies in the ICT sector to align the national ICT in Education rollout in a coordinated and accelerated manner.⁹⁹

⁹⁷ Council on Higher Education South Africa. (2016). Vital Stats on Higher Education 2014. Op cit

⁹⁸ Department of Higher Education and Training. (2016). Statistics on Post-School Education and Training in South Africa: 2014. Retrieved February 23, 2017 from <http://www.dhet.gov.za/DHET%20Statistics%20Publication/Statistics%20on%20Post-School%20Education%20and%20Training%20in%20South%20Africa%202014.pdf>

⁹⁹ South African Government News Agency (2016) Operation Phakisa ICT to take education to new standard. Retrieved February 8, 2017 from <http://www.sanews.gov.za/south-africa/operation-phakisa-ict-take-education-new-standard>

Policy development on ICT in education date back to 1995. In 2001, the National Department of Education and the Department of Communication jointly released a Strategy for Information and Communication Technology in Education, which is believed to have laid the basis for the e-Education White Paper adopted in 2004. The strategy recognizes that revolution in ICT presents three major challenges in the education system globally. These challenges are: participation in the information society, how ICT impacts on access, cost effectiveness and quality of education; and how ICT affects the education system.¹⁰⁰

In the South African context, the concept of e-Education revolves around the-use of ICTs to accelerate the achievement of national education goals. E-education is about connecting learners and teachers to each other and to professional support services, and providing platforms for learning. E-education is aimed at connecting learners and teachers to information, ideas and to one another via effective combinations of pedagogy and technology in support of educational reform.

The goal of the e-Education White Paper (2004) was that every learner in the primary and secondary school sectors should be ICT capable by 2013. This e-Education White Paper (2004) is confined mainly to the schools and FET college sectors and does not consider the higher education sector or the Adult Basic Education and Training (ABET) programmes. It is a matter of concern to the DBE that the goal has not been achieved. The DBE considers that the White Paper is still relevant.¹⁰¹

The White Paper outlines the following strategic objectives for effective integration of ICT into teaching and learning:

- ICT professional development
- Electronic content resources
- Infrastructure
- Connectivity
- Community engagement
- Research and development.¹⁰²

The fundamental issues are teacher development and ensuring that every teacher and learner has access to electronic content. These elements must be in place when e-learning infrastructure is rolled out through connectivity to each school in the country.

In the 2013/14 financial year, the DBE conducted an internal audit of ICT initiatives in all provinces. There have been a number of initiatives over the past ten years, some driven by government and others by NGOs, but the DBE was not aware of all these initiatives in the various provinces. The aim of the audit was to take stock of ICT implementation in the provinces over the past ten years. The audit did not look at the impact of the ICT initiatives in provinces, however, but it is a build up to that effect. At least 162 ICT initiatives were implemented in the provinces:

- 64.2% (104 ICT initiatives) of ICT initiatives addressed individual strategic objectives. Of the 64.2%, 30% of the initiatives addressed the ICT infrastructure strategic objective.
- Connectivity was the least targeted strategic objective (14.4%).
- 35.8% (58 ICT initiatives) of ICT initiatives addressed a combination of strategic objective.
- 32.8% (19 ICT initiatives) of ICT initiatives addressed all four main strategic objectives.
- 19% (11 ICT initiatives) of ICT initiatives addressed three strategic objectives.
- 48.3% (28 ICT initiatives) of ICT initiatives addressed two strategic objectives.

¹⁰⁰ InfoDev. (2007). Survey of ICT and Education in Africa. Retrieved June 3, 2017 from https://www.infodev.org/infodev-files/resource/InfodevDocuments_353.pdf

¹⁰¹ National Science and Technology Forum. (2015). DBE's Progress with ICT Integration in Schools. Retrieved February 8, 2017 from <http://www.nstf.org.za/wp-content/uploads/2015/10/Progress.pdf>

¹⁰² Ibid

Regarding the partnership between the public and private sectors, the audit found:

- 42% (68 ICT initiatives) of ICT initiatives were supported by the private sector.
- 58% (94 ICT initiatives) of ICT initiatives were supported by the public sector.

Regarding the coverage of the initiatives:

- 111 ICT initiatives (68.5%) were of a provincial nature.
- 51 ICT initiatives (31.5%) were of a national nature.
- 36 (70.6%) of the 51 initiatives of a national nature were funded by the private sector.¹⁰³

With respect to expenditure on ICT initiatives, 87.4% was spent on ICT initiatives that targeted a combination of strategic objectives (integrated initiatives). Of this amount, 98.9% was spent on Gauteng Online and the Khanya project in the Western Cape (with Gauteng Online being the most expensive).¹⁰⁴

Some of the national ICT initiatives include:

- Policy/Guidelines: White Paper on e-Education, Guidelines on Hardware and Software Specifications (already in its second edition), Guidelines for ICT Professional Development
- Infrastructure: resourcing of 40 ICT Teacher Resource Centres through partnerships with the private sector; Accelerated Schools Infrastructure Delivery Initiative (ASIDI) schools resourced with ICT infrastructure; resource schools (including multi-grade schools) with ICT infrastructure in partnership with private sector
- ICT professional development: facilitated training through partnerships with the private sector and other government departments
- Connectivity: Facilitating the connectivity of schools through partnerships with the private sector and other government departments. The DBE is in the process of establishing a DBE cloud (www.dbecloud.org.za) through partnerships with other government departments, which will make free content available for every person in South Africa. The DBE appeals to those with content to make it available for the DBE cloud.
- Thutong National Education Portal: The online portal to a comprehensive array of free educational resources, policy information, and interactive services concerning all aspects of the South African schooling sector, providing relevant information about and services for curriculum and teacher development, and school administration and management.¹⁰⁵
- Dinaledi Schools Programme: In 2001, the Department of Education established the Dinaledi Schools Project to significantly improve performance and increase participation in Mathematics, Life Sciences and Physical Sciences. Capped at 500 schools, certain secondary schools that demonstrated their potential for increasing learner participation and performance in mathematics and science were selected to be part of the project. The schools were provided with the resources and support to improve the teaching and learning of these subjects. Besides receiving textbooks, teacher training and laboratory infrastructure and development, many of these schools have been provided with ICT equipment, software and connectivity.¹⁰⁶

Department of Basic Education content development initiatives include the following interactive and non-interactive digital curriculum content:

- The development of Interactive Rainbow Workbooks;
- Development of 'hybrid' Textbooks/Workbooks;

¹⁰³ Ibid

¹⁰⁴ Ibid

¹⁰⁵ Thutong. (no date). About us. Retrieved June 12, 2017 from <http://www.thutong.doe.gov.za/tabid/243/Default.aspx>

¹⁰⁶ Department of Education. (2009). The Dinaledi Schools Project. Retrieved June 12, 2017 from http://www.erenet.co.za/zenex/files/384_Dinaledi%20Report.pdf

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- Distribution of Curriculum Enrichment Videos; and
 - Development of Open Education Resources (OER).¹⁰⁷

The DBE acknowledges that it cannot take responsibility on its own for ICT integration in schools. Expert guidance is required from universities, resources from the private sector and human resources located in NGOs. The private sector supported 42% of the ICT initiatives in schools as identified by the audit, while the public sector supported 58%, including not only the DBE but also the departments of Science and Technology, Communication, and Rural Development and Land Reform.¹⁰⁸

Other initiatives in ICT in education in South Africa, by provincial government and the private sector, are noted below.

The Gauteng Province is providing tablets to all Grade 4 to 9 learners as part of an investment in ICT and innovation projects in public schools. Each classroom will be equipped with a smartboard and access to unlimited data during specific hours. This initiative is focused on creating “paperless classrooms”.¹⁰⁹

In the Western Cape, the Khanya project is being used to promote learning and maximise teacher capacity by integrating the use of appropriate, available and affordable technology (mainly computer technology) into the curriculum delivery process. This is done by installing computer laboratories in schools, with a focus on previously disadvantaged communities.¹¹⁰

The Mindset Network is a South African not-for-profit company that creates, sources and distributes high quality, curriculum-aligned digital content for the education sector. Mindset Learn supports learners and teachers in formal schooling with a focus on Grades 10, 11 and 12 in Maths, Sciences, Social Sciences and Finance subjects. Content is in video format and is supported by PDF notes and computer-based interactive lessons. Mindset Learn is provided directly to thousands of schools and also broadcast live via all satellite networks in the country.¹¹¹

Sci-Bono Online Learning Centre aims to improve public engagement with science and technology by assisting with curriculum delivery, providing teacher training and support, and by providing curriculum materials to schools.¹¹²

The Vodacom Digital Classroom website provides teacher information and professional development resources, curriculum-related digital resources and online reading resources. It is accessible from the basic education department's website.¹¹³

¹⁰⁷ Parliamentary Monitoring Group. (2013). Library services access, e-Education: Departments of Basic Education & Communications briefings. Retrieved June 12, 2017 from <https://pmg.org.za/committee-meeting/16210/>

¹⁰⁸ National Science and Technology Forum (NSTF) (2015). DBE's Progress with ICT Integration in Schools. Op cit

¹⁰⁹ IST Africa. (no date). Current ICT initiatives and projects – Republic of South Africa. Retrieved June 12, 2017 from <http://www.ist-africa.org/home/default.asp?page=doc-by-id&docid=3574>

¹¹⁰ Western Cape Government. (no date). Khanya Project. Retrieved June 12, 2017 from https://www.westerncape.gov.za/dept/department-premier/documents/public_info/F/19802?toc_page=9

¹¹¹ Mindset Network. (no date). Home Page. Retrieved June 12, 2017 from <http://learn.mindset.co.za/>

¹¹² Education South Africa. (no date). Internet resources for teachers. Retrieved June 12, 2017 from <http://www.edusamag.co.za/2013/November/Internetresourcesforteachers.php>

¹¹³ Vodacom Digital Classroom. (no date). Home page. Retrieved June 12, 2017 from <http://digitalclassroom.co.za/digitalclassroom/>

3.2 Curriculum

South African education authorities introduced numerous curriculum policies in the past, starting with Curriculum 2005 introduced in 1997 which was an outcome based education system. It was reviewed in 2000¹¹⁴ and replaced with the National Curriculum Statement (NCS). In October 2009, the NCS was in turn reviewed¹¹⁵ and replaced with the Curriculum Assessment Policy Statements (CAPS).¹¹⁶ With the introduction of CAPS, every subject in each grade has a single, comprehensive and concise policy document that will provide details on what teachers need to teach and assess on a grade-by-grade and subject-by-subject basis. CAPS has the aim of lessening the administrative load on teachers, and ensuring that there is clear guidance and consistency for teachers when teaching CAPS is not a new curriculum, but an amendment to the National Curriculum Statement (NCS) Grades R-12, so that the curriculum is more accessible to teachers.¹¹⁷

The White Paper on e-Education is intended to enable the use of ICTs to extend and enrich educational experiences across the curriculum. The e-Education paper views ICTs as a resource for reorganising schooling, and as a resource for curriculum integration. Teachers are required to be able to use technology to enrich the curriculum and use integrated systems for management and administration.¹¹⁸

The curriculum currently offers Computer Applications Technology and Information Technology for Grade 10 to 12.

A draft Digital Content Resources Strategy that aims to provide a balance between teacher-created content, open education resources (OER) and publisher-provided content resources. Current content development initiatives include interactive and non-interactive digital curriculum content.

The availability of quality e-content is critical to the national roll-out of e-Education. DBE is in the process of developing a dedicated centralised content hosting platform accessible by different ICT devices. Provinces will contribute and shared digital content produced from their different initiatives to the centralized hosting platform. The DBE is also in the process of collating and quality assuring OERs that will be hosted on the centralised hosting platform for access by schools.

At the classroom level, the intent is to change the way the classroom acts. This means less ‘talk-and-chalk’ and more collaboration, creativity, critical thinking, contribution, conversation and connection among and between learners and teachers.¹¹⁹

¹¹⁴ Members of Curriculum 2005 Review Committee. (2000). A South African Curriculum for the twenty first century – Report of the Review Committee on Curriculum 2005. Retrieved February 8, 2017 from http://www.gov.za/sites/www.gov.za/files/21cen_curriculum_0.pdf

¹¹⁵ Report of the Task Team for the Review of the Implementation of the National Curriculum Statement - Final Report October 2009. Retrieved February 8, 2017 from <http://www.education.gov.za/LinkClick.aspx?fileticket=bEcsDg0KUFg%3D&tabid=348&mid=1137>

¹¹⁶ Department of Basic Education: National Curriculum Assessment Policy Statements. Retrieved February 3, 2017 from <http://www.education.gov.za/Curriculum/CurriculumAssessmentPolicyStatements/tabid/419/Default.aspx>

¹¹⁷ UNISA. (2012). The South African Schools curriculum. Retrieved February 3, 2017 from <http://www.unisa.ac.za/cedu/news/index.php/2012/06/the-south-african-schools-curriculum-from-ncs-to-caps/>

¹¹⁸ Department of Education. (2004). White Paper on e-Education. Retrieved June 12, 2017 from <http://www.education.gov.za/Portals/0/Documents/Legislation/White%20paper/DoE%20White%20Paper%207.pdf?ver=2008-03-05-111708-000>

¹¹⁹ Parliamentary Monitoring Group. (2013). Library services access, e-Education: Departments of Basic Education & Communications briefings. Op cit

3.3 Professional Development

Guidelines for Teacher Training and Professional Development in ICT were developed in 2007 as one of the initiatives undertaken by the Department of Education to implement the White Paper on e-Education. The guidelines recognise that ICT is fundamental to the implementation of e-education and offers greater opportunities to access learning, redress inequalities and improve the quality of teaching and learning. ICT also makes it possible for teachers to offer learners unprecedented opportunities for development and lifelong learning. E-education requires that teachers, managers and administrators in public schools and colleges have the knowledge, skills and support necessary to integrate ICT into teaching and learning. However, it is noted that while ICT have brought new possibilities into the education sector, they have placed more demands on the skills' level of teachers.

Teacher training and professional development in ICT is currently provided by provincial e-learning sections, and not the DBE. However, NGOs such as SchoolNet South Africa, through the Microsoft Partners in Learning programme, have been instrumental in conducting reputable courses in basic computer skills in South Africa.¹²⁰

SchoolNet South Africa focuses on educator development in technology integration. All its courses are therefore focused on exposing educators (teachers and education managers) to the latest ICT. SchoolNet SA offers a range of SACE endorsed professional development courses that aim to develop skills and competencies related to different aspects of digital learning. While some programmes are now being offered by some provincial departments of education, SchoolNet SA also offers training to schools that are not part of their department training schedule.¹²¹

Matthew Goniwe School of Leadership and Governance (MGSLG) is non-profit organization and an agency of the Gauteng Department of Education. MGSLG was established to research, develop and deliver innovative capacity-building programmes in School Management and Leadership, School Governance and Teacher Development for schools in Gauteng. MGSLG supports the Gauteng Department of Education capacity-building initiatives for professional growth of educators and school governors; school leadership and management development; improving education practice through research; and other capacity-building initiatives relating to new education policy initiatives and teacher-up-skilling.¹²²

3.4 Key Actors and Players

Actor/Player	Role and Area of Development
Department of Basic Education (DBE) with the support of nine Provincial Departments of Education (PDOE)	Created in 2009, the department oversees primary and secondary education in South Africa.
Department of Higher Education and Training (DHET)	Created in 2009, the department oversees universities and other post-secondary education in South Africa.
SchoolNet South Africa	NGO that develops ICT implementation and PD projects

¹²⁰ SchoolNet South Africa. (2017). What is EDN?. Retrieved February 28, 2017 from <http://www.schoolnet.org.za/teacher-development/educators-network/what-is-edn/>

¹²¹ Ibid

¹²² Matthew Goniwe School of Leadership and Governance. (no date). Overview. Retrieved June 12, 2017 from <http://www.mgslg.co.za/overview>

Actor/Player	Role and Area of Development
Matthew Goniwe School of Leadership and Governance (MGSLG)	A non-profit organization and an agency of the Gauteng Department of Education established to research, develop and deliver innovative capacity-building programmes
University of South Africa (UNISA)	South African University offering specific courses for teacher training
Stellenbosch University	South African University offering specific courses for teacher training
University of Cape Town	South African University offering specific courses for teacher training
University of Johannesburg	South African University offering specific courses for teacher training
University of KwaZulu-Natal	South African University offering specific courses for teacher training
North West University (NWU)	South African University offering specific courses for teacher training
University of Pretoria	South African University offering specific courses for teacher training
University of the Western Cape	South African University offering specific courses for teacher training
Wits University	South African University offering specific courses for teacher training
Nelson Mandela Metropolitan University (NMMU)	South African University offering specific courses for teacher training
Walter Sisulu University	South African University offering specific courses for teacher training
University of Mpumalanga (Foundation phase education only).	South African University offering specific courses for teacher training
National Education Collaboration Trust (NECT)	Organization dedicated to strengthening partnerships among business, civil society, government and labour in order to achieve the education goals of the National Development Plan
Teacher.org.za	Online platform where key stakeholders in the education arena can connect, collaborate and participate

3.5 Challenges facing the education sector

The fundamental challenges facing the education sector in South Africa are ICT accessibility, teacher development, a shortage of qualified teachers, and ensuring that every teacher and learner has access to electronic content.

Whilst policies relevant to ICT in education have been put in place, they tend to focus more on the ICT accessibility and availability of the basic resources, such as computers in schools and internet access, but last-mile access is still a challenge in South Africa.

Further, provincial departments of education are responsible for their own ICT infrastructure and roll out, so provinces such as the Gauteng and Western Cape are further ahead than less resource-rich provinces, with some provinces lacking ICT implementation.

Despite the DBE rolling out digital and non-digital content initiatives, there is still a challenge getting physical textbooks to schools; and interactive content cannot be delivered without the roll out of ICTs.

Another challenge is that in many instances, ICTs are rolled out to schools without sufficient teacher training, or policies in place to protect and use devices. This impacts on the sustainability of initiatives. These elements must be in place when e-learning infrastructure is rolled out through connectivity to each school in the country.

There are no national ICT teacher training initiatives, and this is left to the private sector and provincial departments. While ICTs have brought new possibilities into the education sector, they have placed more demands on the skills' level of teachers, and this needs to be addressed.

The DBE acknowledges that it cannot take responsibility on its own for ICT integration in schools. Expert guidance is required from universities, resources from the private sector and human resources located in NGOs. ICT professional development is outlined by an outdated policy, and is left to the provincial departments and the private sector.

4 Science, Technology, and Innovation (STI)

The Department of Science and Technology (DST) was created in 2004.¹²³ The recognition of the importance of science and technology through the creation of a separate department has led to significant developments in the promotion and support of science and technology activities at the national level. The DST aims to provide leadership, an enabling environment, and resources for science, technology and innovation in support of South Africa's development.¹²⁴

The department's strategic goals are to:

- *develop the innovation capacity of the national system of innovation to contribute to socioeconomic development*
- *enhance South Africa's capacity for generating knowledge to produce world class research outputs and turn some advanced findings into innovation products and processes*
- *develop appropriate human capital in the science, technology and innovation sector to meet the needs of society*
- *build world class infrastructure in the science, technology and innovation sector to extend the frontiers of knowledge, train the next generation of researchers, and enable technology development and transfer as well as knowledge exchange*
- *position South Africa as a strategic international research and development and innovation partner and destination through the exchange of knowledge, capacity and resources between South Africa and its regional and other international partners, thus strengthening the national system of innovation (NSI).*¹²⁵

Much of the DST's work is carried out through various organizations, many of which are government bodies. The DST's budget allocation for 2015/16 was R7,482 billion. A sum of R 2,534 billion from the budget was allocated to parliamentary grants for the following institutions: the CSIR – R827,7 million, the NRF – R885,9 million, the HSRC – R288,7 million, the Technology Innovation Agency – R385,2 million, SANSA – R124,4 million, the Academy of Science of South Africa (ASSAf) – R22,991 million.¹²⁶

The significant role players in this field are discussed below.

Academy of Science South Africa (ASSAf)

ASSAf encompasses all fields of scientific enquiry and it includes the full diversity of South Africa's scientists. ASSAf represents the country in the international community of science academies. Since its inception in 1996, ASSAf has grown from a small, emergent organization to a well-established academy. In 2015, ASSAf launched a consensus study, the State of Green Technologies in South Africa. The overall aim of the study, which was commissioned by the DST, is to document green technologies being used in South Africa; to identify gaps in and opportunities for the use of these technologies; and to make recommendations to promote the growth of green technologies. Transitioning to a green economy is one of the key imperatives of government, as highlighted in the NDP.¹²⁷

¹²³ South African Government. (no date). Science and technology. Retrieved February 8, 2017 from <http://www.gov.za/about-sa/science-technology>

¹²⁴ The National Government Handbook. (2017). Department: Science and Technology (DST). Retrieved March 3, 2017 from <https://www.nationalgovernment.co.za/units/view/36/Economic-Infrastructure-Development/Department-Science-and-Technology-DST>

¹²⁵ Government Communication and Information System. (2016). South African Yearbook 2015/2015. Op cit

¹²⁶ Ibid

¹²⁷ Academy of Science South Africa (ASSAf). (no date). About. Retrieved June 14, 2017 from <https://www.assaf.org.za/index.php/about-assaf/about-assaf>

Africa Institute of South Africa (AISA)

Africa Institute of South Africa (AISA) has been at the forefront of research and training on African affairs. Through the AISA campus, an annual training programme that educates students from universities in research methodologies, AISA has contributed to fostering a new generation of research specialists. AISA has undertaken to promote knowledge creation as a fundamental part of development and growth for Africa and aims to encourage research as a career choice for young people as they leave school.¹²⁸

Council for Scientific and Industrial Research (CSIR)

The Council for Scientific and Industrial Research (CSIR) is one of the leading science and technology research, development and implementation organizations in Africa, with its main site in Pretoria, Gauteng, and regional offices in other provinces. The generation and application of knowledge reside at the core of the CSIR. This takes place in domains such as biosciences; the built environment; defence, peace, safety and security; materials science and manufacturing; and natural resources and the environment.¹²⁹

Human Sciences Research Council (HSRC)

The Human Sciences Research Council (HSRC) was established in 1968 as South Africa's statutory research agency and has become the largest dedicated research institute in the social sciences and humanities in Africa. Its mandate is to inform the effective formulation and monitoring of government policy; to evaluate policy implementation; to stimulate public debate through the effective dissemination of research-based data and fact-based research results; to foster research collaboration; and to help build research capacity and infrastructure for the human sciences. Research activities and structures are closely aligned with South Africa's national development priorities.¹³⁰

National Advisory Council on Innovation (NACI)

National Advisory Council on Innovation (NACI) advises government on the role and contribution of science, mathematics, technology and innovation in promoting and achieving national objectives.¹³¹

National Research Foundation (NRF)

The National Research Foundation (NRF) is an independent statutory body incorporating the functions of research-funding agencies. As a government-mandated research and science development agency, the NRF funds research; and the development of high-end human capacity and critical research infrastructures to promote knowledge production across all disciplinary fields. The goal of the NRF is to create innovative funding instruments, advance research career development, increase public science engagement, and to establish leading-edge research platforms that will transform the scientific landscape.¹³² Their work is discussed in more detail below

¹²⁸ Africa Institute of South Africa (AISA). (no date). About AISA. Retrieved June 14, 2017 from <http://www.ai.org.za/about-aisa-2>

¹²⁹ CSIR. (no date). About Us. Retrieved June 14, 2017 from <https://www.csir.co.za/about-us-0>

¹³⁰ Human Sciences Research Council (HSRC). (2017). What we do. Retrieved June 14, 2017 from <http://www.hsrc.ac.za/en/about/what-we-do>

¹³¹ National Advisory Council on Innovation (NACI). (2016). About NACI. Retrieved June 14, 2017 from http://www.naci.org.za/?page_id=124

¹³² National Research Fund (NRF). (no date). About NRF – Corporate overview. Retrieved June 14, 2017 from <http://www.nrf.ac.za/about-nrf>

South African National Space Agency (SANSA)

The South African National Space Agency (SANSA) was created to promote the use of space and cooperation in space-related activities while fostering research in space science; advancing scientific engineering through the development of South Africa's human capital; and providing support to industrial development in space technologies. SANSA continues to provide state-of-the-art ground-station services to many globally recognized space missions, including the National Aeronautics and Space Administration (NASA) and Indian Space Research Organization Mars missions, and NASA's Orbiting Carbon Observatory-2, which is giving scientists a better idea of how carbon is contributing to climate change.¹³³

Technology Innovation Agency (TIA)

The Technology Innovation Agency (TIA) is a national public entity which serves as a key institutional intervention to bridge the innovation gap between research and development from higher education institutions, science councils, public entities, and the private sector. The TIA was established to support the government in stimulating and intensifying technological innovation to improve economic growth and the quality of life of all South Africans by developing and exploiting technological innovations.¹³⁴

National Intellectual Property Management Office (NIPMO)

National Intellectual Property Management Office (NIPMO) provides support to the offices of technology transfer at publicly funded research institutions, which has led to significantly improved intellectual property management in universities and other research institutions.¹³⁵

Agricultural Research Council (ARC)

The Agricultural Research Council (ARC) conducts fundamental and applied research with partners to generate knowledge, develop human capital, and foster innovation in agriculture by developing technology and disseminating information.¹³⁶

Mintek

Mintek, South Africa's national mineral research organization, is one of the world's leading technology organizations specialising in mineral processing, extractive metallurgy and related areas. Mintek works closely with industry and other research and development institutions, and provides service testwork, process development and optimization, consulting and innovative products to clients worldwide. Mintek is an autonomous statutory organization.¹³⁷

South African Medical Research Council (SAMRC)

The South African Medical Research Council (SAMRC) is an independent statutory body that coordinates health and medical research activities throughout South Africa. The scope of the organization's research projects includes tuberculosis, HIV and AIDS, cardiovascular and non-communicable diseases, gender and health, and alcohol and other drug abuse. The strategic objective of the council is to help strengthen the health systems of the country, in line with that of

¹³³South African National Space Agency. (no date). About Us. Retrieved June 14, 2017 from <http://www.sansa.org.za/overview/about-us>

¹³⁴ Technology Innovation Agency. (no date). About Us. Retrieved June 14, 2017 from <http://www.tia.org.za/about-us>

¹³⁵ Government Communication and Information System. (2016). South African Yearbook 2015/2015. Op cit

¹³⁶ Agricultural Research Council (ARC). (no date). Home Page. Retrieved June 14, 2017 from <http://www.arc.agric.za/Pages/Home.aspx>

¹³⁷ Mintek. (2011). Corporate Profile. Retrieved June 14, 2017 from <http://www.mintek.co.za/corporate-profile/>

the Department of Health, the SAMRC constantly identifies the main causes of death in South Africa.¹³⁸

Council for Geoscience (CGS)

The Council for Geoscience (CGS) is a scientific research council, providing for the promotion of research and the extension of knowledge in the field of geoscience as well as the provision of specialised geoscientific services.¹³⁹

South African Bureau of Standards (SABS)

South African Bureau of Standards (SABS) is a statutory body that promotes and maintains standardisation and conformity assessment services to protect the integrity of the South African market, protect consumers, create a competitive advantage for South African industry, and facilitate access by South Africans to local and international markets. The bureau is the sole publisher of South African national standards.¹⁴⁰

Eskom

Eskom generates 95% of the electricity used in South Africa and about 45% of the electricity used in Africa. The industry in South Africa consists of the generation, transmission, distribution and sales, as well as the importing and exporting of electricity. The enterprise sells electricity to a variety of customers, including municipalities, who distribute power to end users under licence.¹⁴¹

Sasol

Sasol's culture of innovation began in the 1950s in South Africa and has since evolved its operations into fully fledged R&D facilities.¹⁴²

National Health Laboratory Service (N HLS)

National Health Laboratory Service (N HLS) is the largest diagnostic pathology service in South Africa with the responsibility of supporting the national and provincial health departments in the delivery of healthcare. The N HLS provides laboratory and related public health services to over 80% of the population through a national network of laboratories. Its specialised divisions include the National Institute for Communicable Diseases, National Institute for Occupational Health, National Cancer Registry and Antivenom Unit. The National Health Laboratory Service is a public health laboratory service with laboratories in all nine provinces, employing 6,700 people. Its activities comprise diagnostic laboratory services, research, teaching and training, and production of sera for anti-snake venom, reagents and media.¹⁴³

¹³⁸ South African Medical Research Council (SAMRC). (2016). Who we are. Retrieved June 14, 2017 from <http://www.mrc.ac.za/about/about.html>

¹³⁹ Council of Geoscience. (no date). Our Profile. Retrieved June 14, 2017 from <http://www.geoscience.org.za/index.php/about-us/our-profile>

¹⁴⁰ South African Bureau of Standards (SABS). (no date). About The SABS. Retrieved June 14, 2017 from <https://www.sabs.co.za/About-SABS/index.asp>

¹⁴¹ Eskom. (no date). Company information overview. Retrieved June 14, 2017 from http://www.eskom.co.za/OurCompany/CompanyInformation/Pages/Company_Information.aspx

¹⁴² Sasol. (no date). Overview. Retrieved June 14, 2017 from <http://www.sasol.co.za/about-sasol/company-profile/overview>

¹⁴³ Government Communication and Information System. (2016). South African Yearbook 2015/2015. Op cit

Bureau for Economic Research (BER)

The Bureau for Economic Research (BER) monitors and forecasts macroeconomic economic and sector trends, and identifies and analyses local and international factors that affect South African businesses.¹⁴⁴

National Institute for Communicable Diseases (NICD)

The National Institute for Communicable Diseases (NICD) is a major global player in infectious disease intelligence. It is a resource of knowledge and expertise in regionally relevant communicable diseases to the South African government, to SADC countries and the African continent. The NICD assists in the planning of policies and programmes and supports appropriate responses to communicable disease problems and issues.¹⁴⁵

Institute for Economic Research on Innovation (IERI)

The Institute for Economic Research on Innovation (IERI) was established as a public-good research organization for the analysis of systems of innovation. Its mandate is to provide research, capacity-building and community engagement in this field of study.¹⁴⁶

Institute for Security Studies (ISS)

The Institute for Security Studies (ISS) is a leading African organization that enhances human security to enable sustainable development and economic prosperity in Africa. It works across the continent, doing authoritative research, providing expert policy advice and delivering practical training and technical assistance.¹⁴⁷

African Centre for Peace and Security Training

The African Centre for Peace and Security Training enables government officials, journalists, human rights activists and the private sector to understand and implement human security policy through in-depth training courses.¹⁴⁸

South African National Energy Development Institute (SANEDI)

South African National Energy Development Institute (SANEDI) assists in providing political and strategic focus for the country. The institute is entrusted with the coordination and undertaking of public interest energy research, development and demonstration.¹⁴⁹

Safety in Mines Research Advisory Committee (SIMRAC)

The Safety in Mines Research Advisory Committee aims to advance the safety of workers employed in South African mines and prepares programmes for the relevant health and safety research.¹⁵⁰

¹⁴⁴ Bureau for Economic Research (BER). (no date). About BER. Retrieved June 14, 2017 from <https://www.ber.ac.za/About-BER/About-us/>

¹⁴⁵ Government Communication and Information System. (2016). South African Yearbook 2015/2015. Op cit

¹⁴⁶ Institute for Economic Research on Innovation (IERI). (no date). Mandate. Retrieved June 14, 2017 from <http://www.ieri.org.za/node/57>

¹⁴⁷ Institute for Security Studies Africa (ISS Africa). (no date). How we work. Retrieved June 14, 2017 from <https://issafrica.org/about-us/how-we-work>

¹⁴⁸ ISS African Centre for Peace and Security Training (no date). How we work. Retrieved June 14, 2017 from <https://issafrica.org/acpst/about-us/how-we-work>

¹⁴⁹ South African National Energy Development Institute. (no date). About SANEDI. Retrieved June 14, 2017 from <http://www.sanedi.org.za/About%20us.html>

¹⁵⁰ Department of Mineral Resources. (2011). About Mine Health and Safety. Retrieved June 14, 2017 from <http://www.dmr.gov.za/mine-health-a-safety.html>

National Agricultural Research Forum (NARF)

The National Agricultural Research Forum (NARF) facilitates consensus and integrates coordination in the fields of research, development, and technology transfer to agriculture to enhance national economic growth, social welfare and environmental sustainability.¹⁵¹

Water Research Commission (WRC)

The Water Research Commission (WRC) is responsible for promoting coordination, cooperation and communication in the area of water research and development, establishing water-research needs and priorities, stimulating and funding water research according to priority, and enhancing knowledge and capacity-building within the water sector.¹⁵²

Institute for Water Research (IWR)

The Institute for Water Research (IWR) is a multidisciplinary research department of Rhodes University in the Eastern Cape. Its main objective is to contribute to sustainable water-resource management in southern Africa. This is achieved through scientific research into the structure and function of natural water systems; the application of research through specialist consultancy services; tertiary-level teaching and training; capacity-building for community development; and service on national and international management and policy-making committees.¹⁵³

South African National Biodiversity Institute (SANBI)

South African National Biodiversity Institute (SANBI) leads and coordinates research, and monitors and reports on the state of biodiversity in South Africa, as well as providing knowledge, information, and planning and policy advice, and piloting best-practice management models.¹⁵⁴

South African Network for Coastal and Oceanic Research (SANCOR)

The South African Network for Coastal and Oceanic Research (SANCOR) encourages the informed use and management of marine and coastal resources and environments, and provides a forum for interaction, collaboration and communication about marine science. SANCOR contributes to planning for future demands on marine and coastal resources and environments, as well as participating in policy development.¹⁵⁵

4.1 STI Policies and Objectives

The DST executes its mandate through the implementation of the 1996 White Paper on Science and Technology,¹⁵⁶ the 2002 National Development Research Strategy (NRDS),¹⁵⁷ and the 2007 Ten-Year

¹⁵¹ National Agricultural Research Forum (NARF). (no date). Home Page. Retrieved June 14, 2017 from <http://www.nda.agric.za/doaDev/sideMenu/others/RTD/NARF.html>

¹⁵² South African Water Research Commission. (no date). Profile. Retrieved June 14, 2017 from <http://www.wrc.org.za/Pages/AboutUs.aspx>

¹⁵³ The Institute for Water Research. (no date). Research. Retrieved June 14, 2017 from <https://www.ru.ac.za/iwr/research/>

¹⁵⁴ South African National Biodiversity Institute. (no date). About SANBI. Retrieved June 14, 2017 from <https://www.sanbi.org/about>

¹⁵⁵ South African Network for Coastal and Oceanic Research. (no date). Home Page. Retrieved June 14 2017 from <http://sancor.nrf.ac.za/default.aspx>

¹⁵⁶ Department of Arts, Culture, Science and Technology. (1996). White paper on Science & Technology. Retrieved March 2, 2017 from http://www.gov.za/sites/www.gov.za/files/Science_Technology_White_Paper.pdf

¹⁵⁷ The Government of the Republic of South Africa. (2002). South Africa's National Research and Development Strategy. Retrieved March 2, 2017 from http://www.gov.za/sites/www.gov.za/files/rd_strat_0.pdf

Innovation Plan (TYIP).¹⁵⁸ The DST is the custodial coordinator for the development of the NSI and influences this system through key strategies such as the NRDS and the TYIP. The latter, particularly, seeks to contribute to the transformation of the South African economy into a knowledge-based economy.¹⁵⁹

The 1996 White Paper on Science and Technology introduced the South African NSI as the basis of the science and technology interventions in the economy. The NSI is an enabling framework for science and technology, and is central to South Africa's prospects for continued economic growth and socioeconomic development. The NRDS is the basis for the NSI and requires performance and responses in three key areas: enhanced innovation; providing science, engineering and technology Human Resources (HR) and transformation; and creating an effective government science and technology system. The White Paper set out the institutions to be established to promote the development of a well-functioning NSI. These are the national ministry and DST, the National Advisory Council on Innovation (NACI), the National Research Foundation (NRF), the Innovation Fund, and national research facilities managed by government. The NRDS is aimed at being a key enabler of economic growth alongside other strategies, such as the HR Development Strategy, the Integrated Manufacturing Strategy and the Strategic Plan for South African Agriculture.¹⁶⁰

The TYIP, launched in 2008, aims to make science and technology a driving force in enhancing productivity, economic growth and socio-economic development, and to assist the establishment of a knowledge-based economy for South Africa, in which the production and dissemination of knowledge lead to economic benefits and enrich all fields of human endeavour. The missions and platforms under the NRDS were expanded under the TYIP to include challenges in space science and technology, energy security, human and social dynamics in development, global change, and the bio-economy. The TYIP also sets long-term goals based on these challenges, including:

- becoming one of the top three emerging economies in the global pharmaceutical industry, based on innovative use of South Africa's indigenous knowledge and rich biodiversity;
- deploying satellites that provide a range of scientific, security and specialised services for all spheres of government, the public and the private sector;
- achieving a 25% share of the global hydrogen and fuel cell market; and
- becoming a world leader in climate science and responding effectively to the multiple challenges associated with global and climate change.¹⁶¹

The DST is governed by the following legislation:

- Intellectual Property Rights from Publicly Financed Research and Development (IPR) Act, 2008 (Act 51 of 2008): Provides for the effective use of intellectual property coming from publicly financed research and development.
- Technology Innovation Act, 2008 (Act 26 of 2008): Intended to promote the development of discoveries, inventions, innovations and improvements.
- South African National Space Agency (Sansa) Act, 2008 (Act 36 of 2008): Established to promote space science research, cooperation in space-related activities, and encourage an environment for the development of space technologies by industry.
- Natural Scientific Professions Act, 2003 (Act 27 of 2003): Legislates the registration of professional natural scientists, natural science technologists those in training.

¹⁵⁸ Department of Science and Technology. (2007). Innovation towards a Knowledge-based Economy: Ten-Year Plan for South Africa (2008-2018). Retrieved on March 2, 2017 from http://www.esastap.org.za/download/sa_ten_year_innovation_plan.pdf

¹⁵⁹ Government Communication and Information System. (2016). South African Yearbook 2015/2015. Op cit

¹⁶⁰ Ibid

¹⁶¹ Ibid

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- National Research Foundation (NRF) Act, 1998 (Act 23 of 1998): Established to promote basic and applied research, and the extension and transfer of knowledge in the various fields of science and technology.
 - National Advisory Council on Innovation (Naci) Act, 1997 (Act 55 of 1997): Established to advise the Minister of Science and Technology on the role and contribution of science, mathematics, innovation and technology in achieving national objectives.
 - Africa Institute of South Africa (Aisa) Act, 2001 (Act 68 of 2001): Established to promote knowledge and understanding of African affairs.
 - Human Sciences Research Council (HSRC) Act, 2008 (Act 17 of 2008): Established to carry out research that generates knowledge relative to human and social development.
 - The Scientific Research Council Act, 1988 (Act 46 of 1988): Refers to the activities of the Council for Scientific and Industrial Research (CSIR), which undertakes research and development for socio-economic growth.
 - Astronomy Geographic Advantage Act, 2007 (Act 21 of 2007): Provides for the preservation and protection of areas in South Africa that are suited to optical and radio astronomy.
 - The Science and Technology Laws, Amendment Act, 2014 (Act 7 of 2014) seeks to streamline the process for the nomination and appointment of members of the boards or councils of such entities as well as the filling of vacancies on the boards.
 - The Geoscience Amendment Act, 2010 (Act 12 of 2010), amends the Geoscience Act, 1993 (Act 100 of 1993), to mandate the Council for Geoscience (CGS) to be the custodians of geotechnical information and to act as a national advisory authority in respect of geohazards related to infrastructure and development.
 - Sanren, which is responsible for the roll-out of a high-speed broadband network to all academic and research institutions in the country, was awarded a private electronic communications network licence exemption under the Electronic Communications Act, 2005 (Act 36 of 2005).¹⁶²

South African Research Infrastructure Roadmap¹⁶³, launched by the Minister in 2016, is a strategic intervention to provide research infrastructure across the entire public research system, building on existing capabilities, and taking into account future needs. The Roadmap will allow South Africa to set national priorities and to assign funds for development and participation in pan-European research infrastructure activities. Infrastructure includes facilities, resources and services used by the scientific community across all disciplines for research, enabling the generation, exchange and preservation of knowledge.¹⁶⁴

South Africa is set to review its policy and plans regarding science, technology and innovation, Science and Technology Minister Naledi Pandor announced in 2016 at the Fourth Ministerial Meeting of Brics (Brazil, Russia, India, China and South Africa) Ministers Responsible for Science and Technology. The Minister stated that she had launched a process to develop a new White Paper, as well as a Decadal Plan for science, technology and innovation in South Africa.¹⁶⁵

¹⁶² South African Government. (no date). Science and technology. Op cit

¹⁶³ Department of Science and Technology. (2016). South African Research Infrastructure Roadmap. Retrieved February 8, 2017 from <http://www.gov.za/sites/www.gov.za/files/sa%20research%20infrastructure%20road%20mapa.pdf>

¹⁶⁴ The South African Government. (2016). Minister Naledi Pandor launches South African Research Infrastructure Roadmap. Retrieved February 8, 2017 from <http://www.gov.za/speeches/sa-first-research-infrastructure-30-sep-2016-0000>

¹⁶⁵ Engineering News. (2016). SA's science policy to be reviewed but global cooperation will remain. Retrieved March 3, 2016 from http://www.engineeringnews.co.za/article/south-africas-science-policy-to-be-reviewed-but-global-cooperation-will-remain-2016-10-21/rep_id:4136

4.2 Research and Innovation

South Africa has many advantages that support its transition to a more dynamic economy. The 2015/16 *Global Competitiveness Report* published by the World Economic Forum found that South Africa ranked 32 of 140 countries in both the capacity of businesses to innovate and company spending on research and development.¹⁶⁶

The National Development Plan (NDP) recognises the crucial importance of science, technology and innovation in accelerating South Africa's socio-economic development. The South African Government has set a target of raising gross expenditure on research and development to 1.5% of gross domestic product by 2019, from the level of 0.75% by end of 2015.¹⁶⁷

Naledi Pandor, the Minister of Science and Technology, in 2016 announced that the South African economy is attracting research and development investments.

- In the private sector these investments include:
 - General Electric investing R500 million in a customer innovation centre in Gauteng;
 - General Electric's decision to invest a further R200 million to support South African SMMEs through technology transfer;
 - BM investing R700 million over 10 years in ICT research and development;
 - A R66 million investment by Cisco to increase the company's research and development activities in South Africa.
- The Square Kilometre Array (SKA) is a €1.5 billion collaboration between South Africa and Australia to build the world's largest radio telescope. Ten member countries are the cornerstone of the SKA, around 100 organizations across about 20 countries are participating in the design and development of the SKA. Funding for the SKA project in 2016/17 alone – most of which will go towards the construction of Meerkat – is R1 billion from the department's budget.
- Over the past four years, the CSIR's R300 million Technology Localisation Programme has assisted over 140 manufacturing companies. The CSIR's R500 million Industry Innovation Partnership encourages the private sector to invest more into research and development, and enables strategic partnerships with small, medium and micro enterprises (SMMEs).¹⁶⁸

Important research and innovation projects and strategies supported by the DST in South Africa are listed below.

Hydrogen Fuel Cell Technology (HFCT)

Local HFCT development could boost manufacturing capacity and competitiveness in South Africa. HFCT forms part of the technologies identified in government's Nine-Point Plan, which seeks to boost the economy and create jobs. HFCT is a clean and reliable alternative energy source to fossil fuels.¹⁶⁹

Titanium Metal Powder Project

This project has a potentially significant economic impact for South Africa. Titanium is used in industries such as aerospace, medical applications, transport, and chemical processing to create

¹⁶⁶ National Treasury. (2016.) National Budget Review. Retrieved February 3, 2017 from <http://www.treasury.gov.za/documents/national%20budget/2016/review/chapter%202.pdf>

¹⁶⁷ South African Government. (no date). Science and Technology. Op cit

¹⁶⁸ SA news. (2016). SA attracting millions in R&D investments. Retrieved February 8, 2017 from <http://www.infrastructure.ws/2016/05/27/sa-attracting-millions-in-rd-investments/#>

¹⁶⁹ South African Government. (no date). Science and Technology. Op cit

high-performance, lightweight parts. The titanium powder is also used in 3D printing, an alternative mode of manufacturing.¹⁷⁰

National Bio-Economy Strategy

The DST's Bio-Economy Strategy positions bio-innovation as essential to the achievement of government's industrial and social development goals. The strategy provides a high-level framework to guide biosciences research and innovation investments, and decision-making as South Africa transitions to a low-carbon economy. Through this strategy, bio-innovation would be used to generate sustainable economic, social and environmental development. The DST is aiming to have biotechnology make up 5% of the country's GDP by 2050. The strategy focuses on agriculture, health and industrial applications, and is also closely linked to other policies such as the Industrial Policy Action Plan, the NDP and the New Growth Path.¹⁷¹

National ICT RDI Strategy

The DST is leading the implementation of this strategy, with the main purpose of creating an enabling environment for the advancement of ICT RDI in South Africa. The ICT RDI Strategy aims to achieve a marked increase in advanced human resource capacity, promote world-class research and build robust innovation chains for the creation of new high-tech ICT small enterprises. Implementing the strategy will involve partnerships with government, the private sector, higher education institutions and science councils. The Meraka Institute of the CSIR is managing and coordinating the implementation of the strategy. An important envisaged outcome is a vibrant, sustainable and innovative indigenous ICT industry that addresses a significant portion of the country's ICT needs and attracts international research and development investment. The Centre for High-Performance Computing (CHPC), Sanren and the Very Large Databases are the three pillars of cyber-infrastructure that the DST supports. Hosted by the University of Cape Town and managed by the CSIR's Meraka Institute, the CHPC is the first of its kind in South Africa and is making scientific supercomputing a reality for South Africa. A major project for Sanren is the national backbone network, which aims to connect all major metros in the country with a 10 gigabyte per second link. On completion, the network will reach about 200 sites.¹⁷²

Biotechnology

South Africa's research institutions and universities are conducting biotechnology research to understand the nutritional components of food indigenous to South Africa, with the aim of making those with a high nutritional value available and accessible to the majority of people.¹⁷³

Fluorspar

South Africa has the world's largest reserves of fluorspar, with estimated reserves of 41 million tons. The country supplies around 10% of the fluoride requirements to the global fluorochemicals industry.¹⁷⁴

The NRF manages various national research facilities. These include the following:¹⁷⁵

¹⁷⁰ Ibid

¹⁷¹ Ibid

¹⁷² Department of Science and Technology. (2007). Information and Communication Technology Research & Development and Innovation Strategy. Retrieved February 8, 2017 from http://www.ist-africa.org/home/files/RSAICTResearchDevelopmentInnovationStrategy_Final.pdf

¹⁷³ South African Government. (no date). Science and Technology. Op cit

¹⁷⁴ Government Communication and Information System. (2016). South African Yearbook 2015/2015. Op cit

¹⁷⁵ National Research Foundation. (2017). Centres of Excellence. Retrieved February 28, 2017 from <http://www.nrf.ac.za/division/rcce/instruments/centre-of-excellence>

South African Astronomical Observatory (SAAO)

The SAAO is the national centre for optical and infrared astronomy in South Africa. Its prime function is to conduct fundamental research in astronomy and astrophysics.

Hartebeesthoek Radio Astronomy Observatory (HartRAO)

This is a national facility of the NRF. Its radio astronomy research focuses on stellar evolution, pulsars and masers; and its Space Geodesy research uses space-based techniques to study the earth.

South African Environmental Observation Network (SAEON)

The SAEON is a business unit of the NRF and serves as a national platform for detecting, translating and predicting environmental change through scientifically designed observation systems and research.

National Zoological Gardens (NZG)

The NZG has an impressive animal collection, conservation centres, a Centre for Conservation Science as well as an NZG Academy. The NZG is an education and awareness platform for visitors comprising of educators, learners, students, special interest groups, and the general public.

iThemba Laboratory for Accelerator-Based Sciences

This is Africa's largest facility for particle and nuclear research as well as one of only a few facilities in the world producing radionuclides for commercial, research and medical applications.

South African Institute for Aquatic Biodiversity (SAIAB)

A national facility of the NRF, the SAIAB is famous for its association with the discovery of the enigmatic coelacanth and is internationally recognised for ichthyological research, dynamic research staff and active postgraduate school.¹⁷⁶

Centres of Excellence

Centres of Excellence (CoEs) are organised both as single site and decentralized entities that build on and extend capacity in well-established and prestigious research areas. At present, there are 15 CoEs. The choice of centres shows a strong match with pressing social and environmental issues facing the country and the present needs of industry (hydrocarbon synthesis; pulp and paper). The DST and the NRF established 15 Centres of Excellence since 2004, which are:¹⁷⁷

- Mathematical and Statistical Sciences – University of the Witwatersrand;¹⁷⁸
- Food Security - University of the Western Cape (UWC) and University of Pretoria (UP);¹⁷⁹
- Child Development and Livelihoods – Wits University and University of KwaZulu-Natal (UKZN);
- Mineral and Energy Resource Analysis - University of Johannesburg (UJ);¹⁸⁰
- Centre for Research on Evaluation, Science and Technology (CREST)¹⁸¹ - at Stellenbosch University is an interdisciplinary research and academic centre that was established in 1995. It conducts research on the nature of science and technology with specific focus on science policy

¹⁷⁶ Government Communication and Information System. (2016). South African Yearbook 2015/2015. Op cit

¹⁷⁷ National Research Foundation. (2017). Centres of Excellence. Op cit

¹⁷⁸ University of the Witwatersrand. (no date). Centre of Excellence - Mathematical and Statistical Sciences. Retrieved June 13, 2017 from <https://www.wits.ac.za/coe-mass/>

¹⁷⁹ University of the Western Cape. (no date). Centre of Excellence in Food Security. Retrieved June 13, 2017 from <https://www.uwc.ac.za/Faculties/EMS/COEFS/Pages/default.aspx>

¹⁸⁰ University of Johannesburg. (no date). Centre of Excellence for Integrated Mineral & Energy Resource Analysis (CIMERA). Retrieved June 13, 2017 from <https://www.uj.ac.za/faculties/science/geology/Pages/Cimera.aspx>

¹⁸¹ Centre for Research on Evaluation, Science and Technology (CREST). (no date). Welcome to CREST. Retrieved June 13, 2017 from <http://www.sun.ac.za/crest/>

issues in South Africa and on the African continent; the nature and state of knowledge production in the higher education sector in South Africa and selected African universities; the methodology and sociology of science; and the nature of monitoring and evaluation studies. It also offers postgraduate programmes in two areas namely Science and Technology Studies and Monitoring and Evaluation Studies.

- Scientometrics and Science, Technology and Innovation (STI) Policy – Stellenbosch University;¹⁸²
- Centre of Excellence for Invasion Biology¹⁸³ (hosted by the University of Stellenbosch) is concerned with the biology of invasive species, with special emphasis on the impact that invasive species have on southern Africa's biodiversity, agriculture and eco-tourism.
- Centre of Excellence in Strong Materials¹⁸⁴ (hosted by the University of the Witwatersrand) studies hard materials, metal alloys, metal oxides, ceramics, diamond-like materials and composites including carbon nanotubes.
- Centre of Excellence in Birds¹⁸⁵ as key to Biodiversity Conservation at the Percy FitzPatrick Institute (hosted by the University of Cape Town).
- Centre of Excellence in Catalysis¹⁸⁶ (hosted by the University of Cape Town) focuses research on chemical catalysis mainly for the conversion of gas liquid fuels and for downstream processing that adds value to bulk chemicals.
- Centre of Excellence for Biomedical Tuberculosis (TB) Research¹⁸⁷ is co-hosted by the University of Cape Town, University of Stellenbosch and the University of the Witwatersrand.
- Centre of Excellence in Tree Health Biotechnology at Forestry and Agriculture Biotechnology Institute (FABI)¹⁸⁸ is hosted by the University of Pretoria.
- Centre of Excellence in Applied Centre for Climate and Earth Systems Science (ACCESS)¹⁸⁹ is hosted by the Council for Scientific and Industrial Research.
- Centre of Excellence in Epidemiology Modelling and Analysis (SACEMA)¹⁹⁰ is hosted by University of Stellenbosch and specialises in the mathematical modelling of diseases prevalent in South Africa, Southern Africa and the African continent.
- The National Institute for Theoretical Physics (NITheP)¹⁹¹ is a geographically distributed institute that includes all theoretical physicists in South Africa. Its headquarters is the Stellenbosch Institute for Advanced Study (STIAS) at Stellenbosch University, with regional nodes at the University of the Witwatersrand and the University of KwaZulu-Natal.

¹⁸² Centre of Excellence in Scientometrics and Science, Technology and Innovation Policy (SciSTIP). Welcome to SciSTIP. Retrieved June 13, 2017 from <http://www0.sun.ac.za/scistip/>

¹⁸³ Centre of Excellence for Invasion Biology (CIB). (no date). Who we are. Retrieved June 13, 2017 from <http://academic.sun.ac.za/cib/>

¹⁸⁴ University of the Witwatersrand. (no date). DST-NRF Centre of Excellence in Strong Materials. Retrieved June 13, 2017 from <https://www.wits.ac.za/strongmaterials/>

¹⁸⁵ Percy Fitzpatrick Institute. (no date). Centre of Excellence. Retrieved June 13, 2017 from <http://www.fitzpatrick.uct.ac.za/fitz/about/excellence>

¹⁸⁶ C*change. (no date). Welcome to c*change. Retrieved June 13, 2017 from <http://www.cchange.ac.za/>

¹⁸⁷ Stellenbosch University. (no date). DST/NRF Centre of Excellence for Biomedical TB Research (CBTBR). Retrieved June 13, 2017 from <http://www0.sun.ac.za/research/research-facts/centres-of-excellence-1/dst-nrf-centre-of-excellence-for-biomedical-tb-research-cbtbr.html>

¹⁸⁸ Forestry and Agriculture Biotechnology Institute (FABI). (no date). The DST-NRF Centre of Excellence In Tree Health Biotechnology. Retrieved June 13, 2017 from <http://www.fabinet.up.ac.za/index.php/research-groups/dst-nrf-centre-of-excellence-in-tree-health-biotechnology>

¹⁸⁹ Applied Centre for Climate and Earth Systems Science (ACCESS). (no date). Home Page. Retrieved June 13, 2017 from <http://www.access.ac.za/>

¹⁹⁰ Centre for Epidemiological Modelling and Analysis (SACEMA). (no date). Home Page. Retrieved June 13, 2017 from <http://www.sacema.org/>

¹⁹¹ Stellenbosch University. (no date). The National Institute for Theoretical Physics (NITheP). Retrieved June 13, 2017 from <http://www0.sun.ac.za/research/research-facts/centres-of-excellence-1/the-national-institute-for-theoretical-physics-nithep.html>

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- The Centre of Excellence in HIV Prevention (Centre for the Aids Programme of Research in South Africa, CAPRISA)¹⁹² aims to identify the risk factors responsible for these high rates and to develop new technologies and strategies to reduce the spread of HIV in women, especially young women.¹⁹³

The South African National Research Network (SANReN), funded by the Department of Science and Technology (DST) and implemented by the CSIR Meraka Institute, provides a minimum of 1Gbps and to 10Gbps connectivity to all South African public universities, many science councils and entities such as the South African Weather Services. SANReN also supports the Square Kilometer Array and the South Africa Antarctic Research Programme. The SANReN network forms part of a South African government approach to a National Integrated Cyberinfrastructure System (NICIS) to ensure successful participation of South African researchers in the global knowledge production effort.¹⁹⁴

4.3 Human Resource Development

According to the NRF Strategy, the NRF will engage with government-funded programmes and the private sector in its endeavours to address the planned initiatives as set out below:

- *National Plan for Higher Education: The national plan for higher education provides an implementation framework for realising the objectives of the white paper on transforming the higher education system to meet the social and economic development needs of the country.*
- *Strategy for Human Capacity Development for Research, Innovation and Scholarships: The strategy identifies a set of interconnected objectives that aim to significantly increase national capacity in research and innovation.*
- *Human Resource Development Strategy (HRDS): The HRDS recognises the need to implement a systemic strategy for human resource development in order to address the disparities in wealth and poverty through the institutionalisation of HRD planning and implementation as well as the effective monitoring of progress against national targets.*
- *National Strategy for Multiwavelength Astronomy: The strategy aims to leverage off the strong international collaborative network to strengthen astronomy on the African continent.*
- *National Research and Development Strategy (NRDS): The NRDS articulates the need for a competitive research funding system to be built on international best practice as well as the benefits of and need for knowledge generation and innovation. The strategy identifies HCD as essential to transform the system through the upliftment of designated groups and advocates the pursuit of excellence in global terms. The NRF subscribes to and implements all aspects of the strategy.*
- *South African Research Infrastructure Roadmap (SARIR): SARIR is a proactive instrument that supports strategic planning and evaluation of the need for large-scale research infrastructure in the NSI. Through the roadmap, the investment in research infrastructure will now be supported by high-level planning and evaluation that will ensure alignment to national priorities, optimise return on investment and ensure sustainability.*
- *DST Science Engagement Framework: This framework provides an overarching strategic context to advance science engagement in South Africa. It is intended to encourage and improve the coordination of science promotion, communication and engagement activities across the DST public entities, universities, other government*

¹⁹² Centre for the Aids Programme of Research in South Africa (CAPRISA). (no date). Home Page. Retrieved June 13, 2017 from <http://www.caprisa.org/Default>

¹⁹³ National Research Foundation. (2017). Centres of Excellence. Op cit

¹⁹⁴ IST Africa. (no date). Current ICT initiatives and projects – Republic of South Africa. OP cit

departments and science councils, museums and partners outside the public sector.¹⁹⁵

To nurture a new generation of researchers and to address skills shortages, a series of initiatives aim to encourage participation in the science and technology sector, in doctoral and postdoctoral studies (National Research Foundation Fellowships) and in research careers, including for women and the black community. Financial support to researchers has helped to mitigate the brain drain. The new National Human Resources Development Strategy (2010-20) anticipates future national human resources requirements. Increased policy attention has been paid to lifelong learning and better articulation between workplace learning and higher education.¹⁹⁶

In the schooling sector, the Technical Schools Recapitalisation grant and the Dinaledi Schools grant have been combined and are now called the Mathematics, Science and Technology (MST) grant. This grant is intended to promote the teaching and learning of Mathematics, Science and Technology and has been allocated a total of R1.1 billion over the 2015/16 to 2017/18 budget periods. The MST grant will strengthen the implementation of the National Development Plan and the Action Plan to 2019 by increasing the number of learners taking Mathematics, Science and Technology subjects, improving the success rate of the learners as well as improving teachers' capabilities in teaching these three gateway subjects.¹⁹⁷ The 2013 audit on the connectivity status of Dinaledi schools indicates that out of the 492 Dinaledi schools, 269 are connected. 223 Dinaledi schools are not connected including 17 that do have connectivity facilities but currently have no connectivity available.

4.4 Key Actors and Players

Actor/Player	Role and Area of Development
Department of Science and Technology (DST)	South African government department responsible for scientific research, including space programmes
National Research Foundation of South Africa (NRF)	The National Research Foundation (NRF) is a client-centred organization that upholds excellence in its service to the research community. Its primary objective is to contribute to the improvement of the quality of life of all the people of the country. This objective is directly linked to the promotion of a knowledge economy that is based on the generation, transfer and use of knowledge. To assist with this, the NRF promotes and supports research and researchers through the development of the human capital development pipeline, which is geared towards creating critical mass of high-end skills. ¹⁹⁸
Human Sciences Research Council (HSRC)	The Human Sciences Research Council (HSRC) is mandated to initiate, undertake and foster strategic basic and applied research in the human sciences, and to gather, analyse and publish data

¹⁹⁵ Department of Science and Technology. (2016). National Research Foundation Strategy 2020. Retrieved February 8, 2017 from <http://www.nrf.ac.za/sites/default/files/documents/NRF%20Strategy%20Implementation.pdf>

¹⁹⁶ Organisation for Economic Co-operation and Development. (no date). Country profiles, South Africa. Retrieved March 3, 2017 from <https://www.oecd.org/sti/outlook/e-outlook/sticountryprofiles/southafrica.htm>

¹⁹⁷ Digital Classroom. (2015). Accelerated quality, equity and efficiency. Retrieved February 8, 2017 from <http://digitalclassroom.co.za/digitalclassroom/latestnews/news-2015/641-accelerated-quality-equity-and-efficiency>

¹⁹⁸ Department of Science and Technology. (2016). Annual Report 2015/2016. Retrieved February 6, 2017 from http://www.dst.gov.za/images/Attachments/Annual_Report_DST_WEB_2015_2016.pdf

Actor/Player	Role and Area of Development
	relevant to developmental challenges in South Africa, elsewhere in Africa and in the rest of the world. ¹⁹⁹
Council for Scientific and Industrial Research (CSIR)	Science and technology research, development and implementation organization
Academy of Science South Africa (ASSAf)	National science academy, representing South Africa in the international community of science academies
Africa Institute of South Africa (AISA)	Research and training institute
National Advisory Council on Innovation (NACI)	Government advisory council on innovation
South African National Space Agency (SANSA)	Promotes the use of space and cooperation in space-related activities while fostering research in space science
Technology Innovation Agency (TIA)	National public entity which serves as a key institutional intervention to bridge the innovation gap between research and development
National Intellectual Property Management Office (Nipmo)	Supports the offices of technology transfer at publicly funded research institutions
Agricultural Research Council (ARC)	Conducts research in agriculture to develop technology and disseminating information
Mintek	South Africa's national mineral research organization
Medical Research Council (MRC)	Independent statutory body that coordinates health and medical research activities throughout South Africa
Council for Geoscience (CGS)	Scientific research council
South African Bureau of Standards (SABS)	Statutory provider of standards, management systems, business improvement and regulatory approval information
ESKOM	South African electricity public utility
Sasol	An integrated energy and chemical company based in Johannesburg
National Health Laboratory Service (N HLS)	The largest diagnostic pathology service in South Africa
Bureau for Economic Research (BER)	Monitors and forecasts macroeconomic economic and sector trends
National Institute for Communicable Diseases (NICD)	A division of the NHLS
The Institute for Economic Research on Innovation (IERI)	Institute that does policy research in the political economy of knowledge to promote sustainable economic growth
Institute for Security Studies (ISS)	African organization which enhances human security by providing authoritative research, expert policy advice and capacity building
African Centre for Peace and Security Training	Mandated to enhance the ability of practitioners to make and implement policies
National Agricultural Research Forum (NARF)	Facilitates consensus and integrates coordination in the fields of research, development, and technology transfer to agriculture
Water Research Commission (WRC)	Promotes coordination, cooperation and communication in the area of water research and development
Institute for Water Research	Contributes to the knowledge of and promotes the understanding and wise use of natural water resources
South African National	An autonomous, state-aided organization whose mission is to

¹⁹⁹ Ibid

Actor/Player	Role and Area of Development
Biodiversity Institute (SANBI)	champion the exploration, conservation, sustainable use, appreciation and enjoyment of South Africa's exceptionally rich biodiversity for all people

4.5 Challenges facing the STI sector

In 2015, the Minister claimed that the South African government attention did not focus on increased investment in research development and innovation, as it was seen as less significant than water scarcity, food security and disease burdens.²⁰⁰ South Africa thus needs to invest more in research and higher education to fully achieve its goals, and the national system of innovation has to be integrated politically and economically through the National Development Plan.

A major bottleneck for South Africa's economic and social development is the lack of a broad skills foundation. Only 4% of the adult population has tertiary level education and 16% of workers are in science and technology occupations. The lack of design, engineering, entrepreneurial and management capacity is a major constraint. The ageing of the white male population of researchers and engineers further weakens the skills base. IT infrastructures are relatively under-developed. Additionally, it has been argued that the development of network industries has been hampered by market domination by state-owned firms and restrictive legislation.²⁰¹

Another challenge facing the STI sector is the gender gap in the work force, in which there is an especially low number of women areas of science, technology, engineering and mathematics.²⁰²

²⁰⁰ Brand South Africa. (2015). Science and technology can be answer to Africa's challenges. Retrieved March 3, 2017 from <https://www.brandsouthafrica.com/investments-immigration/science-technology/science-forum-south-africa-101215>

²⁰¹ Organisation for Economic Co-operation and Development. (no date). Country profiles, South Africa. Retrieved March 3, 2017 from <https://www.oecd.org/sti/outlook/e-outlook/sticountryprofiles/southafrica.htm>

²⁰² Commonwealth of learning. (2016). Using ICT skills development to address the skills shortage. Op cit

5 Conclusion

South Africa's policies, strategies, platforms, and legislative measures indicate that South Africa is advancing steadily towards a Knowledge Society. The ambition of the South African Government is to integrate fully ICT into all spheres of education starting from the foundation of basic education to all the post-school educational opportunities. Ministries responsible for ICT, Education and STI have some cross-cutting policies in place aimed at the continued economic growth and socio-economic development, and are moving towards achieving KS development goals, but these achievements are being hampered by the lack of last-mile internet connectivity, lack of funds, and lack of a singular national programme for areas such as teacher ICT development and ICT roll outs to schools, where there is a reliance on provincial departments of education to coordinate these efforts, and also in the regulation and governance of the ICT sector being spread across various entities. Further to this, many policies related to ICT focus on infrastructure and roll out of ICTs rather than as using ICTs as a tool for growth and development, with policies and guidelines for their use, as well as basic training. South Africa is also facing political instability, which may threaten foreign capital investment inflows, which is critical for the growth and diversity of industry.

While South Africa has made improvements in basic education enrolment, this has placed tertiary institutions under pressure, as growth in Higher Education Institutes has not been as been in line with the goals set out in the National Development Plan, with fewer enrolments in this area due to lack of capacity, with very high demand. Another factor challenging the status of South Africa as a KS is the low participation of women in science, technology, engineering and mathematics. This is one of the reasons that Maths and Science education at school has been a high priority, with the use of ICTs assisting in the teaching and learning in these areas.

South Africa's national system of innovation has evolved through many stages, strategies, policies and programmes. South Africa has great potential technologically and in human resources to become one of the leading countries in research and development and innovation. This requires investments in research and higher education, as well as basic education. Promisingly, there are numerous national and provincial level visions and plans which indicates recognition of the areas that require development. However, in order for these to be achieved, there is a need for greater alignment between the plans, and also for more collaboration between the public and private sectors.

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About GESCI

The Global e-Schools and Communities Initiative (GESCI) is an international non-profit organisation founded on the recommendation of the ***United Nations Task Force on Information Communication Technology*** (ICT). GESCI was established in 2003 at the first World Summit on the Information Society.

The United Nations ICT Task Force identified **education as an area in critical need of development**, and one where **ICT has the potential to make a positive impact**. Initially GESCI was headquartered in Dublin, Ireland, and in 2011 moved its headquarters to Nairobi, Kenya.

GESCI's mandate is to assist governments in the socio-economic development of their countries through the widespread integration of technology for inclusive and sustainable knowledge society development.

Assessment of Knowledge Society Development in South Africa

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