Assessing the needs of the research system in Rwanda

Report for the SRIA programme

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Executive Summary

This report provides a high-level assessment of Rwanda's research and innovation system and key research organisations. It seeks to identify the main challenges to research capacity strengthening and some priority areas for intervention in order to support decision-making at DFID and among Rwandan partners. The study does not seek to explore issues such as the historical causes of the current situation or the role of the media and other political actors which, albeit important, fall outside the scope of this investigation. Findings in this report are based on quantitative and qualitative data collected through desk-based research and informant interviews. Over 100 indicators are used to assess the country's research environment and political economy context, research production and research diffusion performance. Some of the qualitative findings are based on the views of a small but balanced number of stakeholders and should be verified through further research.

A. Needs Assessment for Rwanda

Political economy context. Following the civil war of 1994, Rwanda has had a stable government ever since. The country has a relatively good rule of law and low corruption compared to other Sub-Saharan African countries, but the government has placed strict limits on academic freedom that have a negative impact on research production. While the country has experienced rapid economic growth over the past 20 years, it is still amongst the poorest in Africa, with low literacy levels and an underdeveloped research system. In order to support economic development, the government has developed a comprehensive policy and institutional framework for science and technology. This framework is not specific to research but draws a direct connection between education, research and innovation policy. While the policy is ambitious, implementation has been slow: until recently, research and innovation policy were not supported by any dedicated government institution or funding mechanism. The establishment of the National Council for Science and Technology in 2017 and of a USD$ 30 million National Research and Innovation Fund (NRIF) in 2018 has filled significant gaps in the research system, but it is too early to assess their practical impact.

Research production. Research production in Rwanda has been limited by a lack of domestic funding and shortage of researchers in the country. In 2009, Rwanda had only 123 researchers or about 12 per million inhabitants, which is far lower than most other Sub-Saharan African countries. At the same time, national funding for research and development was only 0.4% of GDP in 2015 and no dedicated national funding stream for research existed until the establishment of NRIF in 2018. The country has only one research-intensive university and relatively few research institutes, and the quality and influence of their research remains unclear. Although in some universities staff are contractually obliged to spend time on research, this rarely happens in practice due to weak research culture and the lack of research support. The lack of adequate research and scholarly communication infrastructure is a major barrier to development and the government has signalled a desire to invest in digitisation.

Research diffusion. Consistent with a policy focused on innovation and technology adoption, Rwanda performs better in knowledge exchange than it does on research production. Rwanda's research has good international visibility facilitated by international collaborations (over 90% of publications in international journals were the result of international collaborations in 2018). The country also has a

solid knowledge exchange system, spurred by consistent demand for innovation from the government and business sectors. Knowledge management and transfer are supported by the National Industrial Research and Development Agency, but priority is given to the transfer and adoption of foreign technology into the country and most universities do not have a commercial office or a knowledge exchange strategy in place. Attempts to link social science research with public governance are overseen by the recently established Research Governance Board.

B. Options for research capacity strengthening

Although Rwanda's research system is still underdeveloped, considerable donor activity makes it difficult to identify priority areas for interventions. Nonetheless, three areas appear important:

- **Create career paths in research and innovation**. The consultation suggested that universities struggle to find qualified researchers in the country and that lack of funding makes research careers unattractive. As Rwanda is starting to invest in research and innovation, international donors could work with the Rwandan government to leverage these resources to create a better environment for researchers in the country. For instance, a government-sponsored knowledge transfer scheme would establish a direct connection between research organisations and the dynamic business sector. At the same time, initiatives to 'train-the-trainers' would create more capacity within universities to train researchers at a high level, addressing a significant capacity gap in Rwanda. The combination of training opportunities and career paths that straddle the lab and industry could make a career in research and innovation more appealing to young Rwandans while contributing directly to the government's economic ambitions.

- **Support South-South collaborations**. Rwanda's research organisations appear to have a higher degree of dependency on foreign aid than other Sub-Saharan African countries. Increasing the connection with other African research organisations would be important to support African-led research that responds to African priorities, share lessons between countries with similar socio-economic challenges and lessen Rwanda's dependency on development support. For instance, donors could identify opportunities for better integration with institutions and initiatives promoted by the East African Community, or increasing participation in international initiatives such as ACE II.

- **Help establish a research data infrastructure**. An area where limited financial resources could have measurable effects is research data infrastructure. Rwanda lacks repositories for research data and publications. A centralised repository could help research organisations better spread their knowledge, facilitate access to knowledge by the government and the private sector, and help research organisations establish collaborations with one another – both within Rwanda and with other African countries. This would tie in with the government's ambitious digital agenda, which has mobilised substantial investments in recent years.

Contents

Glossary

Organisations

ACFB	African Capacity Building Foundation
ARIPO	Africa Regional Intellectual Property Organization
CIIT	Centre for Innovation and Technology Transfer
ICTP-EAIFR	Abdus Salam International Centre for Theoretical Physics - East African Institute for Fundamental Research
IDRC	International Development Research Centre
IPAR	Institute of Policy Analysis and Research
ISAR	Rwanda Agricultural Research Institute
NCST	National Council for Science and Technology
NIRDA	National Industrial Research and Development Agency
RPF	Rwandan Patriotic Front
SIDA	Swedish International Development Cooperation Agency
UNDP	United Nations Development Programme

Other acronyms

CoE	Centre of Excellence
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
GERD	Gross domestic Expenditure in Research and Development
ICT	Information and communication technology
IoT	Internet of Things
KE	Knowledge exchange
LMIC	Low- medium income country
NGO	Non-governmental organisation
NRIF	National Research and Innovation Fund
NST1	National Policy on Science and Technology
PASET	Partnership for skills in Applied Sciences, Engineering and Technology
PCT	Patent Cooperation Treaty
PPP	Purchasing power parity
R&D	Research and development
RCS	Research capacity strengthening
SRIA	Strengthening Research Institutions in Africa
STEM	Science, Technology, Engineering and Mathematics
STI	Science, technology and innovation
TVET	Technical and Vocational Education and Training

1. Introduction

This report presents the results of an assessment of Rwanda's research needs and it is part of a broader needs assessment of the seven countries in the 'Strengthening Research Institutions in Africa' (SRIA) programme: Ethiopia, Ghana, Kenya, Nigeria, Rwanda, Tanzania and Uganda.

1.1. Structure of the report

The document is divided into two parts. The first part presents a political economy analysis of the country, building on DFID's guidance. Section 2 discusses the country's 'structures', or long-term contextual factors that have a direct or indirect effect on the research system. Section 3 looks at the legal and policy framework for research, while section 4 analyses relevant political economy dynamics within the country, specifically looking at relations between public sector bodies, research organisations and individual researchers. The second part of the document assesses research performance in the country. Section 5 explores research production by assessing research inputs, research culture and support, and research outputs. Section 6 assesses research diffusion by looking at actors and networks working on knowledge exchange (KE), and existing KE practices. The last part of the document focuses on the main bottlenecks or constraints affecting the research system and discusses opportunities to strengthen research capacity. It builds on the performance indicators explored in the previous section and considers the overall impact of each indicator on the research system. A full list of indicators and their relative score is contained in Appendix A.

1.2. Methodology

The evidence presented here has been obtained through desk research and informant interviews. Desk research gathered quantitative data from 15 sources (see Appendix E), while qualitative data was obtained from interviews with six informants, working for research organisations and international organisations based in Rwanda (see Appendix C). Interviews were conducted, recorded, transcribed and analysed using a consistent methodology. Qualitative findings reflect the perceptions of more than one stakeholder, and they have been compared, wherever possible, with available data from published sources. They informed the authors' views on the country performance on each of the indicators listed in Appendix A.

This report has been peer reviewed by the individuals listed in Appendix D and circulated with interviewees for comments and clarifications. Previous versions have been significantly improved in response to the constructive feedback provided by Dr Tom Drake and Dr Alba Smeriglio (DFID), as well as input from DFID staff located in relevant country offices.

1.3. Limitations

The study provides a high-level assessment of the strengths and weaknesses of the Rwandan research system and research organisations. It paints a broad picture of the current situation to inform understanding and action by DFID and others; it does not seek to explore issues such as the historical causes of the current situation or the role of the media and other political actors. Some of the qualitative findings are based on the views of a small but balanced number of stakeholders, many of whom did not feel able to share substantial evidence for this consultation. The analysis is further limited by the scarcity of up-to-date published data compared to the other countries included in this study.

2. Structures

This section provides an overview of the country's demography and of key political-economic parameters.

2.1. Social and political context

Rwanda is a presidential republic which has been led by Paul Kagame since The Rwandan Patriotic Army ended the genocide in 1994. Kagame was sworn in as Vice-President and Defence Minister in July 1994, then as Rwandan President in 2000. He won presidential elections in 2003 and again in 2010 and gained approval by referendum to stand for a third term in 2017 - which he won. The World Bank scores Rwanda more highly than other countries considered in this study in terms of government stability (48/100 where 1 is worst and 100 is best), and in line with Ghana (49/100). However, there are reports of systematic intimidation of voters and opposition candidates that significantly undermine the electoral process. With respect to the rule of law, Rwanda scores highly (59/100) and perceived corruption is relatively low compared to most Sub-Saharan countries. Rwanda ranks 48th out of 180 countries in the Corruption Perception Index 2018, performing significantly better than all other SRIA countries.

However, Rwanda places limitations on individual freedoms, which have a direct effect on research production and diffusion, with informants revealing that self-censorship is a significant problem in the country. The World Bank ranks Rwanda significantly lower in terms of voice and accountability (16/100), which reflects the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. Similarly, the charity Freedom House defines Rwanda as 'not free' and gives the country an aggregate score for political rights and civil liberties of 23/100 (with 0 being least free and 100 being most free). Rwanda has an especially low score for freedom of expression (3/16): the government enforces legal restrictions and informal controls on freedom of the press, while it also "restricts academic freedom by enforcing official views on the genocide and other sensitive topics. Scholars and students are subject to suspension for "divisionism" and "engage in self-censorship to avoid such penalties." Moreover, the 2019 Freedom House Report indicates that "space for free private discussion is limited

in part by indications that the government monitors personal communications." It is probable that this limited the insights gathered throughout the consultation process (see Section 1.3).

2.2. Economic context

Rwanda has a population of 12.3 million. According to the World Bank (2018), it has a GDP per capita of US$772, which is the second lowest after Uganda among the countries considered in this study. GDP per capita is approximately half the average for Sub-Saharan Africa and 30% less than the average for the least developed countries. According to current World Bank classifications[a], Rwanda is a low income country. About 55% of its population lives below the poverty line (calculated as US$1.90 a day). This is the highest percentage of the population living in poverty across the seven SRIA countries and significantly higher than the average poverty rate of low-income countries (43.4%). Rwanda has a human development index (HDI) of 0.524, much lower than the global average rating of 0.728 according to the UNDP (2018). However, post 1994, the national GDP has grown between 4 and 12% each year, with the economy growing over 8% in 2018.

The service sector, which includes tourism, retail and personal services, accounts for the majority of Rwandan GDP (46%) and agriculture provides a further 33% of national income, with 73% of the population living in rural areas. Just 16% of Rwandan GDP is generated through industry, of which manufacturing contributes one quarter of income (4%). Given its strong growth, Rwanda's economy ranks among the most competitive in Sub-Saharan Africa with a World Economic Forum (WEF) ranking of 58th out of 137 countries. A relatively good capacity to innovate compared to other African nations (score 4.3/7) is supporting economic growth, but according to the World Economic Forum, an inadequately educated workforce is one of the main barriers to business growth. Finally, the country has gone through a period of rapid digital development (see section 5.2) and the government aspires to produce 100 ICT companies valued at more than $50 million each by 2030.

3. Institutions

This section looks at the strength of the national policy framework. Specifically, it considers whether the country has a national research policy or strategy and whether it was updated in the last 10 years. It also looks at the existence of an innovation strategy and of national mechanisms for research quality evaluation.

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[a] Low income countries = $995 or less; Lower-middle income countries = $995 - $3,895; Upper-middle income countries = $3,896 - $12,055; high-income countries = $12,056 or more. In addition, the World Bank identifies further groupings based on their average GDP per capita, which are useful reference points for this analysis: Low income = average $787; Least developed countries = average $1,072; Lower middle countries = average $2,209; Middle income = average $5,282; Upper middle = average $8,610; OECD countries = average GDP $45,721; High income = average $47,892.

3.1.   National policy for research

Rwanda's national policy for research is set out in four key documents. First, in 2000 Rwanda published Vision 2020, a 20-year national development strategy which highlights six priority areas for economic development. The document describes science and technology as a cross-cutting issue that underpins the national development framework and highlights the need to "generate, disseminate and acquire scientific skills as well as technological innovations, in addition to integrating them into the social and economic development drive". In order to "have adequate, highly skilled scientists and technicians to satisfy the needs of the national economy", the document sets out to promote science and technology education, to facilitate the creation of high and intermediate technology enterprises and to develop access to ICT. In recent years, the government has stepped up investment in science and technology (see section 5.1).

In 2003, the Education Sector Policy set out to strengthen scientific and technological research in research centres and universities by advocating the establishment of a national body for technological research, the promotion of research and technical training, the mobilization of resources for scientific and technological research and the provision of research equipment. Two years later, the government made progress on these ambitions by releasing the National Policy on Science, Technology and Innovation. The STI Policy identified four objectives: knowledge acquisition (improving education and training in S&T), knowledge creation (improving research capability), knowledge transfer (linking research with social and economic needs) and the creation of a culture of innovation. The policy allowed for the establishment of an institutional framework for research production, comprising a National Commission of Science and Technology and a National Research Funder. It also advocated the establishment of institutions for research diffusion such as Technology Consultation Centers, Demonstration Units and Science and Technology Parks. Furthermore, the document set out 12 strategies for major sectors of the economy (including education, health, agriculture, environment, energy, transport, industry, ICT and tourism).

The recently released National Strategy for Transformation for 2017-2024 (NST1) outlines plans to develop a competitive knowledge-based economy. In particular, it stresses the need to increase the rate of adoption and integration of scientific technology across the country – although it contains little detail of how this can be addressed in practice.

In order to rebuild a cohesive social structure, the Rwandan Government has set out to promote research in public governance, community governance and cultural issues. The law N°56/2016 of 16/12/2016 established the Rwanda Governance Board (RGB) to promote so-called 'home grown solutions' and 'good practices' in governance policy and research. RGB has developed a set of Governance and Home Grown Initiatives (GHI) which translates culturally-owned practices into research programmes aimed at fostering accountability in governance, democracy and decentralisation for sustainable development.

Rwanda has developed a comprehensive policy framework for research over the past two decades. The documents show a good understanding of the importance of investing in research (and especially science and technology) to modernise the economy and address the country's many social and environmental challenges. Considerable emphasis is placed on research capacity building and the

establishment of a science culture starting from school, therefore creating significant overlaps between education and research policy. Both the consultation and the desk reviews revealed that many of these policy documents have been written by foreign consultants using donor money, but nonetheless they appear to have been embraced and supported by the government.

3.2.   National research institutions

Rwanda's Policy on Science, Technology and Innovation (2005) proposed a governance structure for S&T, which has only rolled out over the past few years. The framework comprises the following institutions:

- **Higher Education Council (HEC):** HEC is overseen by the Ministry of Education and is mandated to provide quality assurance in the provision of higher education. The Council is also responsible for enhancing human resource capital, ensuring research in higher education institutions is aligned to national socio-economic needs, and managing the funding and running of universities in Rwanda.

- **Ministry of Education (MoE):** MoE sets policy, norms and standards for the education sector in Rwanda and is also responsible for the monitoring and evaluation of research in the country. The MoE aims to strengthen human capital, support Rwanda's socio-economic development and encourage the promotion of science and technology. MoE oversees a number of agencies including the Higher Education Council and the Rwanda Education Board.

- **National Council for Science and Technology (NCST):** NCST was established in 2017 to integrate science, technology, innovation and research into national development strategies and plans. NCST advises the government on policies, legislation and regulation in the fields of science, technology, research and innovation; monitors the implementation of such policies and legislation; advise the government on setting national priorities; regulates science, technology innovation and research and grants research permits; manages the National Research and Innovation Fund.

- **National Research and Innovation Fund (NRIF):** in 2018, Rwanda launched a USD$30 million NRIF thanks to a loan from the African Development Bank. NRIF has moved away from the original mandate of supporting and disseminating research and now focuses more heavily on providing equity financing for tech-enabled SMEs, training tech-oriented entrepreneurs, and increase awareness of intellectual property rights. The fund also seeks to stimulate competition between research organisations and encourage research that is aligned to the national development strategy.

- **Sectoral Science and Technology Committees:** listed in the national STI Policy as bodies responsible for the coordination of S&T issues within their respective ministries (also see here). It is unclear how developed their implementation has been since the publication of this research policy.

On top of these institutions, law N°56/2016 of 16/12/2016 established the Rwanda Governance Board (RGB), which has become the country's centre of excellence in governance policy and research:

- **Rwanda Governance Board (RGB)** promotes the principles of good governance and decentralisation, conducts research and policy analysis related to governance, monitors the practices of good governance, coordinates and supports media sector development, registers political organisations, provides policy advocacy to Government, and enhances citizen participation in the implementation of various governance initiatives.

Rwanda's institutional framework for research is coordinated at the national level and benefits from a strong central government and a relatively effective civil service. Since the publication of the STI Policy in 2005, however, the government seemed to have prioritised measures to spur the adoption of technology and innovation over research production. Rwanda's institutional framework reflects this business-oriented approach, with a refocusing of research funding to more private sector-led research and development projects. The consultation suggested that the government undertakes monitoring and evaluation of STI and education funding across universities through digital reporting software.

## 4. Agents

4.1.   Stakeholder mapping

Key research policymakers in Rwanda are government ministries. The Ministry of Education leads on the development of policy formulation in science and technology, while the Ministry of Health defines the policy, sets the standards, monitors and regulates activity in health research. STI Policy implementation is the responsibility of the National Council for Science and Technology (NCST), under the authority of the Ministry of Education. The Council also manages applications for research permits and outlines the terms and conditions of research in Rwanda. The HEC determines the categories of activity to be prioritised in S&T research, based on national priorities, and distributes funds for research accordingly.

The Ministry of Education also contributes directly to research through university funding. University funding is managed by the Higher Education Council which is overseen by MoE. There are 31 higher education institutions in Rwanda, of which 27 are universities. Of Rwanda's 27 universities, the majority are private (26 institutions) and only one is public (the University of Rwanda). Moreover, there are two government-funded research institutes in Rwanda: the National Institute of Scientific Research and the Rwanda Agricultural Research Institute (ISAR). To operationalise the STI Policy, NCST has also established Centres of Excellence (CoE) with specialized and complementary mandates but with a common mandate to promote socio-economic transformation through innovation. Finally, the National Industrial Research and Development Agency (NIRDA) is a government institution focusing on improving the competitiveness of Rwandan industries through encouraging private sector investment in applied sciences technologies.

![Research Consulting]

Assessing the needs of the research system in Rwanda. Report for the SRIA programme.

![HEART - HIGH-QUALITY TECHNICAL ASSISTANCE FOR RESULTS]

4.2.   Relations and interdependencies

As the only national policymakers and funder for science and technology, the Ministry of Education and NCST play a central role in Rwanda's research system. They are tasked with coordinating research activities across sectors, but in practice sectoral Ministries appear to have substantial autonomy over the research they support. One key trait of Rwanda's research system is that it has poorly defined boundaries between research, education and innovation. Neither the policy documents nor the funding mechanism seem to draw a clear distinction between research conducted by universities and that conducted by the private sector, or between research capacity strengthening and science education. This flexibility may well be appropriate to a country with limited funding capacity and still considerable research and development needs but may also cause some confusion for research organisations setting their priorities and developing their strategies.

Figure 1. Stakeholder relationships in Rwanda's research system
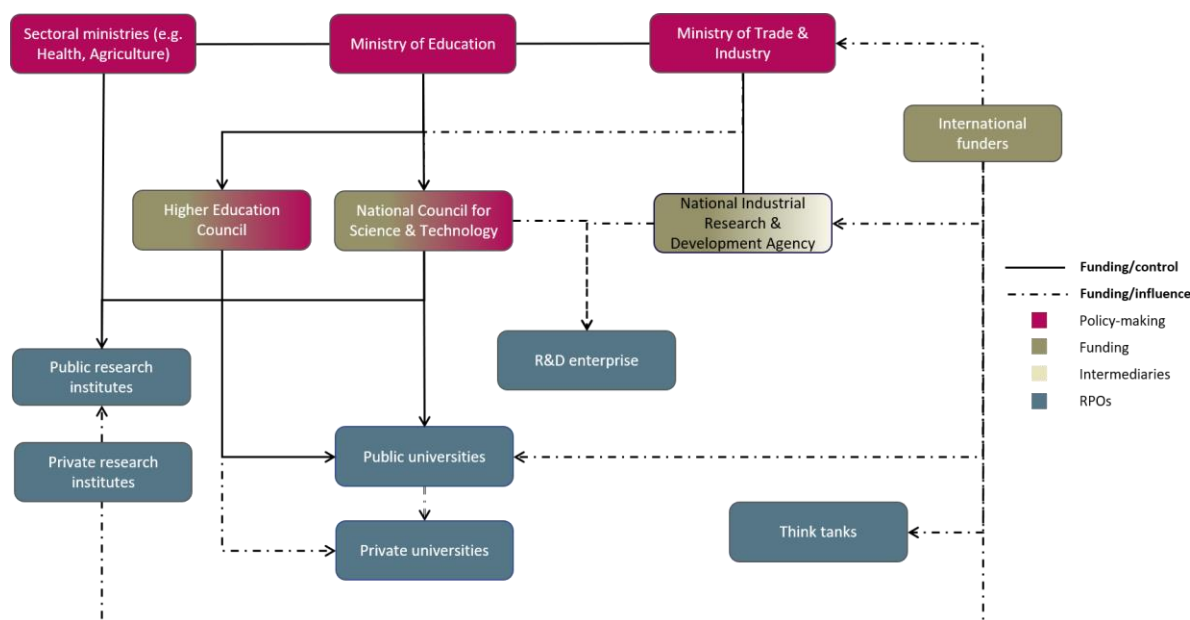
A review of existing research initiatives in Rwanda suggests that most research organisations and national research institutions receive significant funding from international donors, although no comprehensive data on international research expenditure was available at the moment of writing. While foreign support has been instrumental in developing Rwanda's research system, more significant national investment would be required for research capacity activity to be self-sustained. International research funders distribute funds at all levels of the research system including direct grants to Rwandan Ministries, support for Rwandan universities and funding for individual research institutes and think tanks.

The institutional set up could be clearer with regards to the role of the Ministry of Trade and Finance in funding NRIF, cross-Ministerial collaboration with the Ministry of Education, and the role of sectoral Ministries in funding research. More clarity is needed with regards to the eligibility for research and development funding. Additionally, there is a lack of clarity around which research and intermediary

![UK aid from the British people]

organisations are still up and running or whether organisations envisaged in policy documents were set up in the place.

5. Research production

This section discusses the factors necessary for research production within a national system. It considers three components of a research system:

- Research inputs, or the tangible assets that are directly connected with research production: human resources, financial resources and infrastructure.
- Research culture and support, or the enabling environment for research.
- Research outputs, including the products of research and the incentives for producing research.

5.1.   Research inputs

A.   Human capital

A significant barrier to research in Rwanda is the scarcity of human capital. The Education Sector Policy in 2003 stated that "research in higher learning institutions has not been adequately funded, nor equipped and staffed by qualified personnel. Research has generally been uncoordinated and not harmonised." There is a shortage in the supply of trained science and technology teachers, although the Kigali Institute of Education is in the process of training secondary-level science teachers. Since then, things have not improved much. UNESCO data indicates that in 2009 there were only 123 full time researchers in the country, or about 12 per million of the population. This is the lowest proportion of researchers across the seven SRIA countries and significantly below the African average (95) and the average for other low-income countries (63). However, UNESCO's suggestion that 100% of researchers in Rwanda were employed in higher education in 2009 raises questions about the measurement – and specifically whether staff employed in the government, business and non-profit sectors were considered researchers in the original estimate used by UNESCO. Compared to the other nations considered in this study, Rwanda has a higher number of female researchers, but still disappointingly low at 34%.

In 2009, the number of researchers with a PhD or equivalent qualification was reported at 38% according to UNESCO, compared to only one researcher with a PhD qualification in 2003. Although this is the highest percentage of researchers educated to this level across all other countries considered in this study, the small number of researchers included in the sample brings the data into question. The limited talent pool in Rwanda makes it difficult for research institutions to recruit and retain good researchers, and the consultation highlighted that the lack of researchers in the country is exacerbated by significant brain drain. Moreover, there is a discrepancy between the disciplines studied by Rwandans and the economic needs of the country, as defined by the government. According to the Future Drivers of Growth in Rwanda Report published by the World Bank, just 6% of university students in Rwanda are enrolled in engineering, manufacturing, and construction, and only

9% are studying sciences. If Rwanda intends to grow its manufacturing and technology sectors, then the number of students in sciences and engineering clearly also needs to grow.

B.   Research funding

Research in Rwanda has been primarily driven by external funding and the funding trend in recent years has been towards a reduction in government spending. For example, the Institute of Policy Analysis and Research (IPAR) – a flagship independent think tank in Rwanda – relies exclusively on international financial support.[b] However, the creation of a National Research and Innovation Fund (NRIF) in 2018 has changed this trend. NRIF has been funded with USD$ 30 million through a loan from the African Development Bank. Although the sum is significant for a country the size of Rwanda,[c] it is not clear when the fund will be replenished. Moreover, NRIF will fund a wide range of activities, including: research training and capacity strengthening activities, research production and publication, and the production and commercialization of innovation in SMEs. The Higher Education Council provides some funding for universities but this is distributed via a competitive research funding call, i.e. there are is no default funding made available to higher education institutions.

No data on Gross domestic Expenditure in Research and Development (GERD) is available for Rwanda from UNESCO sources, however a 2015 study estimated national funding for research and innovation at approximately 0.4% of GDP (UNESCO 2015).

C.   Research organisations

The network of research and educational organisations operating in Rwanda is in rapid development but overall it remains underdeveloped. There are still few research organisations in the country and little investment in the sector at a national level. The consultation identified four research institutes in operation in Rwanda: the East African Institute for Fundamental Research (ICTP-EAIFR), the Rwanda Agricultural Research Institute (ISAR), the National Industrial Research and Development Agency (NIRDA) and the Rwanda School of Public Health which is part of the University of Rwanda. Each of these research institutes rely on international support for research funding. On top of that, various Centers of Excellence (CoEs) are being set up in the country, in the areas of biodiversity and natural resources management, climate change, ICT, biomedical engineering, health, physics and mathematics. Furthermore, the World Bank ACE II initiative is supporting the establishment of CoEs specialized in research on the internet of things (IoT), data science, renewable energy and mathematics education.

Key actors in the Rwandan research system are universities. The University of Rwanda for example oversees a number of research units including the College of Science and Technology, the Kigali Institute of Science and Technology and the Kigali Institute of Education. However, the quality of scientific research institutions in Rwanda is low. The World Economic Forum gives Rwanda a score of

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[b] IPAR was established in 2008 and received funding from the African Capacity Building Foundation (ACBF) between 2011-13. The think tank is now funded internationally from the International Development Research Centre (IDRC) in Canada but soon even this funding will come to an end. Despite being a major resource for evidence-based policy development, the IPAR is struggling to remain solvent.
[c] To put this in context, NRIF manages 3 times the public research budget available each year in Nigeria, a country whose population is 17 times Rwanda's

3.8/7 for the quality of its research organisations, ranking the country 68th out of 137 countries worldwide. Just one of Rwanda's universities appears in Scimago's institutional rankings. The University of Rwanda ranks 733rd out of 3471 ranked higher education institutions.

5.2.   Research culture and support services

A.   Research culture

The University of Rwanda is the country's only higher education institution with research capacity, while the wider sector does not have the resources, reputation or recognition to undertake meaningful research. As the country's only research-intensive university, the University's Senate approved an academic framework which stipulates time allocations for staff: 40% research, 20% supervision, 25% teaching and 15% community engagement (i.e. reviewing manuscripts, attending conferences, etc.). All academic staff are salaried and the University considers publication for promotions. There is some internal funding available for conference attendance, and the University of Rwanda is developing a reward system which will link publication and citation to financial returns for principal investigators' research accounts but there is no internal budget currently available to implement the system. The University is tackling the increase and influence of so-called predatory journals by not rewarding PIs who publish in these journals, i.e. they are passed up for promotion and/or publication is not counted towards their academic record.

In the wider environment, however, research culture appears very limited. Private universities appear to prioritise their vocational function over their research function, and informant interviews stressed that they struggle to recruit enough PhDs. Both the Education and the S&T policies highlight that the lack of a research culture starts from inadequate science education. According to the World Bank, Rwanda lags behind almost other countries of a similar income in terms of access to and quality of education. Very few people in the country complete secondary and tertiary education, considerably restricting the talent pool for research. Many researchers that acquire a PhD qualification choose to take their skills elsewhere due to the lack of research funding and infrastructure available at home. The consultation highlighted the need to ensure that researchers are trained and are incentivised to continue researching in the country. It also suggested that significant investment will be required to build research capacity and create the conditions for the development of a national research culture.

B.   Capacity building

The consultation found that a significant barrier to developing Rwandan research capacity is a deficiency in human capital (section 5.1 A). Several international initiatives aim to address this issue while little seems to be in place nationally to strengthen research capacity. In 2013, the Partnership for skills in Applied Sciences, Engineering and Technology (PASET) was launched by the World Bank. PASET aimed to develop a critical mass of researchers through professional skills development focused in applied science engineering and technology. Since its formation, PASET has been led by five African governments (Rwanda, Senegal, Ethiopia, Kenya and Tanzania) and focuses on building skills in STEM areas from upper secondary and TVET level to doctoral and postgraduate research.

The Swedish International Development Cooperation Agency (SIDA) also contributes to capacity building programmes in Rwanda. Specifically, SIDA are engaged in a long-term collaboration with the

University of Rwanda designed to support the development of the research environment. SIDA works in Rwanda primarily in the areas concerning: master's and doctoral programmes in collaboration with Swedish universities and colleges, administrative reform of the University of Rwanda, infrastructure investments in areas such as IT, libraries, laboratories and incubators. The consultation indicated that the collaboration was successful in building research capacity at the University of Rwanda.

C.   Research support and administration

Research support and administration across Rwanda's research organisations appears to be very limited. The NCST provides training workshops for grant writing but these are limited in terms of reach and only provided when external resources or government underspend elsewhere is available. The University of Rwanda has a formal research management and administration (RMA) function, comprising 5 central staff, 1 member of staff in each of the 6 colleges and 4 project managers who service all colleges. In addition, there are 12 research and innovation officers, 2 in each college, whose focus is on supporting commercialisation. Since establishing the RMA function in 2014 outputs have increased, from 30 publications in 2013 to 300+ in 2018; and from 100+ citations in 2013 to 1,900+ in 2018. The consultation also indicated that the RMA function has helped achieve a notable increase in grant income, although this could not be quantified. The establishment of RMA capacity at the University of Rwanda was supported by the UR-Sweden Program funded by the Swedish International Development Agency which provided research management support to the University of Rwanda over an 18 year period through a collaboration with a group of Swedish institutions.

D.   Digital infrastructure and data

According to the World Bank, the Rwandan Government is making positive plans to improve the country's digital infrastructure. The ICT Sector Strategic Plan 2018-2024 has confirmed the government's intention to focus on ICT to drive economic development. It is unclear to what extent these ambitious policy objectives have been already realized and, by extension, to what extent Rwanda's digital infrastructure would be capable of supporting data intensive research at present. On the one hand, the ICT Sector Strategic Plan showed that the country has made significant advances in the information communication technology (ICT) sector. Internet penetration has gone from under 10% in 2011 to 40% in 2017 thanks to large investments in the broadband network. On the other hand, the Global Competitiveness Index estimates that only 20% of the population have access to internet and that the speed of connection is limited to 7.5 kilobytes per second. Nevertheless, progress in this sector has been notable and the government commitment to invest in ICT appears genuine.

Building on this growing infrastructure, Rwanda's National Data Revolution Policy of 2017 details the country's aims to establish standards and principles for data management, human resource capacity, and a framework for data creation, release, and analysis. The Policy recognises that "researchers need quality data for their analysis in order to produce quality findings" and that "opening data and derived insights will give an opportunity to academia and other research groups to easily access data that is stored within institutions". However, the policy does not detail any specific measure to build a research data infrastructure or build capacity. Moreover, no national data repository for research appears to have been created yet and most universities do not have institutional data repositories.

5.3.   Research output and evaluation

A.   Research publications

According to Scimago, Rwanda produced 490 publications in 2018, which account for 0.64% of the total research outputs for Africa in 2018. Although Rwanda's contribution is less than a quarter of the total contribution to African research made by the second lowest ranking of the seven SRIA countries (Tanzania 2.22%), when accounting for population size Rwanda's research productivity is in line with other SRIA countries. The number of publications from Rwandan researchers is 39 per million people, which is higher than Ethiopia and Tanzania (33 per million), and just below Uganda (44 per million) and Nigeria (48 per million). In 2018, 38.78% of Rwanda's publications were open access and only one journal was listed in Scimago.

The quality of Rwanda's scientific publications, measured by the number of citations, is above average. In terms of citation per publication, Rwanda ranks 98th out of 239 countries and averages 14.29 citations per publication. This places the country ahead of Ghana (11.8 citations) and Ethiopia (10.96 citations). The high number of citation is likely correlated to the high proportion of research collaborations: according to Scimago, over 90% of Rwanda's research outputs were a result of international collaborations in 2018, consistent with the high level of international research funding in the country. Rwanda has a h-index (an index that measures both the productivity and the citation impact of scientific publications combined) of 78 and is ranked 136th out of 239 countries.

B.   Research evaluation & ethics

Rwanda has a National Ethics Committee, which was established in 2008 and focuses on the protection of human subjects in research. The committee examine all research projects that involve human participants and approve or reject research projects based on their evaluations. The consultation did not provide additional evidence about the work of the Committee or its activity in the Rwandan research system. Moreover, the National Institute of Statistics of Rwanda (NISR), the Rwanda Governance Board (RGB) and the ethics committee at the Ministry of Health have the mandate of ensuring ethics in research in their respective domains.

Monitoring of performance across all public sectors is extensive with a requirement on institutions to report to Government on a quarterly basis using an online system, and all management staff are required to submit information and contribute to the university's report. Some form of research evaluation takes place in distinct disciplines: the Rwanda Governance Board evaluates and accredits research and innovation in public governance while the National Institute of Statistics of Rwanda (NISR) national statistical data. However, no systematic research evaluation appears to be undertaken for research in other disciplines.

6. Research diffusion

This section focuses on the stakeholders and practices underpinning the diffusion of scientific research in the country.

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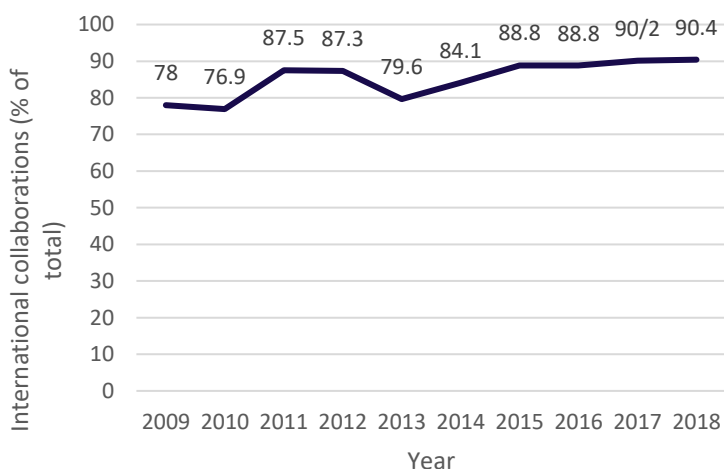## 6.1. Actors and networks

A. National users of research

Rwanda has a dynamic private sector that is open to innovation and able to absorb technology at firm level. According to data from the World Economic Forum (WEF), Rwanda's firms have both good access to the latest technologies and a good ability to adopt latest technologies (only Kenya and South Africa perform better in Sub-Saharan Africa). However, it is unclear how much innovation comes from research and innovation products generated within the country. In fact, WEF data shows that Rwanda benefits from a large amount of foreign direct investments and technology transfer, second only to Kenya in Africa. This confirms the country's openness to international stakeholders and the active role played by overseas development agencies in the country since 1994. It also ties in with a national development strategy that appears to value the adoption of existing technology at least as much as the production of innovation.

Rwanda's government plays a larger role in technology development than any other country in Africa. The government has shown a high propensity to procure technology products, which in turn have a positive effect on innovation. The funding objective of the newly established National Research and Innovation Fund and the establishment of organisations such as the College of Science and Technology, the Centre for Innovation and Technology Transfer (CITT) and the Institute for Scientific Research and Technology (IRST) are examples of the way the government actively promotes the adoption of foreign technologies. The consultation indicated that government agencies have limited capacity to identify appropriate technologies, modify them for use in Rwanda, and get them into the hands of entrepreneurs; at the same time, stakeholders stressed that the government views this as being the role of the private sector.

B. International exposure

Rwanda's international exposure is measured by considering the percentage of papers in the 10% most-cited papers in a field of research, and by looking at the number of international collaborations. According to UNESCO, 9% of Rwanda's papers are among the 10% most-cited in a discipline or field. In 2018 however, over 90% of Rwandan publications came from international collaborations. This figure is extremely high and has remained so for the last decade. This is unsurprising as international research funders play a critical role in the Rwandan research system. In terms of international collaborations, Rwanda's top research partners are based in the USA, Belgium,

Figure 2. International collaborations in scientific publications (% of total)

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Netherlands, Kenya and the UK. Between 2008 and 2014, Rwanda published 83 papers in collaboration with Kenyan research institutions.

6.2.   *Knowledge exchange practices*

A.   *Intellectual property*

Rwanda's Intellectual Property Policy was published by the Ministry of Trade and Industry in 2009. The Policy has two objectives, first to contribute to the promotion of technological innovation and to the transfer and dissemination of technology, and second to create a fair and equitable commercial environment through increased regulation.

Figure 3. Number of patents filed in Rwanda.

Rwanda is a member of the Africa Regional Intellectual Property Organization (ARIPO) however there is no evidence of Rwanda's own national body for intellectual property. Between 2012 and 2017, Rwandan residents filed 55 patent applications. During this same period, 14 of these applications were granted. Filing for patents in Rwanda is a relatively recent phenomenon, with WIPO data showing no patents filed nationally before 2012. Relative to other nations, Rwanda performs poorly in this area. Rwanda ranks 20th out of 21 Sub-Saharan countries and 118th out of 119 worldwide in terms of the number of applications filed per million population under the Patent Cooperation Treaty (PCT) according to the World Economic Forum.
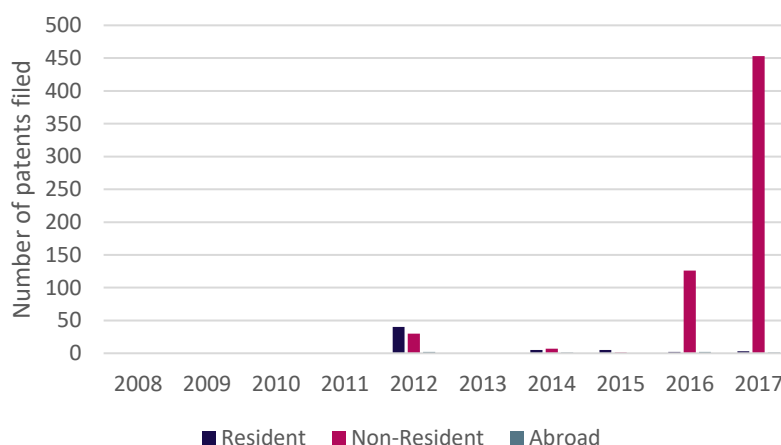
B.   *Knowledge exchange support and administration*

Knowledge exchange is central to Rwanda's approach to research and innovation. The STI Policy indicates a desire to establish "links between research and technological development and the many and varied needs of industry, economy and community including technological hubs to ensure widespread access to the latest technology". Centers of Excellence and research institutes are expected to carry out knowledge exchange activities, but the consultation did not reveal evidence on the level of support provided to researchers at organizational level. At government level, knowledge management and technology transfer are two key functions of the National Industrial Research and Development Agency (NIRDA). NIRDA monitors relevant technologies and expertise nationally, regionally and internationally; provides firms with reliable data and expertise relevant to technology, market and scientific information; and helps enterprises improve their competitiveness through the acquisition and commercialization of appropriate technologies. The only active programme managed by NIRDA is a bilateral technology transfer collaboration with the Indian government. NIRDA is also

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working to establish a Cleaner Production and Climate Innovation Center, which aims to promote access to green technologies and business services. In either case, it is unclear what importance is placed on the transfer of knowledge generated by Rwandan research organisations.

7. Needs assessment

This section summarises the overall score of each component of the research system using a 7-point scale (see Appendix A). Research system component scores are calculated as an average of all indicator scores within it (see Table 4). All research system components are assigned a component ID (see Table 1). The aim of this exercise is to show which components are most deficient. However, there is no exact equivalence between a low score for one component and identification of needs since different components have a different impact on the system. Section 8 discusses other considerations that influence the choice of priorities for action, such as the feasibility of interventions.

Rwanda has experienced rapid and sustained economic growth since 1994. Three factors appear to have played an important role in this recovery. First, Rwanda has had a stable government since the 1990s, with a relatively strong rule of law and low corruption. Second, the country has benefited from considerable overseas development assistance, including both funding and technical assistance. Third, the country has successfully invested in the development of a dynamic private sector to drive growth. At the same time, however, limits to civil and political rights and restrictions to academic freedom have created a difficult socio-political context for research (RSC1, 2.9/7). Moreover, the country's economic context (RSC2) remains an area for improvement scoring just 2.7/7: despite the rapid growth, Rwanda is one of the poorest countries in the world, with over half the population under the poverty line and low levels of literacy. In this context, the development of Rwanda's research system has slowed.

Over the past two decades, Rwanda has developed a fairly comprehensive policy framework for research (RSC3, 3.7/7). Despite the lack of a dedicated research policy, Rwanda has a fairly well-developed STI policy and five-year plans that propose measures consistent with the overarching development vision. Many of these policies have been developed with considerable support from international donors. With a score of 4.2/7, the institutional framework is well developed, with the recent launch of the NRIF plugging a major gap in national funding (RSC4). However, the mandate of national institutions remains unclear as they appear to provide support across a broad ecosystem of startups, business enterprise, universities and other R&D organisations. Moreover, there is a lack of clarity regarding cross-Ministerial competencies and coordination mechanisms, while some of the organisations envisaged in policy have either not been established or have been shut down. Overall, the role, competencies and relationships between research stakeholders remain unclear (RSC5, 3.2/7).

Perhaps unsurprisingly, the biggest gaps in Rwanda's research system over the past two decades have been the lack of national research funding (RSC7, 1/7) and the lack of researchers (RSC6, 1.8/7). Until recently, Rwanda did not appear to have any funding dedicated to research but the recent creation of the NRIF is going in the right direction. Rwanda has also the lowest proportion of researchers in the continent and research organisations have serious problem recruiting qualified staff in the country.

Rwanda also has few research organisations (RSC8, 2.5/7). The University of Rwanda is the only research-intensive HEI in the country and although several research institutes and centres of excellence have been established recently with international funding, it is unclear whether these centres will remain in place when international funding dries up. Rwanda's research productivity (RSC13) is low, scoring 2.8/7, but in line with other SRIA countries. However, the quality and international visibility of the research is very high with an average score of 5/7 (RSC16). This is due to the high proportion of international research collaborations (91% of the total publication output), but in some areas of research it could also be linked to research quality monitoring from government institutions (RSC14, 2.9/7).

Finally, Rwanda performs well with regards to knowledge exchange (RSC15), as business and government are moderately active users of technology products scoring 5/7. Although these appear to be innovations coming from abroad, propensity to embrace innovation creates potential demand for research products developed within the country. This ties in well with national priorities around knowledge transfer and technology adoption set out in Rwanda's STI and development policies.

Table 1. Scoring of research system components

Section	Research system component	Score	Component ID
National context	Social and political context	2.9	RSC1
	Economic context	2.7	RSC2
	Total	**2.8**	**-**
Policy and institutional framework	National policy for research	3.7	RSC3
	National institutions for research	4.2	RSC4
	Stakeholder composition & relationships	3.2	RSC5
	Total	**3.7**	**-**
Research inputs	Human capital	1.8	RSC6
	Research funding	1.0	RSC7
	Research organisations	2.5	RSC8
	Total	**1.8**	**-**
Research culture and support	Research culture	2.0	RSC9
	Capacity building	2.5	RSC10
	Research support	2.0	RSC11
	Infrastructure and data	2.0	RSC12
	Total	**2.1**	**-**
Research outputs and evaluation	Research publications	2.8	RSC13
	Research evaluation	3.0	RSC14
	Total	**2.9**	**-**
Knowledge exchange (KE) actors and networks	National users of research	5.0	RSC15
	International exposure	5.0	RSC16
	Total	**5.0**	**-**
KE practices	Intellectual property	4.3	RSC17
	KE support and administration	5.0	RSC18
	Total	**4.7**	**-**

8. Recommendations

8.1. Identification of priorities

This section identifies options for research capacity strengthening in Rwanda by looking at the worst-performing indicators and considering their overall impact on the research system and their tractability, or the feasibility of external interventions in that area. Identifying priorities for action in Rwanda is made difficult by the fact that the country's research system as a whole appears underdeveloped, while many initiatives currently exist which are funded by international donors. Nevertheless, it is possible to identify three areas of focus:

- **Create career paths in research and innovation**. The consultation suggested that universities struggle to find qualified researchers in the country and that lack of funding makes research careers unattractive. As Rwanda is starting to invest in research and innovation, international donors could work with the Rwandan government to leverage these resources to create a better environment for researchers in the country. For instance, a government-sponsored knowledge transfer scheme would establish a direct connection between research organisations and the dynamic business sector. At the same time, initiatives to 'train-the-trainers' would create more capacity within universities to train researchers at a high level, addressing a significant capacity gap in Rwanda. The combination of training opportunities and career paths that straddle the lab and industry could make a career in research and innovation more appealing to young Rwandans while contributing directly to the government's economic ambitions.

- **Support South-South collaborations**. Rwanda's research organisations appear to have a higher degree of dependency on foreign aid than other Sub-Saharan African countries. Increasing the connection with other African research organisations would be important to support African-led research that responds to African priorities, share lessons between countries with similar socio-economic challenges and lessen Rwanda's dependency on development support. For instance, donors could identify opportunities for better integration with institutions and initiatives promoted by the East African Community, or increasing participation in international initiatives such as ACE II.

- **Help establish a research data infrastructure**. An area where limited financial resources could have measurable effects is research data infrastructure. Rwanda lacks repositories for research data and publications. A centralised repository could help research organisations better spread their knowledge, facilitate access to knowledge by the government and the private sector, and help research organisations establish collaborations with one another – both within Rwanda and with other African countries. This would tie in with the government's ambitious digital agenda, which has mobilised substantial investments in recent years.

8.2. Conclusions

The case of Rwanda provides a good example of a dilemma that international research funders have grappled with for decades: how important is it to support research in a socio-economic context where

short-term poverty alleviation and education goals have priority. In this sense, Rwanda demonstrates that international interventions can help a country recover from the devastation of a civil war, economically, politically and institutionally. However, it is also clear that Rwanda has drawn a clear connection between innovation and economic development and that the separation of the research, education and innovation agendas is neither feasible nor advisable.

Whereas in a more developed economy research funding and policy objectives ought to be distinguished from issues such as firms' technology adoption or start-up funding, the same does not apply in a country with limited financial and human resources. Promoting an inclusive science, technology and innovation agenda that transcends traditional policy boundaries appears to be the best institutional set up for Rwanda. The challenge would be to gradually shift the mindset from adopting foreign technology to developing national innovation, and to create a culture of innovation within both the government and leading organisations.

Appendix A – Full list of indicators and scores

Table 2. How to read the scales

	1	2	3	4	5	6	7
Qualitative indicators	Very poor	Poor	Somewhat poor	Neither poor not good	Somewhat good	Good	Very good
Quantitative indicators	Very low	Low	Below average	Average	Above average	High	Very high

Table 3. Score conversion table

Data type	Description	Score conversion
GDP	We used the World Bank classification: Low income = average $787; Least developed countries = average $1,072; Lower middle countries = average $2,209; Middle income = average $5,282; Upper middle = average $8,610; OECD countries = average GDP $38,283; High income = average $47,892	Low income = 1, least developed = 2, lower middle income = 3, middle income = 4, upper middle = 5, OECD average = 6, upper income = 7
Absolute country rank	Country ranks are converted to scores by dividing the total number of countries ranked in seven groups of equal size and then positioning the country in one of the seven groups.	Variable based on number of ranked countries
Country scores (1-7)	A number of indicators have already been scored on a 1-7 scale. Decimal numbers will be rounded up or down to their closer whole number.	Maintained (rounded)
Country score (1-16)	Freedom House (FH) scores freedom of expression and belief from 1 to 16. We convert the score to 7 but we consider performance of the sub-rating "academic freedom" when rounding up the overall score for freedom of expression.	FH score 1-2 = SRIA score 1; 3-5 =2; 6-7 =4; 8 =5; 9-10 =6; 11-16 =7
Percentile score / percentile rank (1-100)	This scale uses a 1-100 score, generally with 0 indicating the lowest score and 100 the highest (in a few cases, 0 is the best score and 100 the worst). Scores are divided in 7 groups, and the score is given depending on what group a country falls under. Note that percentile score is expressed differently from the percentage value (%) which indicates quantity.	Original score 1-14 = Needs Assessment score 1; 15-28 = 2; 29-43 = 3; 44 – 58 = 4; 59-72 = 5; 73-86 = 6; 87-100 = 7.

Data type	Description	Score conversion
University rankings	A score is assigned based on the position in the combined position on the global rankings of the country's top three universities (sum of individual rankings divided by three).	1-500= 7; 501-1000= 6; 1001-2000= 5; 2001-3000= 4; 3001-5000= 3; 5001 -8000 =2; 8001+ =1
Percentage values	Indicators such as literacy rates, access to internet etc are measured with percentage values (%). For percentage values, scores are given based on a country's performance relative to other countries.	Relative to other countries' performance
Yes/No	Some indicators are scored using a binary system, e.g. whether a country has a or has not a research strategy. Where additional qualitative evidence is available, this will be reflected in the score. Where no additional evidence is available, Yes is equated with the median point of the high rating (6) and No is scored with the median of the low range (2).	When no additional qualitative evidence is available: Yes = 6; No = 2
GERD per capita	We use the 1% African Union target as best outcome (score 7), and modify the score based on the actual GERD. GERD higher than 1% is scored 7.	GERD 0-0.2% = score 1; 0.3-0.5% =2; 0.6-0.8% =3 0-9-1.1% =4; 1.2-1.4% =5; 1.5-1.7% =6; 1.8-2% =7
GERD funding from abroad	The extent to which external funding in R&D is seen positively or negatively depends on many factors. For instance, foreign investment in business R&D is seen as a positive tech transfer opportunity, whilst excessive dependence on foreign funding in HE R&D is rated negatively. Based on existing studies, we take 35% as an optimal value for GERD from abroad for LMICs. Deviation from optimal value is rated negatively.	Deviation (+ or -): 0-5% =7; 6-10% =6; 11-15% =5; 16-20% =4; 21-25% =3; 26-30% =2; <31% =1
GERD performance by sector	We use the following GERD distribution as optimal (based on a slightly modified distribution from the OECD estimate to take into account LMICs unique circumstances): business enterprise = 50%; HE = 25%; government = 15%; non-profit = 10%. Deviation from this distribution is rated negatively.	Total deviation: up to 20% = 7; 21-35% = 6; 36-50 =5; 51-65% =4 66-80 =3; 81-95 =2; <96% =1
Number of journals listed in Scimago	A high number of local journals is positively correlated with research diffusion.	0-5 journals =1; 6-10 =2; 11-20 =3; 21-30 =4; 31-40 =5; 41-50 =6; <50 =7
Country income classification	The World Bank identifies further groupings based on their average GDP per capita: Low income = average $787; Least developed countries = average $1,072; Lower middle countries = average $2,209; Middle income = average $5,282; Upper middle = average $8,610; OECD countries = average GDP $45,721; High income = average $47,892.	Low income = 1; Least developed = 2; Lower middle = 3; Middle income = 4; Upper middle = 5; High income = 6; Very high income = 7
Poverty	The score is based on the percentage of population living with less than $1.9/day, using World Bank estimates.	40% or more =1; 25-39% =2 15-25% = 3; 10-15% =4; 9-5% =5; 1-3% =6; less than 1% =7

Data type	Description	Score conversion
Urban/rural divide	We assume that there is a positive correlation between the proportion of people living in cities and research. We assume see a proportion of urban v rural dwellers above 60% as optimal, while lower proportions are rated negatively.	1-10%=1; 11-20%=2; 21-30% =3; 31-40% =4 41-50%=5 51-60%=6; >61%=7
Literacy rate	Low literacy is negatively correlated with research. Given the international standards of literacy, we weigh low literacy more heavily than relatively high literacy and only give full score to those countries where almost all the population is literate.	1-20%=1; 21-40%=2; 41-60%=3; 61-75%=4; 76-85%=5; 86-95%=6; 96-100%=7

Table 4. List of country indicators and scores

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
1. National context (structures)					
1.1 Social and political indicators					
1.1.1 Social and political factors	Working language	Kinyarwanda	-	No direct impact on research performance	[1]
	Total population (millions)	12.3million	-	No direct impact on research performance	[2]
	Urban population (% of total)	27.8%	2		[2]
	Type of government	Democratic	-	No direct impact on research performance	[3]
	Political stability	48/100	4	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Rule of law	59/100	3	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Regulatory quality	61/100	3	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Government effectiveness	63/100	3	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Voice and accountability	16/100	1	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Corruption (ranking)	48/180	4	See table 3. Ranking goes from 1 (best) to 180 (worst)	[5]
	Access to information	-	-	See table 3. Score goes from 0 (worst) to 150 (best)	-
	Freedom of expression	3/16	2	See table 3 and section 2.1	[3]
	Adult literacy rate (% population aged 15+)	70.8%	4	Literacy rates are lower than the global average.	[6]
	Gender Development Index	0.941	-	Women's achievements in health, education and command are lower than men's, underlying gender inequality in line with the African average.	[7]
1.2 Economic indicators					
1.2.1 Economic development	GDP per capita US$	$772	1	See table 3.	[8]
	Agriculture, value added (% of GDP)	33.12%	-	No direct impact on research performance	[8]
	Manufacturing, value added (% of GDP)	4.84%	-	No direct impact on research performance	[8]

Table 4. List of country indicators and scores

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
	Population living in poverty ($1.9/day)	55.5%	1	See table 3	[8]
1.2.2 Digital infrastructure	Access to internet (ranking)	118/137	2	See table 3	[9]
	Individual using Internet/100 people	20	-	Scored under access to internet.	[9]
	Broadband internet subscription/100 people	0.2	-	Scored under access to internet.	[9]
	International internet bandwidth, kb/s per user	7.5	2	See table 3	[9]
	Mobile internet subscriptions/100 pop	27	1		[9]
1.2.3 Competitiveness	Global Competitiveness Index (ranking 2018)	58/137	5	See table 3	[9]
	Overall technology readiness	3.2/7	3	See table 3	[9]
	Capacity for Innovation	4.3/7	4	See table 3	[9]
	Innovation index (score)	4.7/7	5	See table 3	-
2. Enabling environment (institutions)					
2.1 Policy and institutional framework					
2.1.1 National policies	Existence of a national research policy	No	2	See section 3.1	Various
	Existence of sector-specific research policies	Partly	4	They are part of the STI policy	Interviews
	Research policy updated in the last 10 years	No	2		[10]
	Existence of an appropriate Strategy for STI	Yes	6	See section 3.1	Interviews
	Capacity development is part of the Strategy	Yes	6		Interviews
	Country has appropriate indicators tracking R&D	No	2	See section 5.2	Interviews
2.1.2 National institutions	The country has a ministry or department for research	No	2	See section 3.2	Interviews
	The ministry/department for research is sufficiently resourced	No	2	See section 5.1	Interviews
	The country has one or more national research funders	Yes	6	A research and development fund has been established (NRIF) but is managed by the main STI organisation (NCST). See sections 3.2 and 5.1	Interviews
	The research funders have sufficient financial resources	Yes	6	NRIF funded with USD$30 million. See section 5.1	Interviews
	Quality of the research funder management capacity	Below average	3	NRIF is still new, but no dedicated management	Interviews
	The country has a national research ethic body	Yes	6	See section 5.3	Interviews
3. Stakeholder analysis (agents)					

Table 4. List of country indicators and scores

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
3.1.1 Stakeholder composition	Clarity of relationships between national actors	Poor	2	See section 4.2	Interviews
	Clarity of decision-making and accountability processes	Poor	2	See section 4.2	Interviews
	Level of coordination between government department	Average	4	See section 4.2. There appears to be some efforts in coordinating activities related to R&D among relevant Ministries, but the extent to which coordination takes place is unclear.	Interviews
	Cohesion between policy mechanisms	Above average	5	Policy mechanisms are fairly consistent with the overarching policy vision. See section 3.1	Interviews
	Level of participation in decision-making/standard-setting	Below average	3	No forum or mechanism has been identified to allow research stakeholders to participate in decision-making. However, international funders have appear to have significant influence on policy development in Rwanda.	Interviews
	Quality of monitoring & enforcement mechanisms (M&E)	NA	NA	See section 3.2	Interviews
4. Production of research					
4.1 Research inputs **People and resources needed to produce robust research.**					
4.1.1 Human capital	Total R&D personnel per million people (FTE)	-	-	See table 3	-
	Researchers per million inhabitants (FTE)	12.3	1	See table 3	[11]
	Researchers (FTE) - Business enterprise	0%	1	See table 3	[11]
	Researchers (FTE) - Government	0%		See table 3	[11]
	Researchers (FTE) - Higher education	100%		See table 3	[11]
	Researchers (FTE) - Private non-profit	0%		See table 3	[11]
	Researchers (FTE) – Female	34.2%	2	See table 3	[11]
	Researchers (FTE) with ISCED 8	37.7%	3	See table 3	[11]
4.1.2 Funding	GERD per capita (%GDP)	Very low	1	Although we have no data on total GERD, the consultation revealed that national funding for R&D is extremely limited. See section 5.1	Desk
	GERD per researcher FTE (in current 000 PPP$)	-	-	No data available.	-
	GERD financed by abroad (% total)	-	-	No data available.	-

Table 4. List of country indicators and scores

COMPONENT	INDICATOR		VALUE	SCORE	DETAILS	SOURCE
	GERD performed by	business (% total)	-	-	No data available.	
		gov (% total)	-			
		HE (% total)	-			
		private non-profit (% total)	-			
4.1.3 Research organisations	Average quality of research organisations		3.8/7	4	See table 3	[9]
	Global ranking of University of Rwanda		733/3471		See table 3	[12]
	Global ranking of		-	1	See table 3	
	Global ranking of		-		See table 3	
4.2 Research culture and support services Set of cultural rules and principles, activities and interactions supporting the production of research						
4.2.1 Research culture	Perceptions of the utility of research		Poor	2	Good at the University of Rwanda, non-existent elsewhere. See section 5.2	Interviews
	Time allocated to research		Poor	2	See section 5.2	Interviews
4.2.2 Capacity building	Local availability of specialized research and training services		Average	4	Funding for research training has been supported through international initiatives and centers of excellence. See section 5.1	Interviews
	Funding for Research Capacity Strengthening		Very poor	1	See section 5.2	Interviews
	% HEI with PhD programmes		NA	NA	N/A	-
4.2.3 Research support and administration	Level of access to proposal writing support		Poor	2		Interviews
	Existence of institutional policies				Good at the University of Rwanda, non-existent elsewhere. See section 5.2	Interviews
	Quality of administrative support					
4.2.4 Infrastructure and data	Is there a central repository for research data?		No	2	See section 5.2	Interviews
	Quality of research infrastructure		Poor	2	See section 5.2	Interviews
4.3 Research output and evaluation Products of scientific research (publications and patents) and incentives for producing research						
4.3.1 Research publications	Total # of publications (2018)		490	-	Not scored, depends on population size	[13]
	Total # of citable publications		433	-	Not scored, dependent on population size	[13]
	Citations per publication (1996-2018)		14.29	-	Scored by citation per publication ranking	[13]
	Citations per publication ranking (1996-2018)		98/236	2	See table 3	[13]

Table 4. List of country indicators and scores

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
	H index ranking	136/239	4	See table 3	[13]
	# Journals listed in SciMago	1	1	See table 3	[13]
	Scimago country ranking 2018	131/239	4	See table 3	[13]
	% of the total output for Africa	0.64	-	Not scored.	[13]
4.3.4 Research evaluation	Existence of national mechanisms for research quality evaluation	Yes	5	Mechanisms are in place in some areas of research (governance, statistics, health) but not other	Interviews
	Quality of incentives for research production	No	2	See section 5.	Interviews
5. Diffusion of research					
5.1 Actors and networks National users of research and international research partners					
5.1.1 National users of research	Firm Level Technology absorption	4.8/7	5		[9]
	FDI and Technology Transfer	4.7/7	5		[9]
	Gov't procurement of technology products	4.7/7	5		[9]
	Government use of research information/products	NA	NA	See section 6.1	Interviews
5.1.2 International exposure	Percentage of papers in 10% most-cited papers (2008–2012)	9%	3	The G20 average is 10.2%	[14]
	International collaboration 2018 (% of total)	91%	7	See section 6.1	[13]
	Main foreign partners	-	4/5 Northern	USA, Belgium, Netherlands, Kenya, UK	[13]
5.2 Knowledge exchange practices Activities and structures supporting the exchange of research-based knowledge					
5.2.1 Intellectual property	Country has a body in charge of intellectual property protection	Yes	6	See section 6.2	[15]
	Country is member of a regional IP organisation	Yes	6	See section 6.2	[15]
	Number of patents applications per million people (global ranking)	117/119	1	See table 3	[9]
	Number of patents applications per million people (African ranking)	20/21	-	Score based on global ranking	[9]
5.2.3 Knowledge exchange support and	Country has joined a regional initiative for the promotion of STI	NA	NA		

Table 4. List of country indicators and scores

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
administration	University-Industry collaboration (score)	3.5/7	3	See section 6.2	[9]
	University-Industry collaboration (ranking)	57/137	5	See table 3.	[9]
	Existence of appropriate institutional policies for KE	Yes	6	See section 6.2	Interviews
	Quality of incentives for research diffusion	Good	6	See section 5.3, 6.1 and 6.2.	Interviews
	Existence of commercial office	NA	NA		Interviews

Appendix B - Rwanda stakeholder table

Non-exhaustive list of the MAIN research stakeholders in the country.

Role	Rwanda		International	
	Public	**Private**	**Public**	**Private**
Policymakers	• Ministry of Education • Ministry of Health			
Research funders	• Directorate of Science, Technology and Research (within Ministry of Education)		• Department for International Development (DFID), UK • Federal Ministry of Education and Research, Germany • German Academic Exchange Service (DAAD) • International Centre for Theoretical Physics (ICTP), Italy • International Development Research Centre (IDRC), Canada • UNDP • UNESCO	• Alexander von Humboldt Foundation, Germany • MasterCard Foundation • Google • Robert Bosch Stiftung, Germany
Intermediaries	• National Council for Science & Technology		• The Association for the Development of Education in Africa (ADEA) • VVOB (Belgium)	
Universities	• 1x public university	• 26x private universities		

Research performing organisations	• East African Institute for Fundamental Research (EAIFR) • Rwanda Agricultural Research Institute (ISAR)	• Carnegie Mellon University	• African Institute for Mathematical Sciences (AIMS)	
Think Tanks		• Institute of Policy Analysis and Research (IPAR) • Never Again Rwanda • Great Lakes Initiative for Human Rights and Development (GLIHD) • CCOAIB • Rwanda Civil Society Platform		

Appendix C – Interviewees

Name	Organisation
Dr Alexandre Simons	Institute of Policy Analysis and Research
Eugenia Kayitesi	Institute of Policy Analysis and Research
Anghassi Mkrtchyan	World Bank
Peace Aimee Niyibizi	World Bank
Professor Deo Jaganyi	University of Rwanda
Tusingwire Yassin	Great Lakes Initiative for Human Rights and Development

Appendix D – Peer reviewers

Name	Organisation
Ajoy Datta	On Think Tanks
Justin Pulford	Liverpool School of Tropical Medicine
Robin Drennan	The University of the Witwatersrand

Appendix E – Key data sources

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[15] World Intellectual Property Organisation, "Statistical Country Profile," [Online]. Available: https://www.wipo.int/ipstats/en/statistics/country_profile. [Accessed October 2019].