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Private Sector Federation
(PSF- Rwanda)

ICT SECTOR SPECIFIC SKILLS ASSESSMENT

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LIST OF ABBREVIATIONS AND ACRONYMS

AI		Artificial Intelligence
ATMs		Automatic Teller Machines
AU		African Union
CCA-V		Citrix Certified Associate-Virtualization
CCNA		Cisco Certified Network Associate
CISA		Certified Information Systems Auditor
CISI		Chartered Institute for Security and Investment
CLT		Company-Led Training Programme
CMA		Capital Market Authority
CMUA		Carnegie Melon University Africa
EAC		East African Community
EDPRS		Economic Development and Poverty Reduction Strategy
ELP		Earn and Learn Programme
FRW		Rwandan Franc
GCI		Global Competitiveness Index
GDP		Gross Domestic Product
GoR		Government of Rwanda
HLIs		Higher Learning Institutions
ICT		Information and Communications Technology
IDI		ICT Development Index
ITU		International Telecommunication Union
KIST		Kigali Institute of Science and Technology
LMIS		Labour Market Information System
MFS		Mobile Financial Services
MIFOTRA		Ministry of Public Service and Labour
MINICT		Ministry of ICT and Innovation
MMT		Mobile Money Transfer
NBR		National Bank of Rwanda
NFIS		National Financial Inclusion Strategy
NICI		National Information and Communications Infrastructure
NSDEPS		National Skills Development and Employment Promotion Strategy
NST		National Strategy for Transformation
NST1		National Strategy for Transformation
POS		Point-of-Sales
RDB		Rwanda Development Board
RIPPS		Rwanda Integrated Payment and Processing System

RLFS		Rwanda Labour Force Survey
RURA		Rwanda Utility Regulation Authority
SDGs		Sustainable Development Goals
SRMP		Smart Rwanda Master Plan
TCT		TUMBA College of Technology
TVET		Technical and Vocational Education and Training
UAVs		Unnamed Aerial Vehicles
UK		United Kingdom
UTB		University of Tourism and Business Studies
WDA		Workforce Development Authority
WEO		World Economic Outlook
WFH		Work from Home

Key terms and definitions

Skills: the ability to do something well; expertise (Dictionary)

Skills Gaps: The difference between the skills required for a job and the skills employee actually possess to be able to perform the complete job, or a mismatch between the abilities that employers rely upon in their employees, and the abilities that job seekers possess.

Accelerator: A start-up service working with a start-up or entrepreneur for a fixed period of time and providing intensive mentorship and development services.

ICT (Information and Communication Technology): An umbrella term covering wireless and wired communication, the hardware and software related to them and their applications.

Skills shortage: Skill shortages exist when employers are unable to fill or have considerable **difficulty in filling** vacancies for an occupation, or specialised skill needs within that occupation, at current levels of remuneration and conditions of employment, and reasonably accessible location

Skill gaps occur where existing employees do not have the required qualifications, experience and/or specialised skills to meet the firm's skill needs for an occupation. Workers may not be adequately trained or qualified to perform tasks, or may not have upskilled to emerging skill requirements[1]

Hard skills: direct technical knowledge (Google.com/search)

Apps: Software application developed for a digital device. The term is often associated with the applications that run on mobile phones. (ITU)

Artificial Intelligence: the study of how to produce machines that have some of the qualities that the human mind has, such as the ability to understand language, recognize pictures, solve problems, and learn. (ITU)

Big data: very large sets of data that are produced by people using the internet, and that can only bestow, understood, and used with the help of special tools and methods (ITU)

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[1] *Sue Richardson* National Institute of Labour Studies, Flinders University

Cloud computing: A paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with on-demand self-service provisioning and administration (ITU)

Coding: Writing instructions for a computer program

Internet of Things (IoT): A global infrastructure for the information society, enabling advanced ser-vices by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies. (ITU)

Green Technology: Green technology is technically environment-friendly innovations and technology that relate to safety, health, energy efficiency, renewable resources, and recycling, among other things. (electropages.com)

Advanced digital skills: related to technology development such as coding, software and app development, network management, machine learning, big data analysis, IoT, cybersecurity or blockchain technology; (ITU)

Basic digital skills: related to the effective use of technology, necessary in most professions. They include web research, online communication, use of professional online platforms and digital financial services; (ITU)

Digital entrepreneurship: digital skills required by entrepreneurs, including online market research, strategic planning and business analysis, using financing and crowdfunding platforms, online marketing, and online networking and establishing mentoring relationships

Soft skills: skills necessary to all professionals to ensure collaborative and effective work in the digital economy. They include leadership, communication and teamwork skills, client-orientation, among others. (ITU)

Woo Commerce: is developer friendly, built with a REST API, WooCommerce which is scalable and can integrate with virtually any service. Design a complex store from scratch, extend a store for a client, or simply add a single product to a WordPress site. 13 individuals from ICT chamber member companies were trained on the WooCommerce basic level, 9 individuals from member companies were trained in system at advanced level.

Silo

A silo is a structure for storing bulk materials. Silos are used in agriculture to store fermented feed known as silage, not to be confused with a grain bin, which is used to store grains. Silos are commonly used for bulk storage of grain, coal, cement, carbon black, woodchips, food products and sawdust. [Wikiped](#)

EXECUTIVE SUMMARY

The government of Rwanda choose to provide better, faster, and more secure services to all Rwandans. This requires a strong move towards online services, better protection of private information, more collaboration between government departments, and a change in public service culture. The future of ICT in Rwanda is not is not perceived as just setting modern infrastructure and equipment; it is also about how to use information and technology to improve services, create jobs, and transform Rwandan society and economy in the face of constantly changing development challenges.

Having recognised the importance of ICT investments in achieving socio-economic growth, the GoR adopted the National Information and Communications Infrastructure Plan (NICI) in 2000. The NICI I was further designed to create a conducive environment for establishing an institutional, legal, and regulatory framework for ICT development, putting in place the necessary mechanisms for liberalisation of the telecom market, reducing entry barriers to the telecommunication market, and creating an effective implementation and coordination mechanism. The second plan, NICI II (2006–2010), focused on providing an excellent communications infrastructure to serve as the backbone for current and future communication-related requirements. The third plan, NICI III (2011-2015 Plan), focused on the development of services by leveraging ICT to improve delivery. The Smart Rwanda 2020 Master Plan (SRMP-NICI IV) was developed and adopted in October 2015, to be implemented through 2020.

During COVID-19, there was a sensitive increment in the use of ICT in Rwanda because the government encouraged people to work from home (WFH). Employees have been asked to perform their duties outside of their physical workplace to prevent the spread of Covid 19.

Global ICT policies have become more mainstreaming in the last decade, underpinning growth, jobs, increasing productivity, enhancing the delivery of public and private services, and achieving broad socio-economic objectives in all spheres of life requires ICT skills that can tap into employment and social development thereof. As such, the global ICT industry is fast changing as a result of emerging technologies, economic, social, and business trends. ICT applications and services are becoming pervasive, they are increasingly essential for ensuring all societal functions, without forgetting its contribution to the growth of national economies.

The sector profile has been clearly indicated how the sector has performed so far and different instruments that have been the basis of the sector's progressive development and its contribution to the national GDP of which the sector alone contributes 1.4%.

The ICT Skills Assessment methodology used to obtain secondary data the literature review was conducted as a basis to profile the sector and drivers of change that influence the dynamics of the sector have been identified, for capturing of the skills gap as well as the way to bridge them. For the same purposes, the primary data was obtained through the various meetings held with

the various stakeholders in the sector, the interviews and the questionnaires administered online using the monkey survey system. This holistic methodology was helpful in analysis process. This methodology led the consultant to the following findings:

1. ICT is growing faster than the capacities of the educational and training provided by academic and other institutions can respond to as well as the market demand for in terms of skills and qualification
2. Rwanda Economic Update report published in January 2020 stated that ICT companies met difficulties in filling some job vacancies due to either insufficient supply of qualified job candidates or lack of applicable knowledge in ICT;
3. ICT is leading in acceleration of other sectors' development. Therefore, ICT has all potential to rejuvenate other socio-economic sectors of the country.

To develop the skills profile of the sector, it has been important to define the scope of the work and to use a methodology that made it possible to highlight real skills gaps. The recommendations to make the ICT Skills Sector more competitive are as follows:

1. In-company coaching and on-the-job learning is key to acquaint professionals with real work place functions.
2. Establishing funding principles and incentives to allocate to specific ICT skillset needs across the sector
3. Courses offered are to be constantly upgraded to ensure relevance to industry needs and new technologies as the emerge
4. ICT sector stakeholders must collaborate in targeting funds and providing scholarships and subsidies towards technical training and incubation programmes
5. Gender promotion in ICT should be inhanced through the hosting of local events (guidelines provided in the on-line kit at witnet.org); and using the ITU Girls in ICT Portal: www.girlsinict.org on a regular basis to advertise programmes and events including scholarships, awards, internships and courses; and advertising the Girls in ICT Portal www.girlsinict.org in career guidance, ICT sector in Rwanda should adapt in an inclusive programmes that can accommodate also boys in order to make it a gender balancedA pool of ICT professional should be established to be used in application of new Technologies listed by ITU, as well as needed technologies to be in attainment of Smart Africa, Smart Rwanda.

CHAPTER ONE: INTRODUCTION

1.1. Background and Context

According to the International Telecommunication Union, approximately 4.9 billion people, or 63% of the world's population, were using the Internet by 2021. This represents an increase of 17% since 2019, with 782 million people estimated to have come online during that period. However, this leaves 2.9 billion people offline. Global ICT policies have become more mainstreaming in the last decade, underpinning growth, jobs, increasing productivity, enhancing the delivery of public and private services, and achieving broad socio-economic objectives in all spheres of life requires ICT skills that can tap into employment and social development thereof. As such, the global ICT industry is fast changing as a result of emerging technologies, economic, social, and business trends.[2] ICT applications and services are becoming more widespread, and they are becoming increasingly important for ensuring all societal activities are ICT supported in Rwanda.

The ICT sector in Rwanda is increasingly occupying an important position in the country's endeavour to achieve the targets associated with the National Strategy for Transformation (NST1) and Prosperity, the Vision 2035 and 2050 goals. In order to support the Vision 2020 and 7YGP, the ICT sector has been developing and implementing its own strategies and plans from the year 2000 that has been renewed and expanded with 5 years' cycle as the National ICT strategy roadmap. The first National ICT Strategy, the National Information and Communication Infrastructure plan (NICI-I) focused on the vision setting and creating a conducive legal and regulatory framework. The second NICI-II (2006-2010) focused on Infrastructure development and the third NICI-III (2011-2015) focused on utilization of ICT infrastructure, which included service and private sector development. The fourth and the last 5 years NICI plan evolved into Smart Rwanda Master plan (SRMP)3.

The SRMP is the strategy currently being pursued with the overarching goal of transforming Rwanda into a knowledge-based economy. This goal of SRMP is also aligned with all 3 pillars of the NST-1, which aim at economic, social, and governance transformation. Skills in information and communication technology are very essential, as ICT is a key enabler for every industry, contributing to national economic and social growth. Competitiveness, productivity and transforming business processes in industries cannot be enhanced without ICT operating with it. Thus, ICT is leveraged as a crosscutting enabler of economic growth, innovation, and service delivery. New job roles are created alongside new digital opportunities brought forth by technological advancement. The ICT sector is also a pathway and centripetal force for many technology companies, large and small local enterprises, as well as a growing and vibrant tech start-up ecosystem. However, there are limited skills that go along with every occupation to support start-ups beyond a certain growth stage, including incubators and accelerators, which

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[2]International Telecommunication Union (ITU). Country rank and value in the ITU ICT Development Index.
[3] Smart Rwanda Master Plan (2016), MYICT

serve a crucial function in terms of facilitating access to skills, networks, mentorship, capital, technology, and digital tools for start-ups4.

Greater access to advanced and high-end ICT skills will, for instance, be of high priority to advance the development of new technology-enabled solutions that are relevant to local consumers and attract investors, leading to sector stability. Building human capacity is critical in the context of first identifying technologies needed, which ones are available, what are the trends in the first changing technological ecosystem and cross-checking what other countries are in possession of in terms of ICT adoption. Achieving the United Nations' 2030 Sustainable Development Goals (SDGs) in relation to ICT development and mainstreaming requires a strong mechanism for ICT stock taking in order to make sure the skills required to drive such sustainability are assured. ICT acts as an enabler, as is evident in most of the SDGs.

Rwanda's Vision 2020 aspired to bring Rwanda from an agrarian, subsistence economy to a knowledge-based one, leveraging information and communication technology (ICT) as a crosscutting enabler for this transformation. To achieve this vision, Rwanda developed and implemented a national information and communications infrastructure policy and plan.

Figure 1: Rwanda ICT Sector journey

SRMP
Envisage NICI plans and its emphasis on spearheading the digital transformation towards knowledge based society.

NICI-II
Accelerated the roll out of ICT infrastructure (world-class communication infrastructure)

2001-2005

2011-2015

NICI-I
Established the institutional, legal and regulatory framework enabling the liberalization of the telecom industry.

2006-2010

NICI-III
Leveraging ICT to improve service delivery to citizens.

2016-2020

4 Ibid

1.2.   SMART Rwanda Master Plan

SMART Rwanda 2020 Master Plan (SRMP) constituted the fourth generation of NICI Plans and it was developed to go in tandem with the EDPRSII. The SRMP also drew inspiration from the Smart Africa Manifesto that was launched during the Transform Africa Summit in October 2013.The SRMP therefore derived key initiatives through analysis and assessment from four perspectives: aligning national development vision and strategies, reflecting the achievements of NICI I~III and ICT SSP, and the execution and management performance. It identified three (3) enablers, ICT Capability & Capacity, Governance & Management, and Secured & Shared Infrastructure and seven

(7) Pillars: SMART Agriculture, Finance, Trade & Industry, Health, Education, Government, Women and Youth Empowerment in ICT.

The SMRP-1 was adopted as a critical juncture in which, on the one hand, it serves as the glue that holds the previous NICI plans and the Economic Development and Poverty Reduction Strategies together (EDPRS I and EDPRS II). It, on the other hand, acts as a link between the Vision 2020 and Vision 2050 visions.

1.2 Rationale

Rwanda made rapid progress in ICT, with fibre optic network coverage throughout the country and nearly 100% mobile telephone network coverage, with 45% mobile subscriptions in 2011.By 2020, the Government of Rwanda projected access to the internet for all administrative entities, for all secondary schools, and for a large number of primary schools. Telephone services were projected to have spread in rural areas and the efficiency of public services to have been increased through the application of e-government principles. It was expected that mobile subscriptions would reach 60% and the number of internet users would reach at least 50% (from 4.3% in 2010).

The country decided to continue investment in developing adequate, highly skilled scientists and technicians to satisfy the needs of the transition to a knowledge-based economy. Having laid the foundations for ICT to take-off in the country through the laying of the fiber optic cable network, Rwandans have a completely new world of opportunities to take advantage of. More importantly, the government of Rwanda has encouraged the use of ICT as a tool for self-employment, innovation, and job creation. Policies to encourage the development of smart applications that meet economic needs and develop economic potential have been promoted amongst the youth. The importance of ICT as a tool for improving service delivery in both the private and public sectors was emphasized.

The National Strategy for Transformation (NST 1), which covers the period of 2017–2024, has been developed as the instrument bridging the Vision 2020 implementation and Vision 2050. It also integrates far-sighted, long-range global and regional commitments by embracing the Sustainable Development Goals (SDGs), the African Union (AU) Agenda 2063 and its First 10-

Year Implementation Plan 2014–2023, as well as the East African Community (EAC) Vision 2050. NST 1 acknowledges ICT as a key driver for sustainable socio-economic growth.

The Priority Area three of the economic transformation pillar in NST 1 emphasizes the establishment of Rwanda as a Globally Competitive Knowledge-based Economy by supporting the establishment and operationalization of new and existing Centers of Excellence with a focus on science, technology, and innovation. Partnerships will be reinforced with these sectors to build skills with practical application in health, education, industry, and cyber security[5].

In addition[6], the need for appropriate advanced skills that would take the ICT sector to a competitive edge in the region and international markets is the spark of critical endeavour to assess the required skills that are enough to successfully deliver within the transformed business environment and compare them to the existing skillsets with the aim of having a workforce stock that can respond to the ideal national goal of being an ICT-led economy, thus translating into being the ICT Hub for regional and international markets. Therefore, it is evident that an assessment in the sector be conducted to identify ICT sector existing skills and gaps, anticipating demand and supply of skills required by 2030. This means looking ahead for appropriate responses to anticipated skills shortages.

In this context, it was deemed important for PSF to develop sector-specific skills assessment for Rwanda's private sector to be more competitive and skills gaps and penetrate both regional and international markets.

The ICT sector requires highly trained professionals in the ICT domain, and as the sector is rapidly changing, updated skills professionals to drive the private sector need to catch up with the fast evolving challenges and trends in ICT. Therefore, insufficient ICT skills are the major hindrance to ICT sector growth due to insufficient skilled personnel in the ICT field to drive the sector's development. As such, more ICT-skilled professionals are needed and intensified training programmes in current ICT technologies need to be developed to insure an ICT sector skills pool to meet the aspirations of trends and meet the whole range of investment set out in the Smart Africa Manifesto adopted during the "Transform Africa Summit" held in 2013.

1.3.   Objectives and Scope of the Assignment

The overarching objective of the study was to critically assess the required skills of the ICT sector in Rwanda throughout 2020–2030, formulate policy recommendations to ensure that the future skills needs and requirements of the sector can be addressed up to the end of NST1, and

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[5]Rwanda's 7-year government programme: National Strategy for Transformation (NST1), 2017–2024.

deliver within the transformed business environment successfully. More specifically, the assessment sought to:

1. The ICT sector requires highly trained professionals in the ICT domain, as the sector is rapidly changing;
2. Updated skills for professionals to drive the private sector's needs need to catch up with the fast evolving ICT challenges and trends;
3. anticipated demand and skill gaps by 2030, and appropriate responses to anticipated skill shortages;
4. Assess supply skills for the ICT sector from the education and training system's review of in-employment education and training;
5. Examine and propose best practises and international approaches that can be used in response to the findings of TVET and Continual Vocational Training systems, particularly in competitor countries, as well as possible learnings for the Rwanda context;
6. Forecasting ICT sector skills through 2030, based on mid- and long-term national development and specific goals to achieve;
7. Create profiles of the future skill requirements for the ICT sector's key occupations;
8. Make recommendations to ensure that the skills requirements of the ICT sector can be addressed out to 2030, and propose further education and training disciplines that may need to be introduced or expanded upon.

1.4. Methodological Approach

To conduct the ICT skills assessment, different methods and approaches were used.

1.5. Approach
1.6. Reviewing existing documents

A literature review was undertaken in order to assess other researches and capture what has been done in terms of studies, and assessments regarding issues of skills in the sector. Various documents, including reports, strategies, policies, and plans, were reviewed.

Rwanda Labor Market Information System, 2018, showed in an assessment that the ICT establishments in the private sector had skills gaps of 940 labour units, comprising of 34.5% in ICT managers, 8.9% in ICT scientists' professionals, and 7.7% in ICT technicians. Liberal professionals and artisans represented 18.3% and 30.4% of the overall skills gaps, respectively. The existing employees in the sector also need training in soft (qualitative) skills like leadership, business communication, and innovation.

In the 2012 ICT sector skills survey report, identified the vacancies that were pertinent to the skills gap, mentioning that in the ICT sector, employers stressed a great concern that there were 81 vacancies. A vacancy for ICT professionals constituted 67.9% of the total, and liberal professionals constituted 32.1%. ICT technicians held 30.9% of the total vacancies, accounting for 17.3% of the total vacancies. These vacancies were referred to as "critical" then.

1.7.   Participative Approach

In assessing the required skills of the ICT sector in Rwanda, the ICT sector Strategic Plan (2018-2024) indicated digital literacy is at a low rate, pointing out that computer literacy is at 8.4% and citizens' lack of skills to use smart devices to access digital services without depending on intermediaries (a general ICT skills gap that should be addressed). The same strategic plan stipulated, "colossal investment should be made to develop digital skills and empower citizens in digital literacy to allow consumption of ICT-enabled services, while providing professional education to ensure a high level of qualification amongst ICT professionals." Academic institutions are supposed to provide education at various different levels to create new generations of skilled personnel (ICT education is provided from primary to postgraduate level). According to the National Institute of Statistics of Rwanda (NISR) 2018, the ICT sector has grown by 13%.

1.8.   Key Informant Interview

Due to COVID 19, focused group discussion sessions did not take plan in order to abide with measures for avoiding its spreading.

Interviews were conducted telephonically with different ICT sector actors, which helped to deepen understanding of skills gaps required and desired for the sector to move forward and be able to identify efforts and commitments needed by all key ICT stakeholders to address the skills gaps in the sector. Some key elements were considered from interviews in the process of collecting data, which has guided a comparative line between existing skills and required skills in the ICT sector, leading to a stapes of elaboration of the skills assessment in the subject sector.

1.9.   Survey Monkey

The questionnaire was uploaded to MonkeySurvey, an Internet-based survey provider, and the link was distributed to some sampled ICT companies, stakeholders, and actors via e-mail. Inclusion criteria specified that participants were to be part of the assessment by completing the questionnaire adapted to the Monkey Survey system. The sharing of the questionnaire was administered by PSF, the custodian of ICT sector companies and stakeholders' database.

This has helped in gathering data that reflects the real picture of ICT sector skills issues. Data obtained from different ICT companies and other relevant institutions was contrasted with existing research findings to identify what their representatives presented and interpreted as gaps, required, and future desired skills within the sector.

1.10.   Assessment Process

The assessment was conducted through the process that was guided by systematic conduction of steps that led to obtaining data that shaded light to the real situation in terms of skill in the ICT Sector.   The Assessment was conducted in four stages as illustrated in the graph below.

Consultation meetings
- Sectors's Picture
- Key stakeholders

Stakeholders mapping
- ICT Businesses
- Profile of the sector

Data collection
- Quantative data
- Qualitative data

Data analysis
- Findings
- Ways
- Recommandations

1.11. The Sector's picture

The ICT sector is a crosscutting one that touches every aspect of the development and it has been given priority in support and advancement. Since it impacts all sectors, a diverse skills directly associated with a specific sector will have to be further assessed by every line sector such as agriculture, education, health etc….

1.12. Key stakeholders

In the process of ICT sector skills assessment, it was found out that the sector touches all other sectors, and key stakeholders were identified and their ears of ICT sector development were linked with each of them. **(See Annex 1)**

1.13. ICT sector Businesses

We looked at Information and Communication Technology has become a central engine to driving Rwanda's transformation to a knowledge-based economy, making Rwanda commit a budget to ICT – as a percentage of its GDP.

Several avenues for growth for the ICT sector in the process of Sector skills assessment – from e-commerce and e-services, mobile technologies, applications development and automation were identified.

1.14. Quantitative and Qualitative data

A quantitative and qualitative data collection from stakeholder institutions was carried out through online survey, comprising questionnaire covering companies' profiles, skills specifications, qualifications and experience. Thus, the data were then processed and analysed to

form the basis of the current report, which highlights findings and ways for developing the skills in the sector

1.15. Layout of ICT Sector Report

The sector skills need assessment has six chapters: Chapter 1 illustrates the overriding principles and methodology of the document elaboration. Chapter 2 provides a brief overview of Rwanda's ICT sector, focusing on the sector profile and its subsectors, size, and characteristics. The chapter further tackles the ICT sector's occupational profile. Chapter 3 sets out the drivers of change and their skills implications, which include: i) technological change and innovation; ii) policy and regulation; iii) environmental change; iv) economics and globalization; v) demand change; vi) financial sector data management; and vii) demographic change and also their priority actions. Chapter 4 outlines the ICT sector's skills status. The chapter further tackles the current skills demand and supply, skills gaps, anticipated skills demand, and their policy interventions by 2030, and ends up with the main barriers to closing skills gaps. Chapter 5 addresses skill response to the identified skills gaps. Finally, the last chapter presents the conclusion and key recommendations of the assessment report.

CHAPTER TWO: ICT SECTOR PROFILE IN RWANDA

2.1. Introduction

The sector skills assessment in the ICT sector signalled that the ICT sector is growing faster than the capacities of the educational and training institutions can respond to the demand for qualifications. As reported by Rwanda Economic Updates in January 2020, 85% of the ICT companies surveyed in that period had trouble in filling job vacancies due either to the insufficient supply of qualified job candidates or the lack of applicable knowledge. ICT professionals are the major occupational group in the ICT sector that is most in demand because ICT is a crosscutting enabler for development. Greater digital adoption and ICT-driven innovation are seen as instrumental in supporting productivity gains across both primary and non-primary sectors as a means to accelerate growth and reduce poverty. Currently, the ICT sector represents about 1.4% of Rwanda's GDP[7]. Building Rwanda's digital skills base will not only be key to accelerating digital adoption, but critical to harnessing emerging opportunities, including new forms of employment and skills, as well as the development of new digitally-driven platforms and businesses.

2.2. CT sector profile

Through different strategic documents, the GoR committed to provide better, faster, and more secure services to all Rwandans. This requires a strong move towards online services, better protection of private information, more collaboration between government departments, a change in public service culture and investment of private actors in the sector through different areas such as equipment sale, programs development, teaching, providing services in several domains, etc. . . . The future of ICT in Rwanda is about more than just technology; it is also about how to use information and technology to improve services, create jobs, and transform Rwandan society and economy in the face of constantly changing development challenges.

Having recognized the importance of ICT investments in achieving socio-economic growth, the GoR adopted the National Information and Communications Infrastructure Plan (NICI) in 2000. The NICI 1 was further designed to create a conducive environment for establishing an institutional, legal, and regulatory framework for ICT development, putting in place the necessary mechanisms, liberalization of the telecom market, reducing entry barriers to the telecommunication market, and creating an effective implementation and coordination mechanism.

2.3. Global and Regional Context

There were four international ICT indices selected for continuous monitoring of the performance of the SRMP 1, namely the e-government development Index, the ICT

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[7]Rwanda Economic Updates January 2020

Development Index, the Network Readiness Index, and the Global Competitiveness Index. In the 2018 e-government development index, Rwanda ranked 120 out of 193 UN member states. It has evolved from 32 positions in the last 5 years and is the 9th in Africa for e-government and the 3rd in Least Developed Countries. The **figure 2** below depicts positive evolution trends of Rwanda's scores in both the e-Government Development and e-participation Index.

Global Competitiveness (is done by) assessing variables organized into twelve pillars with the most important including: institutions; infrastructure; ICT adoption; macroeconomic stability; health; skills; product market; labour market; financial system; market size; business dynamism; and innovation capability.

Figure 2: Rwanda's e-Government Development and e-participation indices trends (2010-2020)
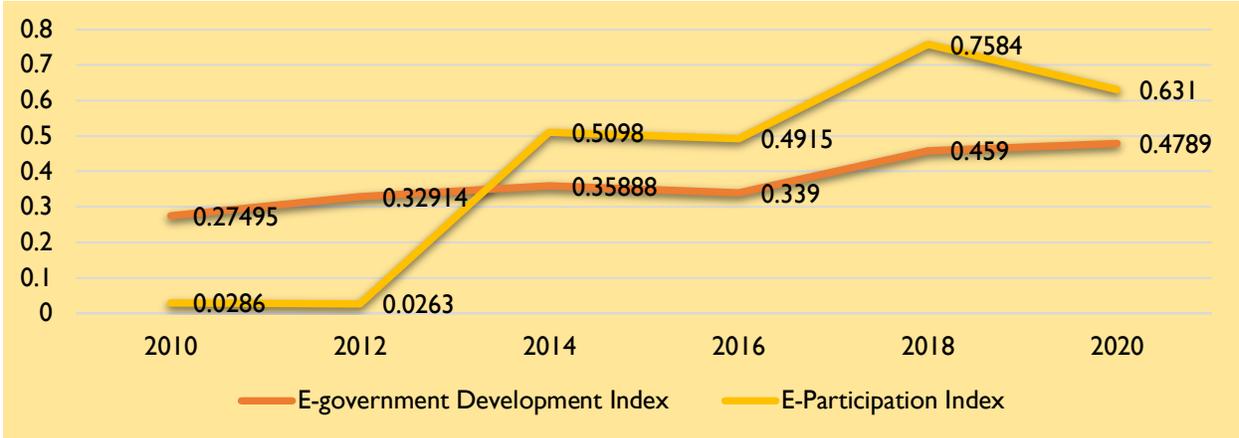
Source: *E-Government Index Report, 2020*

As per the figure above, Rwanda's e-government index score increased to 0.4789 in 2020 from 0.27495 in 2010.

Rwanda was ranked 96th in the latest Network Readiness Index (NRI) in 2020. Despite the fact that Rwanda dropped from first to second place in 2016, the analysis suggests that one low-income economy was positioned in the bottom quartile in the NRI 2020. Rwanda (96th), Tajikistan (109th), and Uganda (120th) are the exceptions (114th).

In fact, Rwanda makes it into the second quartile in three of the four pillars: governance (95th), people (97th), and technology (100th). With respect to governance, the country's strengths are its levels of trust (87th) and inclusion (85th). However, at the sub-pillar level, its best performance relates to its involvement in Future Technologies (47th). The score in the Technology pillar is weighed down by unimpressive access (99th) and the creation of digital content (120th).

In the People pillar, ICT usage and investment by Rwanda's government (57th) is offset by comparatively lower levels of ICT usage and skills by individuals (116th) and businesses (94th).

The country's weakest pillar is impact (103rd), where the greatest challenges include addressing inequalities of various forms and improving health and well-being (Economy, 84th; Quality of Life, 110th; SDG Contribution, 97th).

Figure 3: Rwanda's Networked Readiness Index scoring evolution

Networked Readiness Index

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Value	3.7	3.7	3.8	3.9	3.9	3.9	3.9	3.997	3.724
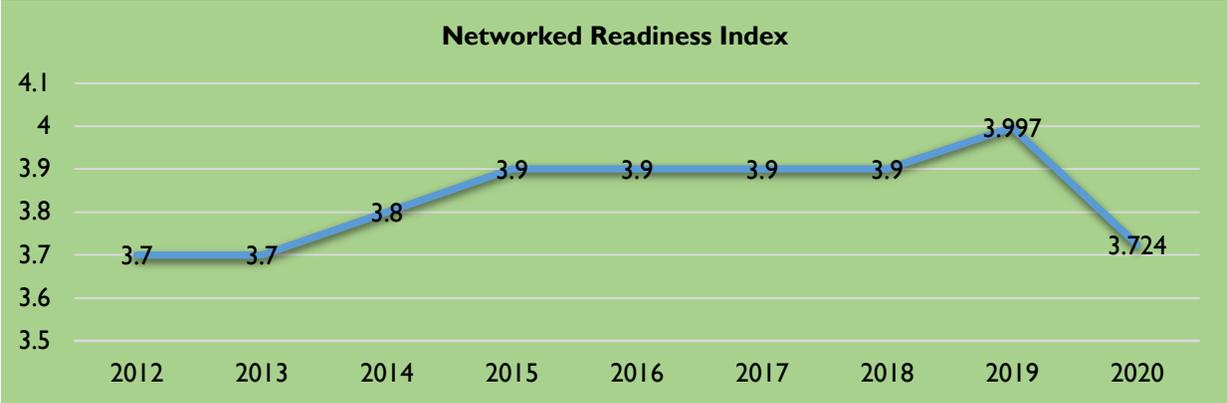
Source: *Rwanda's Networked Readiness Index scoring evolution*

According to the NRI analytical study, Rwanda rose five places to 80th place in 2016 as a consequence of the government's strong focus on the digital agenda and efforts to maintain a solid regulatory environment, resulting in a five-rank improvement in the Environment sub-index. The business sector was making significant progress in terms of digital technology adoption, and efforts to provide Internet access in schools were a significant step toward improving societal gains by providing critical digital skills to the next generation.

The ICT Development Index (IDI) ranks the performance of 176 economies with regard to ICT infrastructure, use, and skills. The 2017 IDI ranks Rwanda 153 out of 176 states, a drop of 7 positions from the 2014 ranking.

Figure 4: ICT Development Index ranking

ICT Development Index

	2011	2012	2013	2015	2016	2017
Value	1.66	1.65	1.86	2.04	2.1	2.18
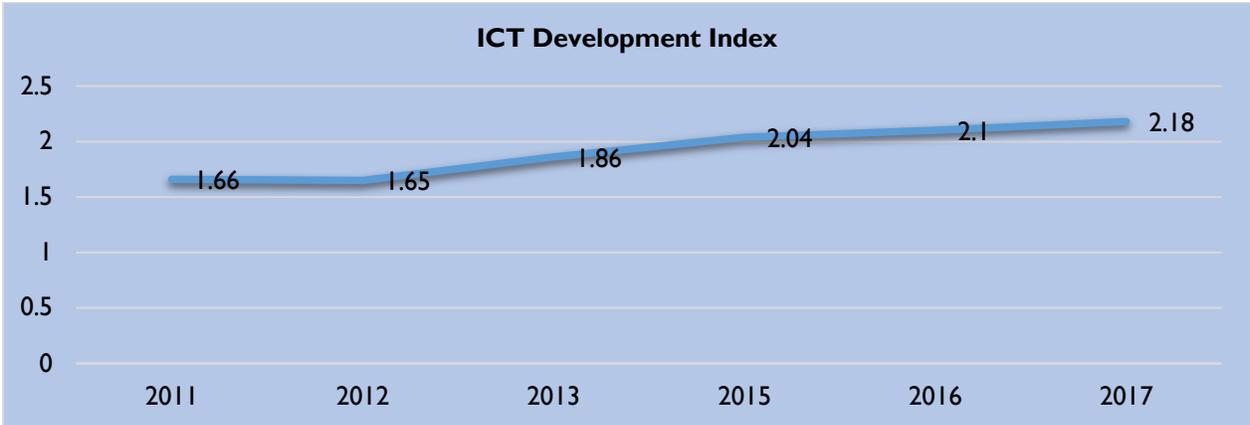
Source5: ICT Development Index ranking

21

Despite failing to meet its SRMP 1 targets, Rwanda's ICT development index (IDI) score increased from 1.47 on a scale of 1-10 in 2010 to 2.18 on a scale of 1-10 in 2017, expanding at a 6.85% annual rate. Rwanda's ICT Development Index report cites best practises in Rwanda's performance in accessing communications infrastructure. Rwanda ranks 58th in the Global Competitiveness Index (GCI) out of 137 countries assessed. The GCI measures factors that drive long-term growth and prosperity.

Figure 6: Global competitiveness Index

Source: World Economic Forum

Between 2011 and 2019, the global competitiveness index of Rwanda grew substantially from 42 to 52.82 0–100, rising at an increasing annual rate that reached a maximum of 3.69% in 2019. The table below depicts Rwanda's standing against the proposed key global ICT indices and the corresponding targets by SRMP.

Table 1: SRMP performance against the ICT Global indices

Global indices		2010	2011	2012	2013	2014 (baseline)	2015	2016	2017	2018	2019	2020	Target 2020 (Ranking)
E-government Development Index	Rank	148	n/a	140	n/a	125/193	n/a	138	n/a	120/193	n/a	130	70
	Score	0.27495	n/a	0.32914	n/a	0.35888	n/a	0.3390	n/a	0.4590	n/a	0.4789	
ICT Development Index	Rank	140	133	141	148	148/166	154	151	153	-	-	-	80
	Value	1.5	1.66	1.65	1.86		2.04	2.10	2.18				
Networked Readiness Index	Rank			82	88	85	83	80	_	80	89	96/133	50
	Score			3.7	3.7	3.8	3.9	3.9		3.9	3.997	3.724	
Global Competitiveness Index	Rank		70	63	62	66/137	62	58	52	58			30
	Score		42	42	42	43	42.9	44.1	49.61	50.94	52.82		

Source: *compiled from Global International Indices, June 2020*

2.4. Performance of ICT Sector in Rwanda

ICTs influence all socio-economic sectors of the country. Only five sectors are taken into account for illustrative purposes to highlight the extent to which ICTs have contributed to their performance. These are the sectors of health, finance, education, agriculture and governance.

2.5. Health

Support ICT innovations and creativities for health promotion in relation to NCDs is one of Strategies for mainstreaming NCDs in various sectors. Thus, the health sector has expanded its

ICT health services at a rate of 57.2% over the past five years since the implementation of SRMP. The Health Management Information System is one of the most used information systems in Rwanda's Integrated Health Systems Strengthening Project. However, during the assessment, it was reported that health information systems in Rwanda have been developed in silos. Key innovations includes: Expand ICT and e-Health resources and availability of web-based training and educational opportunities for the health workforce[8] Studies were carried out in health sector. Technological innovations such as e-learning [which] are rapidly transforming the ways that institutions of higher education teach and students learn. In nursing education, e-learning offers opportunities to reach a great number of students, irrespective of time and space. In the context of Rwanda, the implementation of e-learning in nursing education was motivated by the country's need to upgrade the level of working nurses and midwives at a large scale and in a short period.[9]

2.6.   Rwanda ICT based Health sector performance at EAC level

Across East Africa, mobile phones and tablets are increasingly sitting in the hands of community health workers, clinicians, managers and patients. They are being used for a widening range of functions from diagnostics to health insurance to treatment advice, generating hopes for new healthcare futures and establishing the region as an emerging hub of experimentation in digital health. [10]   This informs the **Universal Health Coverage (UHC**), the idea that everyone should have access to 'health services they need without suffering financial hardship.

2.7.   East African Community and Digital Health Initiative

Regional policies, laws, regulations, guidelines, and standards on health facility and patient safety, data sharing, data security, and privacy to facilitate e-Health in country and cross-border patient referrals in the EAC partner states

In 2018, the EAC launched the Digital Regional East African Community Health (Digital REACH) Initiative

Rwanda Health Information Exchange (RHIE) to improve maternal and childcare at the health facility level. (known as the Rwanda Health Enterprise Architecture (RHEA) project. The goal was to make client information, including medical histories, more easily available to healthcare providers to enable them to more efficiently and effectively provide healthcare services.)[11] Ehealth and Interoperability in Rwanda: Rwanda was one of the first countries in the region to develop a national Health Information Exchange (HIE).

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8 Fourth health sector strategic plan July 2018 – June 2024

9 Conceptualisation of e-learning in nursing education in the context of Rwanda

[10] Global Policy: Digital Health in East Africa: Innovation, Experimentation and the Market

[11] East African Community Digital Health and Interoperability Assessment: Rwanda.

2.8. Finance

The GoR's ICT efforts are actively promoting e-Payment at all levels of financial transaction. The welfare of Rwandan citizens might have improved through new innovations in the financial sector, and this is associated with the chances of transforming the business process in Rwanda. Users of the system are getting access to much-needed financing opportunities without going through more rigorous financial lending processes.

2.9. Active mobile money subscribers

By the end of 2020, mobile payment active subscribers across all mobile network operators would have reached 4.7 million, up from 1.7 million active users in 2013. The number of subscribers has steadily been increasing for the past 5 years, and this reflects the growing use of these services within various sectors. In 2020, there were 131,173 mobile money agents, up from 8,745 in 2014. These agents are the citizens' first point of contact with financial services, especially in rural areas where financial institutions are scarce.

2.10. Number of payment agents

The number of point of sale (POS) terminals increased from 1,698 to 4,335 in 2020. Since 2017, the number of ATM terminals has steadily decreased, from 406 to 334, indicating a growing reliance on mobile-based transactions rather than traditional ATMs.

2.11. Number of Debit cards

The number of debit cards issued in Rwanda kept on going up, from 487,498 in 2014 to 883,755 in 2018, and this was a result of a strong partnership between banks and local telecom operators. The decrease realized from 2019 is associated with the observation of the measures instituted by the GoR in the interest of containing the spread of the COVID-19 pandemic, and this led to the high usage of mobile money transactions and transfers.

2.12. Education

The education projects included: developing a curriculum for student-centered ICT skills; world-class research infrastructure (High performance Computing Center-HPC); broadband connectivity in schools; E-book digital content; computing devices for students in HLIs and IPRCs; Carnegie Mellon University (PPP); ICT in Education Master Plan; MIS for Education Decision-making; ICT education and promotion for citizens and government-related parties to bridge the digital divide; Smart School Expansion; ICT training for teachers and head teachers

Internet connectivity in primary schools is at 35% and 62% in secondary schools. While 83% and 84% of primary and secondary schools, respectively, have computers.

2.13. Agriculture

The objective of ICT in the agriculture sector is to transform agricultural practises to enhance productivity and increase commercialization and industrialization. The agriculture projects included enhancing e-Soko (e-Soko 2.0); Agro-smart traceability; Agriculture information Service Centre; Farmer Management Support System; Meat Processing Management System; and Agriculture Growth Management System. The details on the status of the project performance indicators for each of the projects are indicated in **table 2** below:

Table 2: Status of the ICT project performance of indicators at the end 2020 in agriculture

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
Enhancing E-soko/(e-Soko 2.0)									
Number of SMS-based transactions through e-soko	9,893	11,815	11,320	11,820	11,820	12,320	12,320		
Number of Web-based transactions	3,652	4,640	4,939	5,439	5,439	5,439	5,439		
Farmer Management Support System									
Number of farmers registered in smart Nkunganire							1,062,239	1,133,421	1,500,000
Number of farmers using Fertilizer Voucher Management System	1,503,448	1,671,599	1,859,413						
Number plots of land demarcated for agriculture use	✓ ALIS1 has 24,000 public plots on 57,000ha; ✓ ALIS2 has 638, 821 private plots on 120, 228 ha.								

Source: ICT Sector Strategic Plan (2018-2024)

2.14. The governance

The government's primary objectives of using ICT in governance hinged on the need to build a secured, shared, robust, and resilient infrastructure to underpin service delivery and support national ICT initiatives; enhance the National ICT Governance Structure for effective implementation of ICT programs; and transform digital government through e-Government and provide effective public service delivery to empower rural and urban communities.

Table 3: Government pillars' project achievements status by end of 2020

Projects	Objective	Start and end date	Physical progress	Achievements
Open Data Portal (Open Government Data System)	To ensure all information available and accessible to all institutions and citizens via one centralized data platform (Open data portal)	Start date: 1ˢᵗ July 2017 End date: 30ᵗʰ June 2025	30%	The Open Data portal was established with initial datasets captured and uploaded to the portal. Data managers have been trained, but data classifications are yet to be done. A data protection law was enacted.
Public CCTV	To install CCTV surveillance cameras and vehicle traffic monitoring capability in strategic public places.	Start date: July, 2017 End date: June, 2023	107.69%	The main Monitoring Centre was built at RNP HQ and 5 secondary Centres (NISS, MOD, CoK/One per district) established; 230 CCTV sites installed out of 161 targeted (142.85%) and all 36 Vehicle Enforcement systems (VES) constructed (100%)
National Cyber Security (NPKI)	Secure Rwanda cyberspace and information assets using public key infrastructure (PKI) technology	Start date: 2010	44%	24,146 digital certificates were issued to public and private institutions. NPKI centre maintains 3 systems integrated with PKI (E-Procurement, Smart Admin and Smart NPPA).
Digital	To Improve	Start date:	**20%**	The system was developed

Government Platform (GSB)	Government operational efficiency and citizens satisfaction by acquiring and deploying an Enterprise Service Bus	01/07/2016 End date: 30/06/2023		and 7 backend systems out of 34 have been connected to it (20.5%). The rationale for this project is to create a system that will serve as a single point of integration for all government systems. The system will allow citizens and businesses to have the impression of a "one-stop shop" while interacting with the government.
Smart Administration	The Smart Administration System aims at automating administrative processes and providing a unified and secure communication and collaboration channel across public sector.	Start date: 31/07/2018 End date: 30/06/2022	**44%**	86.2% (100 out of 116 targeted) of all public institutions covered. There were significant delays in this project caused by budgetary constraints as well as prolonged contract negotiations due to discussions involving a lot of activities that needed to be aligned with AOS (including development of 3 new components to be added to the system, customization, deployment, operation, support and maintenance of the System).

Source: https://www.minict.gov.rw/news-detail/a-rwandan-open-data-portal

CHAPTER THREE: DRIVERS OF CHANGE AND THEIR SKILLS IMPLICATION ON ICT SECTOR

3.1.   Introduction

Four specific technological advances are expected to dominate the 2018–2022 periods as drivers positively affecting business growth: ubiquitous high-speed mobile internet, artificial intelligence, widespread adoption of big data analytics, and cloud technology. They are flanked by a range of socio-economic trends driving business opportunities in tandem with the spread of new technologies, such as national economic growth trajectories; the expansion of education and the middle classes, in particular in developing economies; and the move towards a greener global economy through advances in new energy technologies[12].

3.2.   Policy Framework

Regulation and governance cover the key issues of border management, threats to security, changes in global power and conflict, and domestic regulation. For the information and communication technologies (ICT) sector, security (particularly cyber security) and regulation are major drivers and have an important influence on the direction of the sector and skills supply. The threat to national, business, and individual data and information security from cybercrime has emerged over recent years as a key driver of change. Cybercrime is an increasing concern as it is an expanding threat and costly to the economy.

Increasing security skills at all levels will mean that other people working in the sector will need to update and improve their security skills, from software design and development, as products and services need to meet ever more stringent security measures, from technical support to ensure that data and systems are routinely protected and end users are supported against cyber-attacks. The Information and communication technologies industries are also affected by national and international regulation on parts of the economy, in particular the financial services industry where compliance and locally determined banking reforms have long impacted demand for new technology solutions. Regulation also has an impact on the sector in terms of competition, mergers and acquisitions and is a key driver for the Telecommunications sub-sector.

3.3 Demographics and population change

Demographics and population changes are not only a key influence on the ICT sector workforce itself, but also drive consumer demand for information and communication technology products and services and will drive new skills challenges within the sector. The changing demographics of consumers and categories of population groups like age, financial capacities, education levels, culture and its influences, country's history, all these mean that as those familiar with technology

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[12]2016 World Economic Forum

get older, the overall size of the technology market grows with increasing demand for newer, faster, and more advanced technology goods and services. Key initiatives will be in ICT and a high level of skills will be needed to drive the sector at a competitive scale and adaptability to new technologies, which will require all citizens to take part in global technological trends and access social and public benefits.

3.3. Environmental change

Environmental change is a particular issue for the sector, not only in terms of the energy usage of the sector itself but also as a provider of products and services for others. Increasing demands for energy are fuelled by technology, and so whilst there is pressure on the sector to be more efficient, there is an opportunity as 'greener" technologies provide attractive, environmentally friendly solutions for businesses and consumers. Green IT refers to sustainable IT: the invention, analysis, design, implementation, use, and disposal of services, systems, and infrastructure while minimising their environmental impact. The sector clearly has the potential to enhance its own environmental performance as well as that of its clients / users.

An increase in global awareness of the environmental challenge means that businesses need to remain competitive in their offer by ensuring that employees have the relevant skills, fully understand user consumption, environmental impact assessment and management, as well as technology utilisation and recycling, and possess technical design skills related to power management. The extent of consumer, societal, and government pressure will be a key factor in the pace and scale of the development of green technologies.

3.4. Economics and globalization.

This driver covers the outlook for international and domestic economic growth, competition, and the impact of globalisation and emerging markets on the sector. Instability and uncertainty in the global economy are important determinants of growth and, arguably, one of the most significant challenges to the information and communication technologies sector.

There is the potential for even greater workforce concentration in high-skilled technical occupations, with cost reduction and labour loss in administrative and support functions

3.5. Technological change

The changing skills demand in the information and communication technologies sector is driven by technological change. The sector itself both drives technological change and, on a wider scale, has to respond to the new innovations, products, and services developed in order to deliver high quality goods and services to both business customers and consumers. Businesses across all sectors are realising the power of technology to provide "new, innovative, more convenient, and cost-effective ways to interact with today's mobile, technology and customers". The five key technology trends that dominate current and future demand are identified as "*Cloud*

Computing; Social Computing; Mobile Computing; Cyber Security; and Big Data/Smart Computing."

3.6.   Robotics and Drones

Drones are probably the most advanced equipment in the fields of **robotics**, aeronautics, and electronics. The technical name for **drones** is "Unmanned Aerial Vehicles" (UAVs). They are aerial vehicles either controlled by pilots from the ground or, increasingly, autonomously following a pre-programmed mission[13]. Rwanda has made a step ahead and is now using drones and robots in delivering services. However, as with any new technology, like elsewhere, skills in these technologies are still at a low level, and efforts need to be put into ICT education for more skilled forces to be developed.
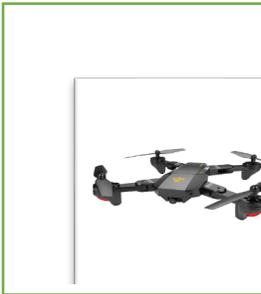
Drones are probably the most advanced equipment in the fields of robotics, aeronautics, and electronics. The technical name for drones is "Unmanned Aerial Vehicles" (UAVs). They are aerial vehicles either controlled by pilots from the ground or, increasingly, autonomously following a pre-programmed mission.

Robotics is a branch of engineering that involves the conception, design, and operation of robots. This field overlaps with computer science, electronics, nanotechnology, artificial intelligence, and bioengineering. ICT education and knowledge levels in robotics and drones might not go beyond the functionality and potential uses of robots. The ICT sector should relook at developing skills beyond robots' functions and uses.

Box1: Prof.*Ryan Calo* said: "We can explore *how the mainstreaming of robots might specifically affect privacy (...) Practically by definition, robots are equipped with the ability to sense, process, and record the world around them. Robots can go places humans cannot go and see things humans cannot see. Robots are, first and foremost, human instruments.*

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[13] http://techandlaw.net/drones-robotics/

There is a need for skills gapes to assess how robots and drones can evade the privacy.

Table 4: Skills required for Drone Industry Involvement

Activity/ Output	Occupational Skills required	Training required
Flying UAVs	Pilots	RPL [14]
Drone design and concept, build and testing	Engineer (Mechanical, Electrical, Aeronautical, Mechatronic, Aviatrician)	BSc, BTech
Drone building and assembly	Technician	Various, NCV, Experience, In-house
All electrical aspects of the flight	Electrician	NDip., NCV
Design and/ or management of drone software	Software developer	Various, NCV, Experience, In-house

Source: https://www.thegpstime.com

3.7. Changing values and identities

Changing values and identities encompass family structures and general attitudes towards government, work, and society. The impact of these changes on the sector includes an increasing demand for new products and services, enabling different ways of working to suit changing values. For example, the expansion of home-based, flexible working for parents and careers; enabling work away from a traditional workplace; the use of technology to address environmental (travel) concerns and remote access to skilled labour.

The information and communication technologies sector has already responded in the form of enabling faster and more efficient mobile and remote work, access to the "cloud", web conferencing, collaboration software, and web-based file sharing.

Changing values also encompass the phenomenon of using the internet to communicate with the masses, and for individuals or small groups to widely publicise their cause, challenging existing laws and institutions. Attitudes towards work are a key influence on skills supply for the sector.

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[14]https://droneops.co.za/do-training-rpl-initial/: "Remote Pilot Licence" (*RPL*) is the licence required for a person to *operate* as a qualified Remote Pilot Licence Holder under Part 101. Duration. 2 – 3 Weeks. Flight hours. 3 Hours. Simulated hours. Unlimited.

3.8. Changing consumer demand

Changing consumer demand considers expectations about the type and quality of products and services produced and consumer preferences and expectations. While there has been a recent squeeze on consumer spending with increasing food and energy prices, consumer use of technology and online activity continues to increase. The range of activities spans: different and more flexible ways of working; shopping and buying and selling; entertainment, including socialising; listening to and sharing music; reading, watching films, videos and TV online; and gaming; learning, communicating and being part of society, including, for example, through voting online, paying taxes and e-petitions.

This range of online, mobile, and technology centric activities is continually expanding IT products and services, generating new demand and expanding markets for the sector.

3.9. SMART Africa

The SMART Africa initiative "is a bold and innovative commitment from African Heads of State and Government to accelerate sustainable socio-economic development on the continent, ushering Africa into a knowledge economy through affordable access to broadband and usage of information and communications technologies." Implementation of this initiative will require high-level ICT skills and new technology operators. Obtaining an investment by making large-scale investments in:

- Fiber Optic Networks;
- Mobile Broadband Networks;
- Satellite;
- Data Centers;
- Cyber Security;
- Smart Cities;
- Internet of Things (IoT);
- Big data and analytics;
- e-Applications;
- e-education;
- e-Health;
- e-Tourism;
- e-Agriculture;
- e-Commerce;
- e-Government;
- Content/Apps development;
- Manufacturing of electronic;
- Consumer devices;
- Investment in local innovations/products;
- Capacity building;

♦ Virtual reality, Artificial Intelligence, 5G…[15]

3.10. Scale of drivers in ICT sector

The scale of the drivers of change for ICT sector identified and measured in terms of their impact on the sector and timescale. For each driver, and in some cases, the key trends for that driver, the scale of impact assessed has been considering by:

♦ Whether the driver affects the supply or demand for labour or skills;

♦ Whether the driver is new or emerging, current or on going, increasing, decreasing, or changing;

♦ Whether the driver provides opportunities for growth for the sector or whether it poses significant risks;

♦ The extent to which the driver affects the whole sector or whether sub-sectors or certain occupations are particularly affected is unknown.

Each driver was ranked by indicating correspondent scale of impact. **Table five** shows that the most significant drivers for the sector are technological change, cyber-security, and the economy (rated "red"). Consumer demand, globalisation, and demographics, population change, and environmental drivers are thought to be important drivers for the sector (rated pink), with developments in the public sector, regulation, values and identities, and migration policy considered fairly important but with a smaller scale of impact on the sector (rated amber).

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[15] Smart Africa strategic vision: www.smartafrica.org

Table 5: Scale of drivers

Driver of demand	Sectoral driver (if applicable)	Driver is new/emerging/current / ongoing, increasing, decreasing	Affects supply or demand for labor and/or skills.	Scale of opportunities or risks	Scale of impact on sector, sub-sectors or occupations.
Policy framework.	-Security / Data protection policy, clauses and provisions in policies are not updated as ICT changes so rapidly	♦ Increasing trend of growing importance	♦ Driving demand ♦ for new skills and jobs, both specialist and across all occupations	♦ Potentially a growth /expanding market area. ♦ Could be a risk area to the industry and economy if the supply of labour and jobs is not met.	Specialist information assurance/cyber security jobs as well as across many other occupations
	National / International regulation	♦ Ongoing, increasing	♦ Potential effect on skills rather than volume of jobs	♦ Increasing regulation could inhibit growth and innovation ♦ Could increase consumer confidence in the sector	Sub-sectors particularly affected include telecommunications and internet providers
	Public sector ICT strategy, efficiency and reform	♦ Current	♦	♦ Although the volume of opportunities may be less, there is a move to less	♦ Potentially more access to SMEs in the sector to public sector work

Driver of demand	Sectoral driver (if applicable)	Driver is new/emerging/current / ongoing, increasing, decreasing	Affects supply or demand for labor and/or skills.	Scale of opportunities or risks	Scale of impact on sector, sub-sectors or occupations.
				bureaucracy opening up of public sector work for more businesses in the sector	
	Migration policy	♦ New, current and changing policy ♦ Politically sensitive	♦ Affects the supply of skilled migrants ♦ Potential to drive further investment in skills in the Rwanda workforce if migration limits are reduced	♦ Could have an effect on the ability of some companies to compete if barriers to migration impact competitiveness	♦
Economics and globalization	Economic growth/uncertainty	♦ Current and immediate concern	♦ Supply of skills could be affected by the scaling back of training in the workforce ♦ The level of overall economic growth will	♦ Opportunities for growth where technology underpins economic recovery, delivers efficiency and innovation	♦

Driver of demand	Sectoral driver (if applicable)	Driver is new/emerging/current / ongoing, increasing, decreasing	Affects supply or demand for labor and/or skills.	Scale of opportunities or risks	Scale of impact on sector, sub-sectors or occupations.
			impact jobs in the sector.		
	Globalization	♦ Longer term, ♦ increasing driver	♦ Increases the need for innovation in the workforce, ♦ Requires new skills ♦ Focus on higher value ♦ add activities	♦ Technology is driving globalization ♦ Increasing competition ♦ Opportunities for inward investment	
Demographic change		♦ Emerging trend for the sector as demographic change and legislation take effect	♦ Traditional supply of labour/recruitment pools affected ♦ Increasing training requirements for the existing workforce ♦ Possible effect in the short	♦ Changing demographics is driving consumer demand and expanding markets	

Driver of demand	Sectoral driver (if applicable)	Driver is new/emerging/current / ongoing, increasing, decreasing	Affects supply or demand for labor and/or skills.	Scale of opportunities or risks	Scale of impact on sector, sub-sectors or occupations.
			term on replacement demand if ♦ employees choose to ♦ retire later ♦ Skills to manage an aging workforce		
Environmental change		♦ Current	♦ New skills requirements	♦ Opportunities for development of green technologies and ways of working ♦ Potential for expanding markets depending on increases in consumer demand and government pressure	
Values and identities		♦ Ongoing and ♦ Increasing	♦ Impact on supply where young people are not	♦ The sector can provide solutions to societal and environmental	

Driver of demand	Sectoral driver (if applicable)	Driver is new/emerging/current / ongoing, increasing, decreasing	Affects supply or demand for labor and/or skills.	Scale of opportunities or risks	Scale of impact on sector, sub-sectors or occupations.
			identifying with the sector ♦ Changing skills needs as technology evolves and demand increases.	changes and technology is both ♦ enabling and changing demand ♦ Growing consumer market ♦ as digital natives, techsavvy and i-workers increase demand for products and services.	
Consumer demand		♦ Ongoing and ♦ increasing	♦ Creates demand for skills to meet customer expectations and new technology skills ♦ Innovation ♦ Security skills	♦ Increasing demand for products and services ♦ Increase in tech-savvy and i-workers grow demand ♦ Balance between standardized products ♦ (volume) and ♦ niche/bespoke products ♦ (high value)	

Driver of demand	Sectoral driver (if applicable)	Driver is new/emerging/current / ongoing, increasing, decreasing	Affects supply or demand for labor and/or skills.	Scale of opportunities or risks	Scale of impact on sector, sub-sectors or occupations.
		♦	♦	♦	
		♦	♦	♦	

Source: *Data collected from the field linked with international general drivers of change for any and Africa ICT development initiatives*

CHAPTER FOUR: ICT SECTOR SKILLS STATUS IN RWANDA

The ICT sector skills assessment revealed that the ICT sector is growing faster than the capacities of the educational and training institutions to respond to the demand for qualifications. Of the ICT companies' responses, their concerns are that they have had trouble in filling job vacancies, due either to the insufficient supply of qualified job candidates or the lack of applicable knowledge. ICT professionals are the major occupational group in the ICT sector.

As it stands, most TVET institutions offer ICT courses that are considered to be at digital neck but are not at specialist level. Thus, few TVET students choose to study advanced level ICT courses at low levels, and fewer graduate at those levels, constituting the ICT labour force. Nevertheless, courses available at public and private institutions focus mainly on programming, software development, computer maintenance, information management, and networking. Available training, thus, is rounded on digital skills available locally. While very few universities do offer courses in cutting-edge technology, few students can afford to access this training. Therefore, a persisting digital skills gap emerges as a key crosscutting barrier to increasing digital adoption and expanding digital innovation.

4.1. ICT in high learning institutions

In general, graduates typically lack hands-on experience due to limited opportunities for practical training. The skills provided are misaligned with those demanded by prospective employers. This is referred to as "an inadequately educated workforce." Thus, emerges as a major deterrent to private sector investment in digital innovation.[16]

The total number of higher education institutions that offer ICT-related programs 13% of HLI offering ICT-related programs, and 41.9% of ICT sector employers want to hire higher-educated professionals for the majority of job openings. Is the same case for other economic sectors, which leads to the widening of the existing skills gaps.

Institutions of high learning: universities and TVETs are required to produce highly skilled graduates able to respond to the ever-changing needs of the contemporary workplace. This has resulted in questions being raised about the quality of the graduate labour market and the ability of graduates to meet the needs of employers. The skills assessment in the ICT sector analyses graduate and employer perspectives on graduate employability, taking into account "hard skills" and "soft skills." However, "learner transition, based on exam results and not

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[16] OECD (2012-04-19), "ICT Skills and Employment: New Competences and Jobs for a Greener and Smarter Economy", OECD Digital Economy Papers, No. 198, OECD Publishing, Paris.
http://dx.doi.org/10.1787/5k994f3prlr5-en

guidance nor proof of technical ability and the lack of career counselling are other factors that reduce TVET efficiency[17].

The number of students enrolled in hands-on technical skills at the TVET schools in ICT-related programmes reached 13,464 (6,409 girls and 7,055 boys) in 2018, up from the 9,901 students who were enrolled in the same programmes in 2017.

Given that the target set by the "Five Year Program for Priority Skills Development to Deliver EDPRS II (2013–2018)" to produce "Professional certification/International certificate: ICT (92%)", institutions of high learning and TVETs were supposed to work towards meeting this target, and the curriculum development and enrolment of students was to be lined up with the desired skills number as it was projected and highlighted in the table showing priority skills arranged along with thematic areas of the EDPRS II, for the period of 2013-2018. Below is the total number of skills required to deliver EDPRS II[18].

Table 6: Total number of skills required in ICT sector to deliver EDPRS II

Skills Area	Number		
	Associate	Professional	Experts
Network Security	254	99	39
Wireless & Transmission Security	96	66	36
Application Security	320	162	81
Security audit			154
System Administrator	406		78
Windows System Specialist			308
Storage Specialist			227
Network Administrator	454	310	79
IP Network Engineer	234	157	81
Fiber Engineers			227
WiMax Specialist	135	206	112
Voice Engineer			96
Data Center Management			85
Radio Frequency Planning Specialist			148
Radio Transmission Specialists			274
Telecommunication network switching specialist	365	213	159
Telecommunication Network Performance optimization specialist	260		148

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[17] Technical and Vocational Education and Training (TVET)
18Policy in Rwanda Five Year Program for Priority Skills Development to Deliver EDPRS Ii (2013 – 2018.

Database Administrator			162
Graphic Designer			700
Multimedia Specialist			519
Game designing and development			160
Industrial Designer			106
Software Developer			227
Mobile Applications Developer	811	438	316
Business Analyst			876
Enterprise Architect			373
IT Project Manager			389
Online work skills	**1800**		**292**

Source: Five-year program for priority skills development to deliver EDPRS II (2013 - 2018)

In order to overcome the ICT skilled profession and expert workforce challenges, the institutions under the Workforce Development Authority (WDA) are offering IT professional courses, including TUMBA College of Technology (TCT) in Cisco Certified Network Associate (CCNA). TCT also offers training in IT courses at ordinary diploma and higher diploma levels. Kigali Integrated Polytechnic Regional Centre (IPRC) also offers training at diploma level in IT courses. Kigali Institute of Science and Technology (KIST) is a public testing centre for IT professional courses like Cisco Certified Network Associate (CCNA), Cisco Certified Network Professional (CCNP), and Microsoft Certified IT Professional (MCITP), but also offers ICT courses to the bachelor's level[19]. Moreover, the five-year programme for priority skills development to deliver EDPRS ii (2013–2018) identified the skills required in different areas and categories.

The ICT skills assessment conducted revealed that companies operating in the ICT sector responded to the availability of professional certifications at an institutional level, as indicated in figure_4. ICT Project Management System and software development presented the highest level of professional certifications available for occupations to be filled, followed by application development and programing, and project planning and management.

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[19]Draft 1s (physical meeting) wsis+10: overall review of WSIS outcome implementation

Figure 7: Professional certifications available at institutional levels
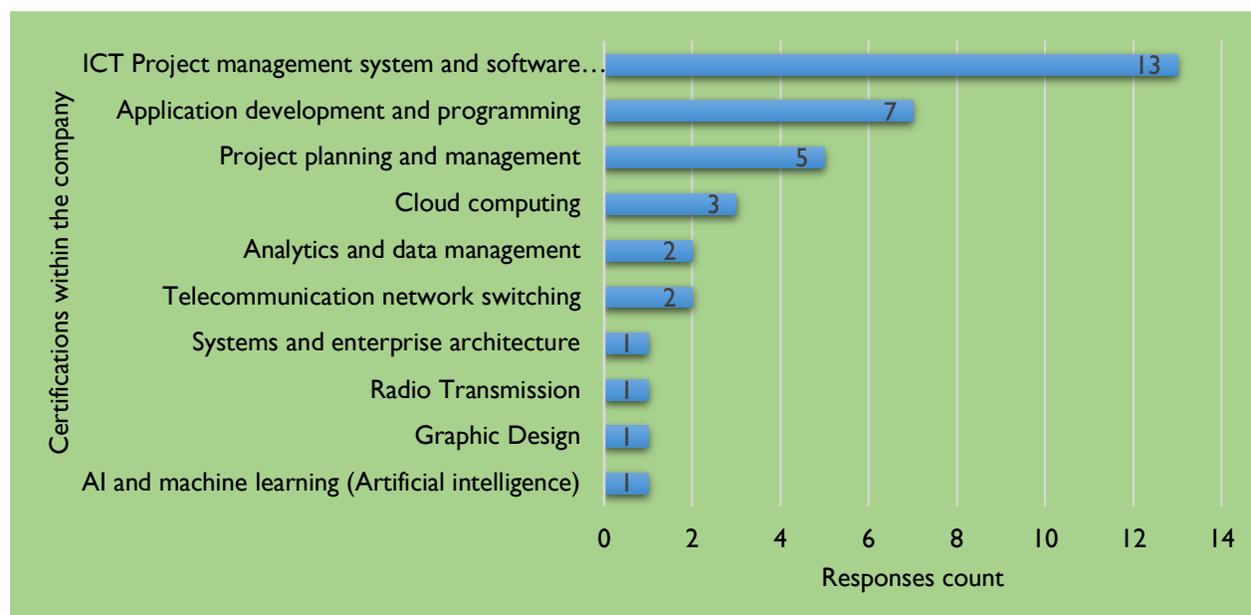
Source: Data analysis collected from ICT companies' responses

4.2. CT Sector Skills Training opportunities

The ICT sector's skills development effort is a concern of all ICT sector actors. *Table_7* shows the training provided by the ICT chamber to its members. The total number of people trained by some of the association members is 311. However, the number of skilled professionals' available is not enough compared to the on-market skill demands. Therefore, closer dialogue between education providers and industry is needed to align and optimise the region's demand and supply of skills. Although the trainings were offered in various programs and might have made an impact on skills required, these programs are not really featuring among the most skills gaps in current technologies such as the ones identified as most crucial offered by ICT Chamber, Andela in collaboration with MINICT and ITU.

Table 7: ICT skills provided by ICT sector Chamber to its members

Training Program	Number of Trained Companies and Individuals	Level of the Program
Corporate Governance & investment Readiness	**15-member** companies.	Advanced
Woo Commerce	**13** individuals from member companies.	Basics
Woo Commerce	**9** individuals from member companies.	Advanced

Training Program	Number of Trained Companies and Individuals	Level of the Program
Shopify	**7** individuals from member companies.	Intermediate
Google Ads	**9** individuals from member companies.	Advanced
Facebook Ads	**12** individuals from member companies.	Advanced
Google & Facebook Shopping	**3** individuals from member companies.	Intermediate
Finance and Law in ICT startups (through 250 Startup Program)	**60** individual lawyers and finance graduates.	Intermediate
250 Startups Incubation Program	**40** Startups have completed the six months 'incubation program (these startups are now considered as members of the ICT Chamber).	Intermediate
Digital marketing and importance of online v visibility (one of the activities completed through "Digital Transformation Clusters")	**26** individuals from different tourism businesses).	Intermediate
Software Development (WeCode Program)	**76** graduates.	Intermediate
Software Quality Assurance (WeCode Program)	**86** graduates.	Intermediate

Source: *Data collected from ICT Chamber*

The above information indicates that higher learning institutions need to adapt their teaching methodologies in order to produce graduates who meet the skills requirements for the digital economy.

4.3. Training opportunities offered by ITU

The International Telecommunication Union (ITU) is the United Nations specialized agency for information and communication technologies – ICTs.

According to the International Telecommunication Union (ITU), the following are the most global ICT technologies that are currently and in the future needed for which training opportunities are offered by the same institution.

ITU-Development offers extensive opportunities for ICT skills development through its ITU Academy initiative. The ITU Academy's web-based learning management system enables access to ITU training interventions and resources, whether delivered face-to-face or through distance learning. The ITU Academy aims to strengthen the individual, institutional, and organisational capacity of developing countries by making the highest-quality ICT learning and development opportunities available.[20]

4.4. *Training Opportunities offered by Andela[21]*

Andela, in collaboration with the Ministry of ICT and Innovation (MINICT), has launched Stack Up, a nine-month career accelerator programme. The program's goal is to equip Rwandese nationals with the software engineering abilities they need to become excellent engineers. It is a combination of technical and soft skills training that is necessary for professionals to succeed in any workplace, especially while working with a remote team.

4.4.1. *Cloud computing*

Cloud skills are in high demand, and the main reason cloud is N°1 is because it intersects with every other skill on the ICT skills list. The cloud has, quite simply, changed the game, as it is the ultimate enabler, opening new channels of revenue by leveraging technologies like artificial intelligence (AI) and the Internet of Things (IoT). Other topics like data analytics, networking, project management, and cyber security have all been greatly influenced by cloud adoption, which continues to soar. The public cloud services market is expected to grow 17.3% by the year 2019.

4.4.2. *A comprehensive cloud training solution*

Using the cloud is the way forward for organizations. However, living in the era of cloud technologies requires different skills that organizations are struggling to fulfil in existing or new job roles. Organizations are in different phases with unique business goals to achieve, which is why we enable companies, teams, and individuals to bridge skills gaps and advance their cloud maturity. Our comprehensive training solution creates structured learning paths for executives and ICT pros to acquire the knowledge and deep technical skills the technology community needs to maximize cloud solutions. No matter the stage of the cloud initiative, *Global Knowledge* can help every step of the way.

4.4.3. *Cyber security*

An analysis of worldwide identity and access management by the International Data Corporation (IDC) revealed that 55% of consumers would switch platforms/providers due to the threat of a data breach, and 78% would switch if a breach influenced them directly. There is

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[20] https://www.itu.int/en/Pages/default.aspx

[21] Andela is an **American company** with operational campuses in Africa including Nigeria, Ghana & Kenya that identifies and develops software developers.

too much at stake when it comes to the data. That is why security is the top concern for a majority of organizations. Cyber-attacks are escalating in frequency and sophistication. As a result, companies are scrambling to hire cyber professionals, and they are not always succeeding. For the fourth straight year, IT security is the most challenging hiring area for decision-makers. There are not enough of them to fill open positions. Moreover, more are needed due to specialization. There is no longer a cyber-security jack-of-all-trades.

Nevertheless, if the skills are available, there will be assurance of data safety. Cyber-certified professionals earn 9% more than the national average. As the amount, frequency, and creativity of cyber security breaches grow, so does the shortage of cyber security professionals with the appropriate skills to defend enterprise, government, and military networks, said Brad Puckett, *Global Knowledge global portfolio* director of cyber security. This global shortage of cyber security professionals has created an in-demand market for anyone who wants to rise to the challenge and build career-advancing skill sets.

4.4.4. Application development and programming

Developers' jobs are expected to grow continuously in the near-term. Application developer employment is forecast to grow by 31% globally, and software developer jobs are forecast to grow by 24% by 2026. Overall, that is more than 550,000 new developer jobs.

Developers are responsible for web, social, and mobile applications. In addition, as more and more people conduct business on their phones, the skills needed to build and manage apps are increasing in criticality.

According to the Global Knowledge IT Skills and Salary Report, application development and programming jobs pay an average of $118,276 in North America, which is 8% higher than the national average. According to IDC's analysis of over one million job listings, top programming languages such as SQL, C#, Python, and JavaScript are also among the most mentioned skills.

4.4.5. Networking and wireless

The market for software-defined networks (SDN) is growing quickly, due to the flexibility and adaptability they provide. For those with an updated networking skill set, there are certainly opportunities for advancement and higher pay.

Cisco is the market leader in networking and wireless, and Cisco's routing and switching certifications are some of the most popular throughout IT. This year, CCNP Routing and Switching ranks among the top 15 highest-paying certifications, at nearly $107,000 a year. **CompTIA** Network+ also has a similarly high average salary for 2019.

IDC expects the SD-WAN (software-defined wide area network) market to grow exponentially going forward. The SD-WAN market reached $833 million in 2017 and is projected to balloon to $4.5 billion by 2022. With this level of growth, networking skills are a safe and smart bet for IT professionals.

4.4.6. Analytics and data management

Analytics and data management are growing skill needs as organizations are striving to be more data-driven. This culture of information allows for better insight into patterns and trends. Thus, critical business decisions are made with data as the driving force. IT professionals with these skills are tasked with helping organizations solve problems and make more evaluations that are informed.

However, it has been a double-edged sword as organizations have struggled to manage the wealth of new data. By 2025, IDC estimates the world will create and replicate 163 zettabytes (ZB) of data, 10 times the number that was created in 2016. This new data is constantly accumulating, creating a host of storage and security risks that must be addressed. IT professionals are desperately needed to manage the exponential growth of data. It is a top challenge for decision-makers, and it is exacerbated by the fact that they cannot find enough qualified individuals with this specific skill set.

4.4.7. Systems and enterprise architecture

There is increasing pressure on organizations to align departments. This has become a more complex assignment given emerging technologies. IT, for example, may evolve at a different pace than other departments. Systems and enterprise architecture professionals needed to ensure legacy programmes and procedures align with modern practices. A highly complex role requires a lot of planning and coordination with different departments.

According to CompTIA, only 34% of firms currently have IT architecture strategies beyond 12 months because it is difficult to predict IT environment changes. Without architectural planning, investments likely will not be a priority, and long-term goals will not be reached within outdated frameworks. It is no surprise that remuneration of enterprise architects is good. It is the second highest-paying IT functional area. Business architecture certifications (e.g., TOGAF) have the highest global salary associated with them.

4.4.8. Project management

As skills gaps rise they are up nearly 50% in four years, project planning is more vital than ever. There are many roadblocks preventing projects from being complete on time and within budget. It is a project manager's job to create, communicate, and execute a project strategy. Given attention or not, IT sector is look at in lenses of the success or failure of projects.

Project managers ensure projects are highly visible to stakeholders. They must be able to communicate with leadership the skill needs and risks associated with a given project. It's a delicate balance, as critical skills aren't always readily available. IDC believes that by 2020, 90% of all organizations would have adjusted project plans, delayed product/service releases, incurred costs, or lost revenue because of a lack of IT skills, with losses worldwide totalling $390 billion annually. A good project manager keeps their focus on the big picture even as disrupters emerge and cause havoc within a department.

4.4.9. Artificial Intelligence (AI) and machine learning

55% of IT professionals say workloads are higher year over year. With so much to do, the scramble is on to develop programmes that automate the more time-consuming, menial duties. Enter artificial intelligence, which frees up employees to focus on more consequential responsibilities. It's no surprise that AI and machine learning are key investment areas for 2019.

Cloud migration has amplified the need for automation. With a majority of organizations shifting to the cloud, manual migration tasks have been automated to save time. IDC examined the advancements in cloud migration programs, tools, and services, especially from cloud service providers like AWS, Microsoft, and Google. Each provider has expanded their portfolio with AI-enabled automation and machine learning. From IDC: For businesses planning their move to the cloud, many of the manual, time-consuming tasks associated with migration have been automated and reduced from days to minutes. Automation reduces the arduous tasks of manual configuration, extensive customization, and, in many cases, integration.

4.4.10. Service desk and tech support

5% of the 12,200-plus professionals we polled for our 2019 IT Skills and Salary Report worked in customer service or tech support. This particular skill set is in-demand due to the growing amount of hardware and software that organizations are utilizing and distributing.

There's now more of a need to bring help desk professionals in-house so they can get their hands on and diagnose issues more easily. Tech support professionals are more likely to be remote, though it's critical that they possess strong soft skills, such as communication and conflict resolution. Technical support is the fourth most in-demand tech skill. While both positions can be outsourced, companies are looking to bring them in-house to ensure a consistent message and experience.

4.4.11. Virtualization

Virtualization remains a useful way to reduce IT expenses and increase IT agility. It can also help accelerate the transformation to cloud computing.

This year, virtualization is a key concern for companies of all sizes. It is the No. 6 tech interest area worldwide. Decision-makers are still investing heavily in the concept, and staffs are seeking out these skills. Citrix Certified Associate-Virtualization (CCA-V) is the 12th highest-paying certification in 2019, while VMware vSphere: Install, Configure, manage remains one of most popular training courses.

The market for virtual machine software increased by 2.9% in 2017. IDC forecasts it to increase at an average pace of 4.6% from 2017 to 2022[22].

4.5. *Challenges within skills supply institutions*

It is evident, as highlighted by skills supplier institutions, that students have computers and Internet facilities at home and universities. They are acquainted with simple skills like MS Word, MS Power Point, searching and browsing the Internet, social networking, email, file attachments, and computer games, but are less skilled or poor at other skills like using digital libraries, discussion forums, and blogs. Students spend more time on computers for recreational and other purposes than for academic purposes. They believe that the use of ICT supports their learning. The majority of students face issues such as slow computer speeds, Internet signal problems, virus threats, poor computer working conditions, load shedding, and a lack of Internet access. The issues here seem to be at the shudder point of academic and skills acquisition, and institutions of high learning are responsible for addressing that problem. This has also been articulated by the Eurasia Journal of Mathematics, Science, and Technology Education *that* private institutions should invest more in improving the infrastructure to address the ICT related problems of students at universities[23].All the 29 public and private Higher Learning Institutions (HLIs), offer ICT related courses. Universities offering ICT courses concentrate on Bachelor of Science in Computer Science or Computer Engineering, Information Technology, Electronics & Communication Systems. Most of these programs are of a general nature focusing on basic aspects of computer management and engineering at the undergraduate level. [24]

Integration of ICT in education is still in its low and initial stages. There are many challenges regarding the integration of ICT in private institutions of high learning and TVETs that produce highly skilled professionals that can meet the labour demand and compete with the new emerging ICT technology trends. This is due to the high opportunity costs that are involved in establishing institution-wide ICT systems. The main problems are the high cost of getting,

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[22]Global Knowledge 2019 IT Skills and Salary Report, why initial and on going training are solutions for IT skills gap
[23]https://www.researchgate.net/publication/319104127, The ICT Facilities Skills Usage and the Problems Facing Students in Higher Education.

[24]National Digital Talent Policy 2017

installing, operating, maintaining, and replacing ICT systems; the use of unlicensed software; outdated hardware and software systems; and a lack of technical support for system maintenance, which leads to ICT in education being a challenge as infrastructure is neglected. This can also be attributed to thin resources across multiple innovation support programmes and institutional arrangements. In order to improve the supply of ICT professionals, harmonisation of the training programmes with international standards has been identified as an ideal approach to match workers' qualifications to their jobs in the ICT sector. Companies trading in the ICT sector highlighted areas that are needed to comply with Rwanda Utility Regulation Authority (RURA) and ITU standards when it comes to ICT sector business operations.

Figure 7: Areas required complying with ICT international standards
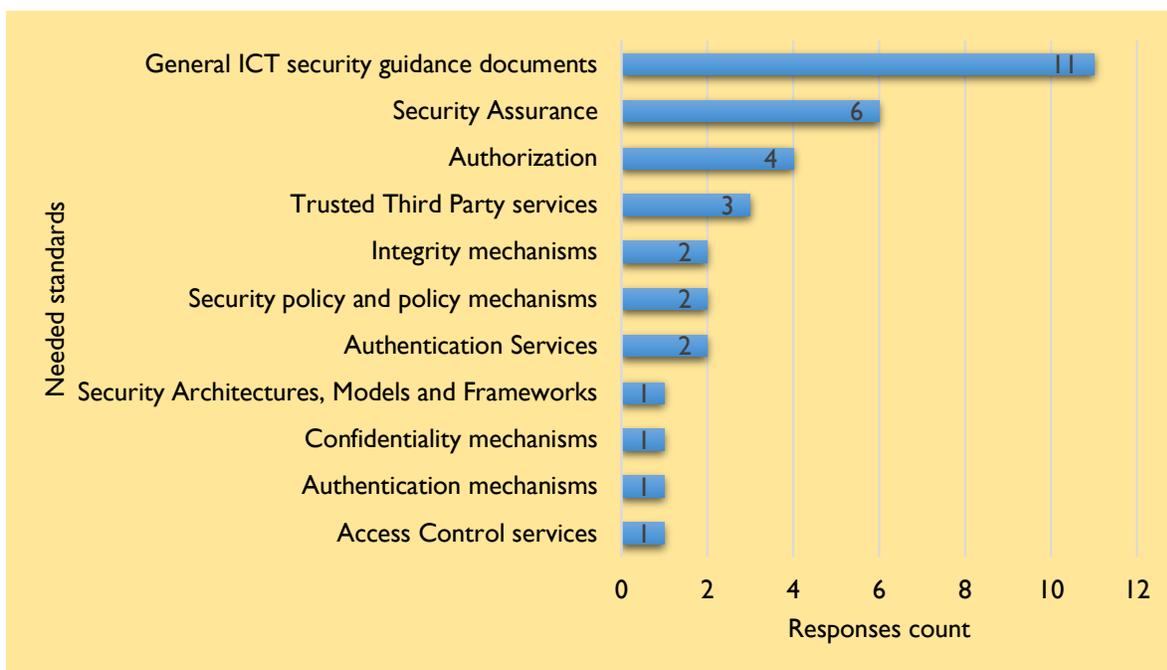
Source: Customised from data collected

Lack of compliance with international ICT standards is one of the obstacles to the competitiveness of the sector. Although the many respondents stated that private companies do not comply with "general guidance documents on ICT security", all factors are essential to respect in order to be competitive. It should be noted that when a company undertakes to comply with the standard, it absolutely requires developing the capacities of the staff; therefore it is obliged to improve the skills of its employees.

Figure 8: Standards needs to comply with RURA Standards
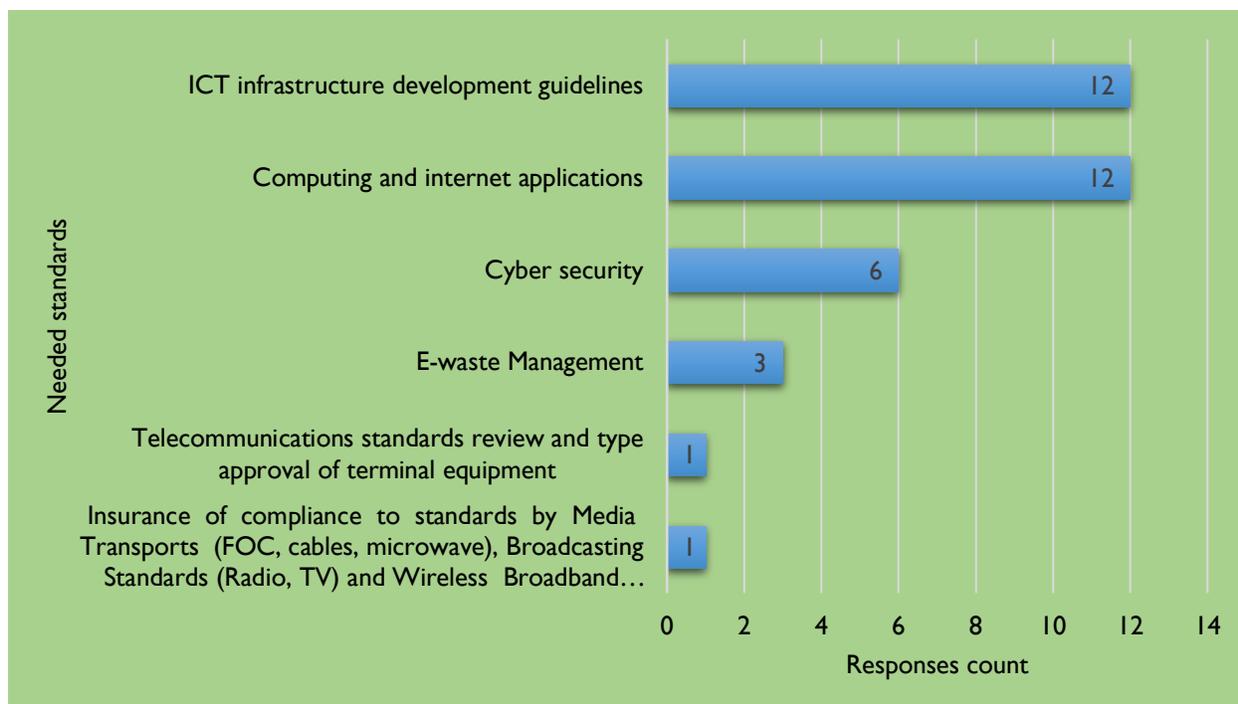
Source: Customised from data collected

As for international ICT standards, RURA ICT standards are critical to grow the level of ICT sector in Rwanda to build capacities of private companies operating in the ICT. To be under standard does not ensure does not predispose a company to a delisted future, therefore, improving the skills of its employees. It is therefore critical to put a support mechanism for private companies operating in the ICT sector.

As the global economy becomes more and more volatile to different circumstances and pandemic events, the ICT sector is becoming more and more dependent on ICT technological skills, which turn out to be extremely important in order to fill all human inadequacies caused by the handicaps of immobility. Collaboration efforts between all ICT sector actors, stakeholders and all other ICT dependent sectors need to come together and discuss the future needs of ICT technologies and their relevance to each sector. Institutions of higher learning and other educational bodies' collaboration is of urgent matters to assess and draw up agreements on immediate, short-term, and long-term solutions to the ICT sector's skills gaps.

Collaboration and interaction between ICT skills providers, including academic institutions, and all ICT sector actors is critical for discussing new technological trends in ICT, as illustrated in *figure_8.*

CHAPTER FIVE: SECTOR SKILLS RESPONSE TO ADDRESS THE IDENTIFIED SKILLS GAP

5.1. Introduction

The National Strategy of Transformation (NST1) recognises ICT as a cross-cutting enabler for development. Greater digital adoption and ICT-driven innovation are seen as instrumental in supporting productivity gains across both primary and non-primary sectors. In the decade through 2018, ICT was the fastest-growing services subsector and has rejuvenated other sectors. However, in the first three quarters of the same year, its output contracted. Hereon, *Table_3* shows available professional certifications in different domains of the ICT sector. *Figure_9* also highlights that ICT project management and software development have the largest number of professional certifications in the ICT sector, followed by application development and programming, as well as project planning and management, according to responses obtained from ICT companies' representatives.

As it stands, the number of digital specialists needed is not producing at the level of emerging technologies and does not possess the requisite calibre to propel the kind of cross-sectors digital transformation that the ICT sector aspires to achieve. While ICT courses are offered by most types of TVET institutions, few are considered to be at digital specialist level. Moreover, few TVET students choose to study advanced-level ICT courses and even fewer graduate[25]. Meanwhile, courses available through public and private universities focus primarily on computer maintenance, software development, programming, information management, and networking. Available training thus restricts the breadth and depth of digital skills available locally. While a handful of universities do offer courses in cutting-edge technology, few students can afford to access this training. Some 9,427 students were thus estimated to be graduating with a degree in ICT in 2018–2019[26]. However, these graduates typically lack hands-on experience due to limited opportunities for practical training as well as a misalignment between skills taught and those demanded by prospective employers.

In order to be able to respond to all key requirements for Smart Africa targets, respondents during the conduction of ICT Sector Skills assessment confirmed some ICT technologies that are required for current market demand.

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[25] According to TVET enrolment figures from 2017, only 11% of all TVET students were studying ICT, which equates to 9,901 students. Yet, according to the Ministry of Education, only 327 students graduated with a certificate, diploma or advanced degree in ICT from polytechnics in 2016 – equivalent to 16 percent of the total graduating cohort.

[26] 2018-2019, Education statistics.

Figure 9: Professional certifications available at ICT companies' level
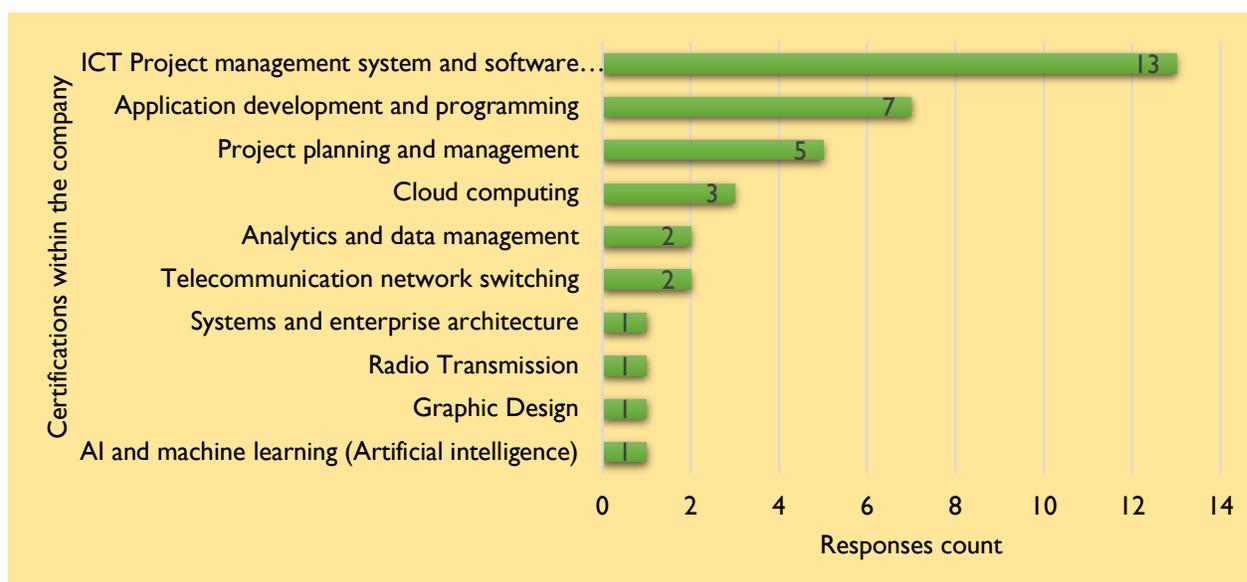
Source: Information provided by different ICT stakeholders

The fields of ICT are very dynamic and demanding in terms of standards, kills and qualifications hence the requirement for a certification attesting to the capability in one or the other fields. By analysing the figure above, it is noticed that the majority of the companies surveyed have one or more employees certified in "ICT Project Management System and Software", followed by an "Application Development and Programming" certificate. On the other hand, there is each time that one company out of 14 surveyed has one or more employees certified in "Artificial intelligence and machine learning", "Graphic Design", Radio Transmission" and in "Systems and enterprise architecture". For more competitiveness, Rwandan ICT companies should have many people certified in various fields of ICT.

5.2.   ICT Sector Skills Gaps.

The ICT establishments in the private sector had 2,007 labour units employed as managers, professionals (engineers), liberal professionals, technicians, and artisans. The managers constituted 26.7% of the workforce and the largest cadre in the sector, although this is biased upwards by the large number of owner-managers of micro-enterprises. Skilled ICT staff (professionals and technicians) accounted for just 23.2% of the total occupations in the sector. The large proportion of managerial and non-technical staff in the sector reflects that the sector is mostly engaged in the selling and distribution of hardware and software. In total, 19.8% of all employees were women, and 7.5% of all employees were expatriates, constituting 9.9% of total

labour units[27].These occupations indicate in Figure 10, but are not aligned with the specific skills but rather linked with qualifications alone.[28]

The skills assessment, however, has indicated that as of August 2020, the skills gap is aligned with occupations. From the skills assessment conducted, it was noted that the skills that are most crucial and should be aligned with those occupations are pointed out **in *figure11*.**

Figure 10: ICT Sector Skills gaps by occupation categories
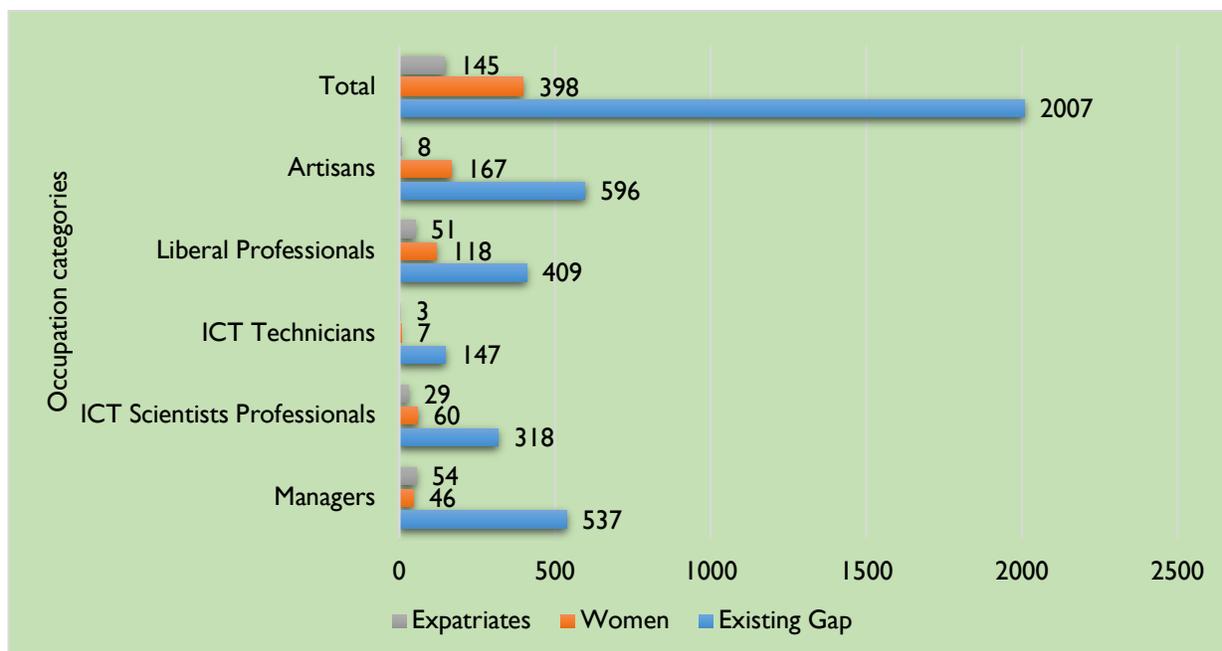
Source: Rwanda Market information System: ILO.

Figure 11: ICT Skills that are lacking leading to companies' inability to perform
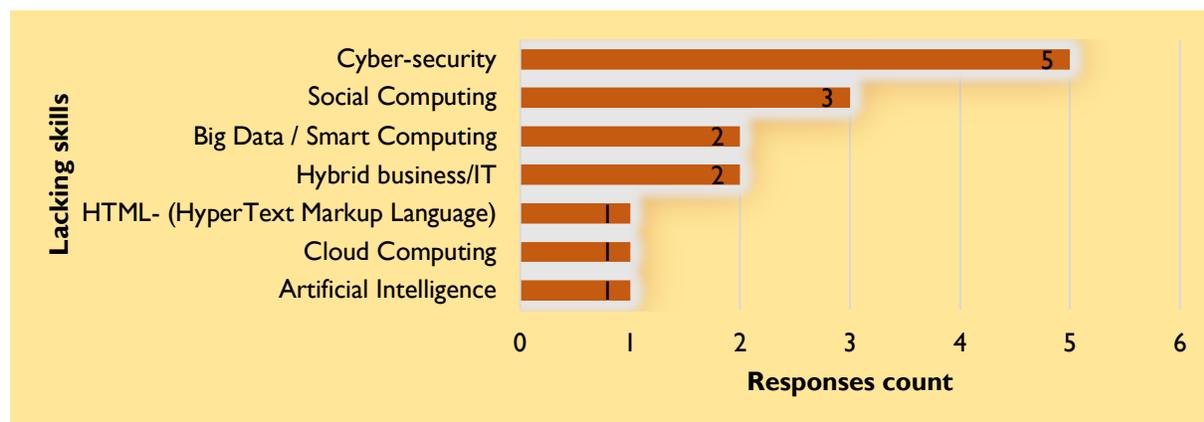
Source: **Customised from data collected**

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[27] LMIS: Rwanda Labour Market Information System (2018)
[28] Ibd

Currently companies fear about cyber-attacks and number of them face it. Nevertheless, skills development in all ICT areas above required increasing competitiveness of Rwandan private ICT companies through a well-designed skills assessment programmes and skills development plans that are agreed upon by all relevant institutions and stakeholders.

5.3. ICT skills required by 2030

ICT skills are fundamental for participation in today's information society and correlate positively with social well-being and economic productivity. ITU data and other cross-nationally comparative data sources show that there are considerable gaps across the board in the skills needed at all levels.

According to the ITU, looking at international skills trends, ICT skills required from an international perspective are: Next generation networks (NGNs): IPv6, Cloud computing, Internet of Things (IoT), Big Data, Artificial Intelligence (AI), Quality of Service (QoS), and cyber-security. Furthermore, the most required ICT skills for 2030 were identified and listed by ITU as:

1) Computing in the cloud
2) Cyber-security;
3) Application design and development;
4) Wireless and networking;
5) Data analytics and management;
6) Enterprise and system architecture;
7) Project administration;
8) Artificial Intelligence (AI) and machine learning
9) Service desk and technical support; and
10) Virtualization.

> While Data mining is developing around the world, Artificial Intelligence and robotic are governing economic and technology development, it is urgently needed to be aligned to current trend of technology development holistically. To achieve this, Rwanda through its private sector and its education system should anticipate by giving itself the means to have early the skills that ITU recommends to have in sufficiency in 2030.

The ICT sector skills assessment revealed trends for required ICT skills required for the sector to be more effective and competitive. As shown in *figure_11*, mobile internet cloud technological skills are the highest in skills required, followed by processing power. big data This is for the World Economic Forum 2018 because current requirements necessitate ICT expertise.

Relating information from the ICT skills assessment conducted in the ICT sector with information produced by ITU indicated in*table_8*, a number of respondents presented a range of digital skills required to respond at each level of skills category. Basic functional digital skills can be used in knowing how to use a touchscreen device, customer education (e.g., basic tips on devices and services), and digital skills in the education curriculum. Hence, generic or intermediate digital skills can be used in specialist software for work, employee training (e.g. training in Excel), and digital skills in education curriculum. Finally, high-level digital skills or advanced skills can perform such tasks as developing apps or software, ecosystem development (e.g. collaborating with a start-up incubator), and policies to foster entrepreneurship in a range of ICT technologies.

Table 8: Basic, intermediate and Advanced Kills needed in ICT Sector

Basics	Intermediate	Advanced
Creating professional online profiles	Desktop publishing	Artificial intelligence
Word processing	Digital Graphic Design	Big Data
Managing private settings	Digital marketing	Cybersecurity
Using Keyboard and touchscreen		Internet of Things
Email		Virtual Reality

Source: ICT Development trends and approaches for digital transformation: (ITU) prospects

Table_9 depicts a skill in demand now and in the future in order for the ICT sector to be at the readiness point of ICT competitiveness, market demand, and supply. These skills respond to emerging trends, coherent with information provided by representatives of ICT sector actors that there are a number of skills that are needed for the companies to perform at competitive levels. These skills, once available, will respond to the ICT calling investment opportunities presented in Smart Africa as one of the drivers of change.

Table 9: ICT Skills in demand now and in the future

Technological Emerging Trends	Relevant required Skills	
Artificial Intelligence and Data Science	Analytics and Computational Modelling Business Innovation Business Needs Analysis Business Process Re-engineering Business Innovation	Cyber Forensics Data Strategy Data Governance Data Design Data Engineering Data Visualisation
Cyber Security	Business Needs Analysis	Security Programme

	Cyber Forensics Cyber Incident Management Cyber Risk Management Security Assessment and Testing Security Governance	Management Stakeholder Management Threat Intelligence and Detection
Immersive Media	Analytics and Computational Modelling Application Development Business Innovation Business Needs Analysis Data Design	Infrastructure Design Embedded Systems Programming Product Management• User Experience Design User Interface Design
Internet of Things	Analytics and Computational Modelling Data Strategy Data Engineering Embedded Systems Interface Design	Embedded Systems Programming Security Architecture Security Administration

Source: Future requirement for high-level ICT skills in the ICT sector

However, the ICT sector skills assessment reveals that the ICT sector is in an emerging state and a relatively low-skilled workforce is matched by the limited demand for high-level cognitive skills. In these countries, the supply of highly skilled workers tends to outstrip demand. Although the availability of a better-skilled workforce in the ICT sector could in itself stimulate a move to a higher-skilled equilibrium, demand-side policies to support firms especially SMEs and new innovative ventures are also required. These may involve programmes to encourage innovation and the adoption of new technologies, coupled with providing the skills that go along with them.

5.4. *Impactful Causal of inadequacy of skills required in ICT Sector*

The skills assessment in the ICT sector identified from literature reviews and respondents' representatives of institutions of high learning and TVETs, that the most crucial and impactful causes of inadequacy of skills in the ICT sector are the lack of knowledgeable teachers who are well trained and well paid, as well as a lack of teaching qualifications coupled with specific standards set for market projection demand. Such market demand should be equally balanced with the ready-to-do work perfectly so that delivery of ICT services and goods is competitive and meets the market needs. The continental strategy, technical and vocational education and training (TVET), and the most significant contributors to skill inadequacies acquired from

institutions of higher learning and TVETs were also highlighted[29].These most pressing causal inadequacies are:

5.4.1. Fragmented structuring of High learning institutions and TVET

Public technical and vocational institutions belonging to the State, private vocational training institutions; and traditional apprenticeship are not operating on the same line of teaching, financial supports and capacities, thus, they should have one streamlined system of expected skills based on qualifications and certification.

5.4.2. Systems are supply driven instead of demand driven

Despite significant efforts to raise awareness about the need to make institutions of higher learning and TVETs demand-driven, the reality is that the system is frequently inherited from the colonial era, which primarily focuses on supply and is still prevalent in the education system. non-target skills are a major weakness of the system. Training institutions have no relationship with the employment destination of their graduates.

5.4.3. Mismatch between supply and demand for skills

According to the "Continental Strategy for Technical and Vocational Education and Training", a large number of graduates from the formal school system, including university graduates, are unemployed, and those that are in possession of different qualifications and working are in mismatched positions. This leads to poor service delivery and the prevailing absence of skilled personnel, which sometimes forces employers to look elsewhere in the region or internationally for quality workers.

5.4.4. Weak policy implementation structures

The Continental Strategy for Technical, Vocational Education, and Training also indicated that supervisory responsibilities are for the policy makers and agencies to account for some of the inefficiencies in the policy implementation by enforcing skills development provisions contained in them. Hence, the policy implementation is fragmented and uncoordinated.

5.4.5. Insufficient funding

Insufficient resources to acquire modern equipment and facilities in institutions of high learning and TVETs for quality and relevance education systems and programmes, this call for private sector involvement and funding specialized skills required by the market.

5.5. Strategies to leverage inadequacy and bridging ICT skills gaps

The Continental Strategy for Technical and Vocational Education and Training suggests strategies to balance inadequacy and bridge ICT sector skills gaps, saying that ensuring that

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[29]African Union Development Agency's AU-TVET strategy

everyone involved in the ICT sector has the right skills for an increasingly digital and globalised world is essential to promote inclusive labour markets and to spur innovation, productivity, and growth. This requires implementation of four major strategies to meet the demand for the relevant required skills:

♦ **Education and Career Guidance**: providing students with the knowledge, skills, and values they need to make informed educational and career choices. With the help of trained trainers and counsellors, students will be exposed to a wide range of educational and career options, and given the opportunity to make informed post-secondary education choices.

♦ **Enhanced Internships:** Enhanced internships should be designed to provide students with a more meaningful internship experience through more structured learning and support in the workplace. Participating companies must work closely with the ICT sector, institutions of high learning, TVETs, and polytechnics to deliver a positive and meaningful internship experience for their interns.

♦ **Earn and Learn Programme (ELP):** Earn and Learn is a work-learn programme designed to give ITE and polytechnic graduates a head start in careers related to their field of study. Suitable candidates will be matched with a job related to their field of study and undergo structured on-the-job training and mentorship in participating companies, allowing them to gain industry experience and attain an industry-recognised certification concurrently.

♦ **Company-Led Training Programme (CLT):** A structured training programme that lasts up to 12 months and is targeted at fresh and mid-level ICT professionals as well as those from the Science, Technology, Engineering, and Math (STEM) disciplines. The programme should be run by ICT sector actors or highly proficient training companies.

♦ **Follow-up and implementation of the TVET continental strategy:** The TVET continental strategy provides a comprehensive framework for the design and development of national policies and strategies to address the challenges of education and technical and vocational training to support economic development, the creation of national wealth and contribute to poverty reduction through youth entrepreneurship, innovation and employment[30].

5.6. Gender skills gaps in ICT sector

According to EICV, a person is considered "computer literate" if he/she expresses her/himself confident with using a computer. Only 7% of females aged 15 years and above were computer literate in 2016/2017, slightly up from 6.8% in 2013/2014, while for males, 10.9% were computer literate, slightly up from 10.3% in the same period. The results further

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[30]Continental strategy technical and vocational education and training (VET) to foster youth employment

indicate the same gender imbalance in computer literacy for the younger age group (15–24 years), where men slightly lag behind compared to their female counterparts, but on a decreasing trend from 2013/2014 to 2016/2017[31.]

Rwanda's Labour Market Information System revealed that by 2018, there was a skills gap of **398** women, while the skills gap for men was **596**. Hence **146** expatriates were occupying different positions in occupational categories.

The Smart Rwanda 2020 Master Plan, as an ICT Sector Strategic Plan developed in 2015, highlights the empowerment of women and youth in ICT as one of its pillars. Through the plan, there is a commitment to facilitate women and girls in ICT capacity building and facilitate projects related to increasing women and girls in ICT related business.

The skills assessment conducted in the ICT sector looked into gender gaps in high risk that will be brought about by ICT automation32as the research conducted by the IMF report 2019, figure 5, indicates that the gaps vary in all occupational categories across sectors. In the composition of the ICT sector alone, women count 3.45%, while men count 6.53% at risk [33.]

To promote women in the ICT sector, one approach was put in place by the Rwanda ICT Chamber, which founded WeCode, the first programming school and IT-agency for women in East Africa. It offers high-class IT training to working-age Rwandan women with and without prior ICT degrees[34].

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31 National Institute of Statistics of Rwanda, EICV 2017.
32 IMF Working paper 2019:
33IMF Working paper 2019
34 Promotion of Economy and Employment Programme, 2019-GIZ

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Timing is critical. The World Economic Forum estimates that more than half (54%) of all employees will require significant reskilling by 2022. The ICT sector should be the spearhead of tackling the ICT skills gaps with urgency.

What is required is a holistic solution that prioritises new approaches to skills development within an existing workforce to address the ICT sector's skills problem, companies must invest more in enabling their workforce to reskill, starting now and in previously untapped talent pools. Such an approach would also help address the shared responsibility (with governments and education providers) of ensuring that the technological advances of new ICT trends don't increase economic inequality as lower-skilled workers find themselves out of a job[35]

6.2 Recommendations

The growing demand for a range of ICT skills across the sector presents a wide range of opportunities to strategically position the sector with the tools necessary to succeed. The following recommendations apply to all ICT sector groups, including academic institutions, and can be customised and adapted to suit every ICT-related institution's needs. They will also address the gender contexts outlined in the ICT skills assessment report.

The successful implementation of these recommendations will require a collaborative approach among many of the stakeholders involved. While the recommendations are designed to support the ICT sector, and specifically to address its high-level skills needs, some undoubtedly have a positive impact on adjacent sectors and support the wider agenda on skills for enterprise focusing on summarised recommendations in the table below.

10 Table: Recommendations for ICT sector skills development

No	Recommendations	Responsible	Timeframe
I	Put in place a strategy of skills development and road map to develop and upgrade skills specifically in: 1. Computing in the cloud 2. Cyber-security;	MINEDUC, MINICT, RISA, WDA, Universities and	Short term

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[35] World Economic Forum

No	Recommendations	Responsible	Timeframe
	3. Application design and development; 4. Wireless and networking; 5. Data analytics and management; 6. Enterprise and system architecture; 7. Project administration; 8. Artificial Intelligence (AI) and machine learning 9. Service desk and technical support; and 10. Virtualization.	High Learning Institutions, Private operators	
2	Negotiation with International institutions competent to evaluate and certify national companies and individuals in ICT domains. This will be the best way to bridge ICT skills gaps	MINICT, RDB and RISA	Short term
3	A pool of ICT professional must be established in order to be used in applying and operationalisation of new Technologies listed by ITU, as well as needed technologies to be in attainment of Smart Africa, Smart Rwanda.	MINICT, MINEDUC, Partnerships	Short term
4	Establish in Rwanda certified institutions specialized in training in following specialized area: 1. Computing in the cloud 2. Cyber-security; 3. Application design and development; 4. Wireless and networking; 5. Data analytics and management; 6. Enterprise and system architecture; 7. Project administration; 8. Artificial Intelligence (AI) and machine learning 9. Service desk and technical support; and 10. Virtualization.	MINEDUC, MINICT, RISA, WDA, Universities and High Learning Institutions, Private operators	Medium term
5	In-company coaching and on-the-job learning	MINICT, RDB	Long term
6	Establishing funding principles and incentives to allocate to specific ICT skillset needs across the sector	MINICT, RDB	Long Term

No	Recommendations	Responsible	Timeframe
7	Courses offered are to be constantly upgraded to ensure relevance to industry needs and new technologies as the emerge	MINEDUC, ICT Chamber	Long Term
8	ICT sector stakeholders must collaborate in targeting funds and providing scholarships and subsidies towards technical training and incubation programmes	MINEDUC,PSF, MINICT	Long term
9	Gender promotion in ICT should be enhanced through the hosting of local events (guidelines provided in the on-line kit at witnet.org); and using the ITU Girls in ICT Portal: www.girlsinict.org on a regular basis to advertise programmes and events including scholarships, awards, internships and courses; and advertising the Girls in ICT Portal www.girlsinict.org in career guidance, ICT sector in Rwanda should adapt in an inclusive programmes that can accommodate also boys in order to make it a gender balanced.	MINEDUC, MINICT	Long Term

Note: PSF must be the coordination body in implementation process of these recommendations

ANNEX

Annex 1: Key ICT Sector Stakeholders

Although ICT is a crosscutting issue that touches every aspect of development, the key stakeholders listed below are the custodians of ICT sector skills development programmes embedded into their specific responsibilities.

Table 11: ICT Institutional Stakeholders framework

No	Stakeholder	Responsibilities
1	**MINICT**	For developing, coordinating, monitoring, evaluating and supports implementation of policies and strategies that aimed at economic and social transformation and a productive and patriotic generation. The ministry is also charged with integrating and disseminating ICT through policy
2	**RISA**	Implement national Information and Communication Technologies (ICT) policies and programs in order to fast-track socio-economic growth.
3	**RURA**	Grant licenses, monitor and enforce license obligations, manage scarce resources, advise policy makers on ICT related issues and represent Rwanda in international organizations on issues pertaining to ICT
4	**NCST**	Provides strategic advices and recommendations to the Government on all matters relating to policies, legislation and regulation in the fields of

No	Stakeholder	Responsibilities
		science, technology, research and innovation and monitor the implementation of such policies and legislation.
5	RDB	Addresses the needs of ICT companies of all sizes and both local and foreign investors
6	IPOSITA	Provides postal services, which will contribute to the social and economic development of Rwanda as well as to ensure continued universal service
7	Telecom Operators	Provide voice and data, and various value added (including financial) services
8	PSF ICT Chamber	Creating career paths through skills development, especially among the youth, stimulating entrepreneurship and competitiveness, Driving and protecting investments and innovation, promoting export of ICT products and services, Becoming the arbitrator of the ICT sector
9	Development Partners	Work with the GoR to achieve Socio-economic development of Rwanda, particularly using ICT and developing the ICT sector
10	Ministries	Formulate appropriate policies, strategies and provide the necessary legal framework for the development of ICT and its optimal use across all sectors
12	DISTRICTS	Implement and provide enhanced services to the citizens through ICT
13	Professional Certification Institutions	Provide professional education to ensure high level of qualification amongst ICT professionals.
14	Academic Institutions	Provide education at various different levels to create new generations of skilled personnel (ICT education provided from primary to Post Graduate level)
	Civil Societies	Implement various different ICT capacity building and advocacy initiatives to strengthen Rwandan human resources in the area of ICT

Source: ICT Sector Strategic Plan 2018-2024

Annex2: The Key Communications of the Report

✓ Considering both views from the employer and from the workers' perspectives, there is robust evidence of a skills gap in the ICT sector.

✓ Employers look for a mix of professional and technical job-specific and soft cognitive skills, but the current educated population does not acquire adequate amounts of these skills.

✓ To bridge skills gaps, it requires the involvement of finances, at the expense of workers and employers, and companies as well. Workers with lower skills earn less but produce

substandard work. This affects the sector's growth and, therefore, these skills gaps risk the future economic development of countries.

✓ Education systems are not equipping graduates with the skills needed to make a successful transition from school to work, and firms are not providing training to continue skills development throughout their career life.

The trail to effective skills development depends greatly on reforms that enable collaboration on a strategic dream for skills development, involving employers, educational institutions, companies, and all.

References

1. *http://techandlaw.net/drones-robotics/*
2. *https://droneops.co.za/do-training-rpl-initial/: "Remote Pilot Licence" (RPL) is the licence required for a person to operate as a qualified Remote Pilot Licence Holder under Part 101. Duration. 2 – 3 Weeks. Flight hours. 3 Hours. Simulated hours. Unlimited.*
3. *Fourth health sector strategic plan July 2018 – June 2024*
4. *Conceptualisation of e learning in nursing education in the context of Rwanda.*
5. *Global Policy: Digital Health in East Africa: Innovation, Experimentation and the Market*
6. *East African Community Digital Health and Interoperability Assessment: Rwanda.*

7. *National Institute of Statistics of Rwanda, EICV 2017.*
8. *IMF Working paper 2019:*
9. *IMF Working paper 2019*
10. *Promotion of Economy and Employment Programme, 2019-GIZ Smart Africa strategic vision: www.smartafrica.org*
11. *https://www.itu.int/en/Pages/default.aspx*
12. *Andela is an American company with operational campuses in Africa including Nigeria, Ghana & Kenya that identifies and develops software developers.*
13. *According to TVET enrolment figures from 2017, only 11% of all TVET students were studying ICT, which equates to 9,901 students. Yet, according to the Ministry of Education, only 327 students graduated with a certificate, diploma or advanced degree in ICT from polytechnics in 2016 – equivalent to 16 percent of the total graduating cohort.*
14. *Continental strategy technical and vocational education and training (VET) to foster youth employment*
15. *National Institute of Statistics of Rwanda, EICV 2017.*
16. *IMF Working paper 2019:*
17. *IMF Working paper 2019*
18. *Promotion of Economy and Employment Programme, 2019-GIZ*
19. *2018-2019, Education statistics.*