African leadership in ICT

Assessment of Knowledge Society Development in 16 African countries

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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[1]

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.[2] 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.[3]

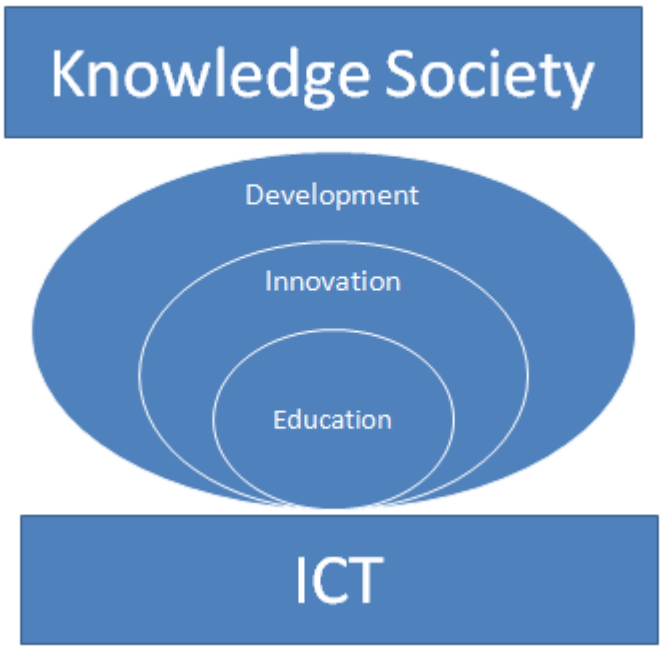
Gesci believes that ICT, education, and innovation are the critical pillars and key elements for development towards a knowledge-based future. Butcher (2010) visually captured the inter-relationship between the three pillars as follows:

[1] This overview is based on the country report introductions from the 2013 reports

[2] 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

[3] 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 Society[4]



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. [5]

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.*[6]

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.[7] This enables continuous adaptation to a

[4] Neil Butcher and Associates. (2011). Thematic Paper: ICT, Education, Development, and the Knowledge Society. Gesci. Retrieved July17, 2017 from http://gesci.org/fileadmin/user_upload/4_ICT_in_STEM_Education_Files/ICT__Education__Development__and_the_Knowledge_Society_1__1_.pdf

[5] 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

[6] 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

[7] 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.[8] 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.[9] 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.[10]

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.[11] 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).[12]

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.[13] 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.

[8] Hooker, M. (2011). African Leadership in ICT and Knowledge Societies: Issues, Tensions and Opportunities for Learning for Gesci.

[9] Neil Butcher and Associates. (2011). Thematic Paper: ICT, Education, Development, and the Knowledge Society. Gesci. Retrieved July17, 2017 from http://gesci.org/fileadmin/user_upload/4_ICT_in_STEM_Education_Files/ICT__Education__Development__and_the_Knowledge_Society_1__1_.pdf

[10] Hooker, M. (2011). African Leadership in ICT and Knowledge Societies: Issues, Tensions and Opportunities for Learning for Gesci.

[11] 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

[12] Hooker, M. (2011). African Leadership in ICT and Knowledge Societies: Issues, Tensions and Opportunities for Learning for Gesci.

[13] Hooker, M. (2011). African Leadership in ICT and Knowledge Societies: Issues, Tensions and Opportunities for Learning for Gesci. Retrieved July 17, 2017 from

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 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 revisitation 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.[14]

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

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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

[14] 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

efforts to end all forms of poverty, fight inequalities, and tackle climate change over the next 15 years.

> *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.*[15]

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 responsiblilty 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.[16]

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.

[15] 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/

[16] 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/

Country reports

As mentioned above, 16 country reports were prepared, focusing on key developments with regards to education, STI, and ICT. Each country report provides an outline of where the country is with regards to developing a knowledge society. The table below provides a short summary of the findings from each of the countries.

Table 1 Summary of findings from country reports

Country	Summary of findings
Botswana	• Policies, strategies, and plans are well aligned to KS development goals as articulated in Vision 2036. • Progress in implementation of policies and frameworks has been hindered by infrastructural issues, human capital deficits, and lack of adequate funding. • Economic success to date has not depended on technological advancement. • There are several contradictions in Botswana's development – for example, it ranks very highly in Africa with regard to its ICT platform, but has low penetration and internet usage. Investments in broadband infrastructure have not directly translated to cheaper internet access, and operators do not appear to have taken advantage of focusing on retail or the last mile. • Ministries responsible for ICT, Education, and STI lack cohesiveness and inter-linkages, and progress on their agendas are independent of one another. For example, the education sector appears prepared with regard to the training of teachers, introducing computers and internet connectivity across all the schools. However, its success is hampered by the lack of internet connectivity and electricity. • There is low participation of women in science, technology, engineering, and mathematics. Also, the over-reliance on the mineral resources has placed the STI pillar of the KS at a very low priority, although it is now being considered to diversify the country's economic portfolio.
Cote d' Ivoire	• The government is focusing on policies and strategies to restore socio-economic health, including development of technology and communication policies. There is also some investment in ICT infrastructure. • Although Côte d'Ivoire has made progress in providing access to basic education and has a proactive policy in this area, it has placed little focus on integrating ICT into its education system. Whilst there is an e-education programme, most of schools do not have access to ICT facilities. There is, however, a drive towards improving ICT in public higher education institutions.
Ethiopia	• The development of KS is still in the nascent stages. • Ethiopia is a low-income country with one of the lowest literacy rates in the world. Current poor performance in education, particularly the low level of enrolment in higher education institutions, impedes its readiness to transition into a KS. • There is a lack of updated policies, particularly in the STI sector and in ICT for development. • 40% import tariffs on ICT equipment make it too costly for most citizens. The incumbent public telecommunications operator has a monopoly over all telecommunications services. Although the number of mobile phone subscribers is growing, uptake in Ethiopia is among the lowest in Africa. This is due to the limited telecommunications infrastructure, low levels of computerization outside the capital, and lack of human resources. The low level of internet access is limiting the usefulness of ICT in creating a KS.
Ghana	• Several policies, strategies, and programmes within frameworks recognize the need to embrace opportunities associated with a fully functional information society and KS. • ICT is increasingly being woven into the curriculum. At the tertiary levels, entrepreneurship and innovation are being recognized as wielding huge potential in

Country	Summary of findings
	assuaging graduate unemployment. • Comparing the formulation of policies and their implementation timelines leaves a wide gap between the intended position and the actual situation. Many of the problems are attributable to implementation gaps that arise largely from a lack of continuity in programmes and roadmaps laid out, the suitability and timeliness of the interventions the programmes seek to promote, and leadership issues. • Implementation gaps also arise because of a scarcity in multi-stakeholder consultations and dialogue on one hand and a transformational leadership on the other.
Kenya	• The government is moving towards a knowledge-based and 'innovation driven' model of economic development. • The large and growing body of major recent policy blueprints in Kenya appears unanimous that STI is critical for promoting economic growth, stimulating productivity, and improving people's livelihoods. Kenya's Vision 2030 and the STI policy and strategy provide the framework for creating a knowledge-based economy. • Since the progress that has been made in both policy and institutions, research and innovation have begun to advance in Kenya. Universities are competing to set up software and hardware incubation centres that would link them to industry. • Some studies attribute Kenya's growing economy largely to ICT. • Current restructuring of the education system and implementation of the digital learning programme also shows promise in gearing the country's direction towards ICT and STI. • Integration and application of ICT within the learning process in the education sector is still in its infancy. New initiatives are still dominated by technical aspects. • With devolved governance, continuity in government reforms, and a fairly stable political environment, Kenya is in a good position to leverage innovation. • Kenya is firmly committed to nurturing a knowledge-driven development agenda. However, the issue of whether there is sufficient capacity and financial commitment to these goals remains debatable. • Whilst Kenya has developed comprehensive policy frameworks, the relationships between research institutions and industry remain disjointed.
Malawi	• Malawi recognizes ICT as a significant driver of development, as articulated in the country's ICT policy. However, the ICT Development Index (IDI) ranks Malawi at 168 out of 175 countries. The country faces challenges such as limited coordination of ICT infrastructure development, sporadic availability of ICT services, scare geographic coverage of these services, little institutional and human capacity in ICT services, and low adoption rates of modern broadcasting technologies. • Exposure to ICT at school remains a luxury, and teachers have little or no professional development in ICT, both of which pose a threat to the development of a KS. However, there are several initiatives to address this. • STI is a priority in the Vision 2020, and the government and institutions are involved in initiatives towards making science and technology more accessible to the general population. • Malawi still has a long way to go in achieving a KS. The measures that have been undertaken thus far have provided a good start, but projects that make a larger impact and that do not rely so heavily on donor funding will be crucial. Equally as important will be solid governance mechanisms, political stability, and public education that emphasizes the importance of ICT and STI for the country.
Mauritius	• Mauritius is one of the leading countries in Africa with regard to developing a KS. It has a strong infrastructure, and its financial economy is strong. • Initiatives to create an information society revolve around the instilling of a 'technology temper' in Mauritians to bring about increased adoption and usage of ICT, ICT-enabled knowledge networking among citizens, and generally accepting ICT as a stream of professional persuasion at par with others. • ICT infrastructure is strong and telecommunication rates regularly revised to facilitate ICT growth and boost the competitiveness of Mauritius as a destination for ICT activities.

Country	Summary of findings
	In addition, there are many worthwhile ICT initiatives that aim to integrate ICT into Mauritian society. However, the ICT sector faces serious challenges such as erratic speed of connectivity and insufficient government support to help Small and Medium enterprises (SMEs) integrate ICT into their businesses. • All public schools are equipped with computers, and there are several programmes and initiatives aimed at introducing ICT literacy into schools. The new national curriculum framework specifically notes that all teachers will be provided with technological skills to manage ICT and social networks, and to adopt ICT-mediated learning. However, challenges that the education system will need to overcome to strive toward a KS include connectivity problems and access to online learning. The quality and relevance of higher education also needs to be addressed to give Mauritius the critical mass of expert scientists it needs to fulfil its ambitions. • There are no STI policies in the country, but some efforts are being made to grow the STI sector. Mauritius is investing in a collaborative research and development grant scheme to promote innovative ideas and commercialize them to create jobs, and ultimately, wealth. Several organizations contribute to research and STI and there are programmes and scholarships aimed at human resource development. However, there is still much work to be done in the sector and challenges include a brain drain as skilled scientists are leaving the country.
Morocco	• The government is committed to developing Morocco as a KS. • In 2000, the country undertook a restructuring of the education system. Major efforts have been made to reform the educational system in both the institutional and pedagogical aspects. This includes efforts to integrate ICT in education. • Despite the progress made, the quality of education remains a challenge. • Morocco is one of the few African countries to show an upward trend in science and technology.
Mozambique	• Development of a KS in Mozambique is still in its nascent stages. • The various policies and plans in place indicate willingness and commitment from the Mozambican government to transform the country towards a KS. The major focus is accelerated national development by integrating ICT in different sectors of the economy, providing free and compulsory primary education, and development of the STI sector for socio-economic development. • While there is a commitment by government, many policies and strategies are outdated, impeding the development of the country. • Key challenges faced in education include low completion rates, high student-to-teacher ratios, lack of ICT integration into teacher training and the curriculum, lack of qualified mathematics and science teachers, and lack of equipment in schools. • Research, innovation, and human resource development face challenges including lack of equipment and funding for research institutions, high unemployment rates particularly among the youth population graduating from basic and secondary education, low ICT skills, lack of connectivity, poor distribution of electricity supplies, low levels of innovation activities, a heavy reliance on donor funding, and uncoordinated cross-ministerial relationships.
Namibia	• Plans and policies show evidence of a desire to create a KS, and KS development is a central tenet of Vision 2030. • The strength of the economy is indicative of its great potential to become a leader on the African continent, although significant social inequality remains an issue. • Namibia's IDI has been increasing steadily since 2002, and the percentage of individuals and households using the internet is increasing. However, these figures are still low. • Government plans for ICT are clearly articulated in relevant policies, and there are efforts to develop infrastructure. • There is an increase in primary completion rates, and significant strides in achieving gender equity. However, tertiary institutions still do not have the capacity to enrol all those seeking a university education. • Although ICT literacy has been made a priority in the education system, supplying ICT

Country	Summary of findings
	hardware to schools across the country remains a challenge. However, there are several ICT in Education initiatives in schools. • STI has also been noted as a priority area, and the results of several partnerships have yielded positive developments. • There is still a significant amount of work that needs to be done. In particular, additional work is required in policy development and implementation of policies.
Rwanda	• Rwanda has made significant progress in socio-economic development, and has seen considerable progress on the path towards recovery and sustainable growth following the violent genocide and civil war in 1994. The government and private sector have invested in building infrastructure, skills, and institutional frameworks to provide an environment that is conducive to developing a KS – from establishing higher institutions of learning to the laying of fibre-optic cable nationwide. • Several polices and plans focus on developing ICT, education, and STI in Rwanda. • Rwanda continues to be one of the fastest growing African countries in ICT. ICT is acknowledged as a key driver for economic growth, and is the core of the reform agenda geared towards reconstruction and higher levels of development. • In education, one of the major strengths of ICT in education is that it is already strongly supported by the government and is well considered in national policy documents, and various projects are already implemented or underway. The potential for using ICT to strengthen teacher professional development is acknowledged in several policies as important in improving the quality of education in Rwanda. • While overall ICT access is growing and creating accelerated development opportunities in Rwanda, several challenges hinder the sustainability of new growth and development. Challenges include low levels of telecommunication penetration especially in remote areas, and a lack of basic infrastructure such as electricity. The education sector faces challenges of overcrowded classrooms, high student-teacher ratio, and lack of adequate funding in institutions of higher learning. Gaps still exist such as inadequacy of computer deployments, lack of teacher training in computer skills, and lack of electricity grid infrastructure in rural areas hindering ICT in education development. • Insufficient funding of research institutions and insufficient capacity to innovate may also hinder the development of a KS. Further, the rate of adoption and integration of STI is low, with there being a shortage of technically qualified professionals. However, there are efforts to address this via the numerous partnerships to develop capacity in this area.
Senegal	• The government has invested a large part of its budget in education, training, research, and innovation. However, the quality of education, especially that of basic education, remains a challenge, and the country has not attained universal primary education. • The government recognizes the significance of ICT and STI in the development and economic competitiveness of the country. However, these sectors have failed to create as many jobs as desired, and there is a great need for education and training of quality human resources in the control and use of science, technology and innovations. • The recent establishment of the Virtual Campus of Senegal and signing of several partnership agreements in research, science, and technology are encouraging.
South Africa	• Government policies, strategies, platforms, and legislative measures indicate that South Africa is advancing steadily towards a KS. The government aims to integrate ICT into all spheres of education. • 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, lack of a singular national programme for areas such as teacher ICT development and ICT roll outs to schools (which relies on the coordination of provincial departments of education), and 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 ICT rather than as using ICT as a tool for growth and development.

Country	Summary of findings
	• South Africa has made improvements in basic education enrolment, but tertiary institutions are under pressure, as growth in these institutions has not been as been in line with the goals set out in the National Development Plan. • Another challenge is the low participation of women in science, technology, engineering, and mathematics. Thus, the government has afforded a high priority to Maths and Science education at school. • South Africa's national system of innovation has evolved over the years, showing great potential technologically and in human resources to become one of the leading countries in research and development and innovation. However, there is a need for greater alignment between the plans and for more collaboration between the public and private sectors.
Tanzania	• The development of KS in Tanzania has shown some progress over the past decade. While policy and the regulatory frameworks that direct, enable, and link primary, secondary, Technical and Vocational Education and Training (TVET), tertiary education and STI are in place, it appears that adequate implementation is lacking. • Mobile penetration rates, fixed broadband subscriptions, and the percentage of the population using the internet are slowly increasing. • The government aims to position Tanzania as a regional ICT hub by connecting to the region's submarine cable infrastructure and extending access to this to its landlocked neighbours. As a result, the cost of connectivity has fallen dramatically recently. However, high retail technology and access costs seem to be stifling demand and usage at a time when it should be greatly increasing. • While enrolments, particularly in secondary schooling, are increasing, improvements in access have not necessarily been accompanied by improvements in quality. Furthermore, low progression rates to secondary and tertiary education means that most Tanzanians are unable to access university education, critical for the development of skills required for the development of a KS. • While ICT is formally part of the secondary curriculum and is documented as being important for teaching and learning, few primary and secondary schools have access to ICT and Internet connectivity, while the majority of those that do, still tend to make use of ICT only for administrative purposes. Recent efforts to improve the quality of pre- and in-service teacher training and to embed ICT into pedagogy are unlikely to yield results until there is more ubiquitous access to ICT in classrooms. • Significant investment is required to fully develop the country's STI capabilities. • There is a lack of the relevant institutional capacity and knowledge in most key parts of the education, technology and STI sectors. The structures and institutions seem to be in place in theory but they appear to be unable to translate policy intention into strategic operating plans.
Uganda	• There has been a proliferation of policy and strategy initiatives that have taken place over the past decade. Many, particularly those in the ICT, Education, and STI sectors, are in line with Uganda's vision of transforming itself into a middle-income country by leveraging the development of a modern knowledge and innovation based economy. These policy and strategy initiatives have laid a solid foundation for progressing and realizing this vision. • A great number of Ugandans still live at or below the poverty line and are economically dependent on agriculture, generally poorly educated, and culturally relatively conservative. • There have been some gains made in terms of access to ICT such as improved access to broadband Internet services, mobile phone growth, and general telecommunication liberalization. There have been some advances made in terms of making government more accessible, transparent, and efficient. However, Uganda is performing poorly in ICT sector development and was ranked 157 out of 175 in 2016. Nevertheless, current fibre optic infrastructure projects should lead to further gains being realized for more people. One notable exception to this is access to electricity, especially in rural areas. This will likely continue to limit any further ICT gains in terms of quality, accessibility and

Country	Summary of findings
	price. • There have been several efforts to transform the education sector. Enrolments have increased and gender parity, especially in primary education, has effectively been reached. Poor quality and throughput rates remain stubborn challenges. Current curriculum revisions, especially to the lower secondary curriculum aim to bring about a better match between education outcomes and job market requirements, as well as increased enrolments into post-primary and tertiary programmes related to STI or in areas demanded by the economy. Efforts in all these areas are being hampered by the slow and relatively uncoordinated implementation of ICT in the various education systems. • Development and implementation of the National Science, Technology and Innovation Plan 2012/13 – 2017/18 (2012) has had some positive effects on STI, including an increase in research and development capacity. Space is slowly being created for local and foreign investment to spur Research and development (R&D) and innovation. • The STI sector is challenged by a lack of legal and regulatory frameworks, especially regarding Intellectual Property (IP) protection, weak and overlapping research institutions, and a lack of institutional and administrative reforms to facilitate STI and R&D. There is also inadequate partnering between the various public and private role players. Further, universities offer inadequate course provision in science, technology, and engineering despite these subjects' critical contribution towards innovation and enrolments in such programmes remains below 25% of all students. Funding of research institutions is also inadequate while the indigenous technologies that are developed lack promotion and exploitation.
Zambia	• Vision 2030 is widely recognized as the guiding document for many plans and policies. Their national development plans have identified various specific sector issues and defined strategic goals, but tend to be relatively weak in terms of actionable means of achieving goals and implementing strategies. Sector-specific plans, where they exist, tend to be out of date and/or lacking in the necessary detailed implementation strategies necessary to realize Zambia's ambitious planning objectives. • Zambia requires massive and consistent investment in all the areas required for the development of a KS, including education and human development at all levels, research and development, especially in STI, ICT infrastructure, and the policy and regulatory frameworks that direct, enable, and link these sectors. • There have been gains made in implementation of ICT, particularly in mobile phone penetration. However, these gains are tempered by relatively low levels of internet adoption and usage, a moderately constrained bandwidth environment, and the high costs of both ICT equipment and access. Although the government has indicated its intention to review the National ICT policy of 2006, no such reviewed or revised policy seems to be publicly available yet. • Zambia has made significant progress in Universal Primary Education, but increasing enrolments have put tremendous strain on the education system, affecting quality. The TVET and tertiary sub-sectors both require large investments to increase their capacity, accessibility, and quality. • There is no ICT in education policy, but ICT is included as a subject at both primary and secondary level. • The STI sector is relatively underdeveloped due mainly to a weakness in coordination, an inadequate policy and legal framework, human resource constraints, inadequate modern equipment, and insufficient infrastructure. Improving the quality of primary and secondary education will also have a positive impact on STI by making the pool of potential research students larger.

The country summary reports above highlight that there are significant variations between countries as they develop towards a KS. Most countries have developed some sort of 'Vision' document, which outlines where the country plans to be in the future. In some cases, these documents are accompanied by action/implementation plans outlining how the country plans to achieve its vision.

Countries are at various stages in developing policies on ICT, Education, and STI. Some countries still need to create an environment that is favourable to building a KS and thus still require effort in developing a comprehensive regulatory and institutional framework that allows for the mainstreaming of ICT across sectors and governmental entities. Whilst some have targeted all the relevant sectors identified as significant in developing a KS, others may have prioritized some sectors over others, usually education or ICT. Countries are also at various stages in implementing their plans.

With regards to ICT, many countries have e-government strategies, which are in various stages of being implemented. The country reports also highlighted the insufficient number of skilled workers in the industry. With continuous development of new technologies, this is significant. Thus, there still appears to be lack of capacity and capability when it comes to ICT. Most countries have an ICT Innovation Hub (but this also varies in terms of the work that they do and the impact they have). ICT infrastructure appears to be growing, but a major challenge is lack of electricity and, particularly, last-mile connectivity (especially affecting those in rural areas). This is compounded by the fact that most of the population in each of the countries is relatively poor. With the high cost of data and internet services, this makes ICT adoption slow. Nevertheless, fibre optic cable systems in most countries are likely to be a game-changer for internet connectivity, although the full effects of progress in ICT infrastructure can only be felt if there is greater penetration in rural areas.

In education, whilst enrolments in primary school in most countries is growing, there is less growth in secondary school enrolment. Tertiary education faces a huge obstacle in terms of access as, in most instances, there are insufficient spaces to meet student enrolment demands. Some country reports highlight the mismatch between country needs and what is being taught in education systems. Despite education being a priority for all countries, significant gaps are apparent with regards to ICT infrastructure at schools, teacher training in ICT, and the integration of ICT into curricula. Where there are such efforts, many tend to be donor funded discreet initiatives. With high drop-out rates, there is thus a general lack of the ICT skills that are necessary for citizens to contribute towards a KS.

In STI, there are wide discrepancies between countries. Some countries appear to give this more prominence than others, but it appears to be a 'less popular' focus area than ICT and Education. Additionally, statistics around STI were difficult to find, and thus it is difficult to 'measure' the significance it has in many African countries. Indeed, an article pointed out that, across Africa, relatively few resources are devoted to research and development.

> *It's telling that there is barely one scientist or engineer per 10,000 people on the continent, compared with 20-50 per 10,000 in developed countries. Countries funding science and research face one key decision: how to balance applied research that focuses on current development challenges with basic research that focuses on long-term development.* [17]

Most countries still have low levels of enrolment in STI fields at the tertiary education level, and a small number of women in science, maths, and engineering careers. The country reports also suggest that more needs to be done in terms of research and innovation, and particularly the need to develop partnerships in this field. A recent position paper on STI in developing countries stated the following:

> *Technological and innovation capability building is about enabling firms and farms to move up the innovation capability ladder; that is enabling them to adopt imported technologies, to adapt them to suit local condition, combine indigenous and foreign knowledge to radically improve existing technologies; and finally be able to produce things that are radically new to the world. This process, especially for poor countries, cannot happen through market*

[17] Musafiri, P. (2016). Rwanda takes long view to invest in African science. Retrieved April 7, 2017 from https://blog.ruforum.org/2016/03/31/rwanda-takes-long-view-to-invest-in-african-science/

mechanisms alone, but should be guided by the government through policies and incentive structures; and good and effective policies are always those informed by evidence–the whole purpose of a policy is to address existing challenges…Innovation being a complex, systemic and dynamic endeavour, requires high quality research to produce good evidence. However, very unfortunately, expertise for such kind of research is very scarce in poor countries such as those in Africa…poor countries hardly feature in innovation studies, and therefore existing relevant knowledge for innovation policy making is extremely scarce. According to Lorentzen & Mohamed, for instance, between 1997 and 2008, some major journals in the field of innovation published 849 articles on innovation, of which only 37 or 4% were on Least Developed Countries, including Africa; and authors of these few articles are largely from individuals outside the least Developed Countries, who may not know the context very well. The impact of scarcity of such knowledge and expertise is evident from the fact that at best ST&I policies in poor countries are informed by empirical evidence from more developed countries, and at worst are not informed by any evidence, but rather base on political statements that are not backed by credible evidence. This is a major reason why – despite long term existence of ST&I policies – some of the poor countries still live in abject poverty.[18]

However, promisingly, according to the latest Africa Capacity Report (ACR) 2017 entitled 'Building Capacity for Science, Technology and Innovation for Africa's Transformation', African countries have a long way to go in improving the outcome of capacity development, given that capacity needs assessments are not the priority for most. The report identified brain drain of skilled scientists and other experts as a key factor impeding the development of STI in Africa.[19] Clearly, STI is an area that requires much more work and consideration.

[18] Science, Technology and Innovation Policy Research Organization. (2016). Simplifying the Implementation of the Sustainable Development Goals (SDGs) in Poor Countries: the Centrality of Goal 8 and 9. Retrieved April 19, 2017 from http://www.stipro.or.tz/in

[19] The Nerve Desk. (2017). Africa's Powerhouses rank low in commitment to Science and Technology. Retrieved July 17, 2017 from http://thenerveafrica.com/11090/africas-powerhouses-rank-low-in-commitment-to-science-and-technology/

Conclusion and Recommendations

The findings from the country reports confirm that the ALICT programme's focus areas of ICT, Education, and STI are relevant and still require much attention and continuous work in African countries (whilst acknowledging that there are variations between countries). Efforts to achieve a fully functioning KS will require a unique combination of strong leadership, innovative policy creation, and implementation, as well as ICT and, more broadly, STI development.

Leadership and capacity building is required to enable a greater transformative impact of policy towards KS development. The research findings suggest that there is still a need to develop awareness of KS issues among government, and to encourage governments to develop human resource capacity in ICT and STI. Furthermore, the findings indicate that there is still room for development of appropriate policies and to update policies in line with ICT and STI developments.

Furthermore, a clear finding from the desktop research is the need to focus on implementation of policies and plans. Slow or delayed policy implementation, leads to a lack of traction and continuity of programmes and impacts on sustainability. Implementation has been deterred by infrastructural issues, insufficient human resource capacity and lack of adequate funding. This provides a clear opportunity for the ALICT programme in focusing on developing capacity to on how to translate policies into practice.

As highlighted, there is significant work that is required with regards to STI. Thus, more emphasis may need to be placed on this pillar in the ALICT programme. Additionally, to realize the various plans and policies requires systematic coordination and commitment from government agencies and respective stakeholders. One way of approaching this would be to align the KS focus areas with the SDG goals of a country. The focus of the ALICT programme could also be on fostering a multi-dimensional approach to addressing KS, allowing participants to clearly see the interplay between the different aspects of KS development. Significant in this regard would, for example, be consideration of issues of climate change or gender disparities and how these would impact on developing KS. The programme might further focus on fostering and building partnerships within and between organizations.

The challenge that Gesci will likely face given variations between countries, is determining the level at which to pitch the programme. One possible way of addressing this is to group training sessions with a mix of development levels to enable slower adopting countries to benefit from the experience of more advanced countries. An alternative approach would be to group all similar performing countries together to ensure that the level of the programme is consistent and directly meet the needs of the countries involved. Consideration can also be given to fostering regional collaborations, looking at how to share ideas and pool resources.

An additional challenge is determining the target audience for the programme. As highlighted in the impact evaluation report, those who have more decision-making power or who are in top positions have been better able to achieve change and create an impact at the macro level. It may therefore be useful to ensure a mix of participants from within organizations so that there are at least two participants per organization, with one being in a higher position with decision-making power and another being a middle manager.

Finally, it should be noted that the country reports focused on the formal education systems in the countries, but given ALICT's underpinning of education as lifelong learning, it may be worthwhile to consider researching non-traditional forms of learning in an African context. It may also be useful to

consider a research exercise focusing on how the SDGs intersect with ALICTs programme aims and content, and how Gesci could leverage these goals within the ALICT programme revisions.