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Assessing the needs of the research system in Tanzania

Report for the SRIA Programme

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Executive Summary

This report provides a high-level assessment of Tanzania'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 Tanzanian 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 Tanzania

Research environment. Tanzania is a low income country with a GDP per capita of USD1,050 and almost half of the population living in poverty (World Bank). Two thirds of the population live in rural areas and literacy levels are low. Despite having regular elections since the early 1990s, World Bank data show that the country is affected by high government instability, a weak rule of law and low regulatory quality. Moreover, Freedom House finds that political and civil rights are limited and that academic freedom had recently been threatened by a legal requirement that scientific data be approved by the National Bureau of Statistics (the requirement was eventually removed in June 2019). Desk research suggests that Tanzania has a well-developed policy which sets national research priorities and their contribution to the development vision. The main national institution responsible for implementing research and innovation policy is the Tanzania National Commission for Science and Technology (COSTECH), while the National Centre for Transfer of Technology and Development (CTTD) is responsible for matters relating to the transfer, adaptation and development of technology. However, as highlighted in interviews, a widespread lack of funding, staff and skills in key national bodies causes a substantial gap between policy ambitions and reality.

Research production. Research production in Tanzania faces strong headwinds. The country has only 18 researchers per million inhabitants, the second lowest proportion of researchers among the seven countries considered in this study (UNESCO). UNESCO data reports that one third of researchers have doctoral qualifications and the consultation process revealed that research training and capacity strengthening activities are limited by lack of funding. Tanzania has seen a rapid increase in the number of universities but most of them perform little research. Much of Tanzania's research happens in research institutes and non-profit organisations. Gross expenditure in research and development is only 0.5% of GDP and the country relies on foreign aid for over half of its national R&D expenditure (UNESCO). Given the size of the research funding gap, research infrastructure remains inadequate and universities provide little or no research support services to their staff. Given the challenging research environment, interviews suggested that many researchers seek to pursue a career in wealthier countries in Europe, North America or neighbouring African countries.

Research diffusion. Tanzania's research output is limited to only 30.3 publications per million people. 83% of papers published by Tanzanian researchers are the result of international collaborations, which helps explain the relatively high number of citations per paper. However, the impact of international research collaborations does not seem to extend much beyond academia (Scimago). Only one patent application was filed in Tanzania by residents in the last 10 years, and no patent was granted (WIPO). Knowledge exchange and commercialisation are priorities for the national government but most institutions lack technology transfer capacity while the national framework for intellectual property is weak. Procurement of technology from domestic sources by the government is low and technology absorption capacity by businesses limited. Moreover, although the government collaborates with think tanks, the consultation found limited evidence that policy decisions are influenced by research.

B. Options for research capacity strengthening

Tanzania's research system is underdeveloped and would benefit from initiatives that support research capacity among research organisations and national research bodies. Three areas appear important:

- **Create research training opportunities for women**. Tanzania appears to face an especially severe challenge in training and retaining researchers in the country – with research talent often attracted by better career options in high-income countries but also in neighbouring countries, according to interviewees. At the same time, UNESCO data shows the number of women pursuing a career in research is lower than other African countries, as they make up just over a quarter of the country's researcher population. There seems to be an opportunity to encourage and support more women in pursuing a research career as a way of plugging both the talent gap and the gender gap in research.
- **Support research infrastructure.** One of the major hurdles to retaining qualified and experienced researchers is the lack of adequate research infrastructure, both physical and digital. DFID could help resource existing research institutes or help establish new ones that perform research linked to the national research agenda and economic priorities. While this type of intervention might generate measurable impact in a relatively short space of time, long-term impact on the research system would depend on these centres achieving financial sustainability (e.g. to maintain and continue to develop the research infrastructure) when DFID funding comes to an end.
- **Support capacity and coordination among national institutions**. Desk-based research and views of interviewees have shown that Tanzania's national framework for research suffers from weak coordination between ministries and capacity gaps in national research bodies, especially COSTECH. There seems to be a clear opportunity to help COSTECH identify its critical needs with regards to its numerous functions (policymaking, funding, monitoring and evaluating). Support could then be given for the development of appropriate responses, including relevant organisational changes needed to improve the coordination and harmonisation of government action on research.

Contents

Glossary

Organisations

ARIPO	African Regional Intellectual Property Organization
COSTECH	Commission for Science and Technology
CTTD	National Centre for Transfer of Technology and Development
MEST	Ministry of Education, Science and Technology
MHEST	Ministry of Higher Education, Science and Technology
MoCST	Ministry of Communication, Science and Technology
NASAC	Network of African Science Academies
SIDA	Swedish International Development Cooperation Agency
STIPRO	Science, Technology and Innovation Policy Research Organisation
TAAS	Tanzania Academy of Science
UNESCO	United Nations Educational, Scientific and Cultural Organization

Other acronyms

GDP	Gross Domestic Product
GERD	Gross domestic Expenditure in Research and Development
KE	Knowledge exchange
LMICs	Low- and medium-income countries
NAEM	National Award for Environmental Management
NARST	National Award for Research in Science and Technology
NFAST	National Fund for the Advancement of Science and Technology
PPP	Purchasing power parity
R&D	Research and development
R&I	Research and innovation
RCS	Research capacity strengthening
SSA	School Science Award
STI	Science, Technology and Innovation
TASTA	Tanzania Award for Scientific and Technological Achievements

1. Introduction

This report presents the results of an assessment of Tanzania'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 16 sources (see Appendix E), while qualitative data was gathered from interviews with 9 informants, working for think tanks, research organisations and intermediary organisations based in Tanzania (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 Tanzanian 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 which, albeit important, fall outside the scope of this investigation. Some of the qualitative findings are based on the views of a small number of stakeholders and should be verified through further research.

2. Structures

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

2.1 Social and political context

Tanzania is a presidential democracy that has held regular multiparty elections since its transition from a one-party state in the early 1990s. However, the ruling party has since retained its power and maintained restrictions on political rights and civil liberties that make it difficult for political alternatives to emerge. Since the Presidential elections of 2015, the government has cracked down with growing severity on the political opposition, the press, and civil society.

The World Bank places Tanzania close to the bottom quartile in a percentile ranking of political stability (26/100) due to frequent violence. Despite the ruling party's firm grip on the country, government effectiveness is reported to be limited (28/100), the rule of law relatively weak (35/100), and regulatory quality poor (30/100). Ranked 99th out of 180 countries in the Corruption Perception Index 2018, Tanzania has a high level of perceived corruption. The country scores marginally better under voice and accountability (37/100) as the restrictions to freedom of expression and association are balanced by a free and fair electoral process. The charity Freedom House finds that Tanzania is 'partly free' and gives the country an aggregate score for political rights and civil liberties of 45/100 (with 0 being least free and 100 being most free). The country scores 7/16 for freedom of expression and belief (where 0 is least free and 16 most free) and 2/4 for academic freedom. Political rights and civil liberties have worsened in recent years and the outlook appears negative. In particular, the 2018 Freedom House report notes that, "Tanzania's reputation as a bastion of academic freedom was tarnished by the passage of 2015 Statistics Act, which requires data released publicly to be first approved by the National Bureau of Statistics, making the body the de facto arbiter of the validity of any data produced by academics." Up until 2018, anyone who disputed official government figures could have been charged with prescribed fines and prison time, which effectively criminalised academic data that contradicted official government statistics. Criminal liability was relaxed in an amendment to the law passed in September 2018 and then removed in an amendment passed in June 2019.

2.2 Economic context

Tanzania is a country of 56 million people. It has a Gross Domestic Product (GDP) per capita of USD1,050 (2018), which is well below the average for Sub-Saharan Africa and broadly in line with the

least developed countries. Using the current World Bank classification,[a] Tanzania is near the top of the low income category. However, almost half of the population (49.1%) lives with less than USD1.90 a day, which is above the average for both Africa (41%) and low-income countries (43.4%). Tanzania is ranked 154th out of 189 in the world in the composite Human Development Index.

Two thirds of the Tanzanian population live in rural areas (66.2%) and the country's agricultural sector accounts for 28.7% of the national economy. Industry, which includes construction and manufacturing, accounts for 25.1% of Tanzanian GDP, and manufacturing accounts for over one fifth of this (7.7%). The service industry, which includes retail, tourism and personal services, is worth over USD19 billion. World Economic Forum data shows that 16/100 people have access to an internet connection, putting Tanzania near the bottom of the list for internet access (126th out of 137 countries). Finally, Tanzania ranks 113/137 for economic competitiveness: the country's technology readiness (2.6/7) and capacity for innovation (3.6/7) scores indicate a below-average economic dynamism and ability to modernize the economy.

3. Institutions

This section looks at the strength of the national policy framework for research. Specifically, it looks at the national research policy and institutional capacity at the national level.

3.1 National policy for research

Tanzania's national policy for research is defined in several documents. Tanzania was one of the first countries in East Africa to develop a science and technology policy. In 1986, the Tanzania Commission for Science and Technology Act set up the institutional framework for research which remains in place today (see section 3.2). Among others, it established the Tanzania National Commission for Science and Technology (COSTECH), its Advisory Committees and the Centre for Transfer of Technology and Development. It also established the National Fund for the Advancement of Science and Technology (NFAST), which provides debt and grant funding for research production and training but, crucially, does not have an explicit mandate for research infrastructure. The overall direction of Tanzania's research policy is currently set by the National Research and Development Policy of 2010, which identified shortcomings in the national research system and laid out ambitious measures to address them. The policy's goals appear similar to the objectives of previous policy documents, seemingly suggesting that little progress had been made since the establishment of the national institutional framework in 1986. Among others, the policy includes commitments to improve coordination between ministries, departments and agencies undertaking R&D activities; increase the use of ICT and

[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.

socio-economic research in research by establishing centres of research excellence; establish a human resource development programme and provide better remuneration and incentives for research. The 1996 Science and Technology Policy set out an as yet-unmet objective to dedicate "about 1% of GDP" to scientific research and technology development and affirmed that the objective of Universities is to "produce scientists, engineers, teachers and technologists", emphasising a focus on education and training over research which remains in place today. Research priorities are defined in research strategies published every 5 years, consistent with the objectives defined in Development Vision 2025. Research Priorities for Tanzania 2015-2020 identifies the top challenges for research (education, health, food and nutrition, water and sanitation and land management), the key areas for economic competitiveness (energy, manufacturing, transportation, mining, agriculture and tourism) and the key environmental challenges (natural resource management, ecosystems and climate change).

Overall, Tanzania has a well-developed policy framework that relies on long-term planning and underlines the connection between research and economic development. The reviewed policy documents present long lists of ambitious objectives but are thin on implementation detail. In fact, there seems to be a gulf between policy development and policy implementation which could be partly explained by the widespread lack of funding, limited capacity and uncertain commitment to research at all levels. National research objectives and priorities have changed little since 1986, and there are signs that little progress has been made. For instance, the 2010 Research policy calls for the establishment of implementation strategies for the national R&D agenda, mechanisms for research dissemination and commercialization (this is 24 years after the establishment of the Centre for Transfer of Technology and Development) and action to address COSTECH's difficulties with funding capacity. The overall impression is that Tanzania, just like many other Sub-Saharan African countries, struggles not in developing policy but in translating abstract aspirations into reality.

3.2 National bodies that support research

Tanzania's national bodies for research rely on the central role of COSTECH as the government entity responsible for policymaking, coordination and funding of research nationwide.

- **Ministry of Communication, Science and Technology (MoCST):** it is mandated to implement the National Research and Development Policy and ensure that national strategic goals are set and achieved. The R&D policy states that several Ministries have distinct responsibilities for sectoral R&D, and that cross-ministerial coordination remains a challenge.
- **Ministry of Education, Science and Technology (MoEST):** it is mandated to oversee research, science and technology in Tanzania, identify the country's needs in terms of skills and developments and manage research in science and technology. The Ministry is also responsible for the coordination of departments, including the Department of Science, Technology and Creativity and the Department of Information and Communication Technology and Internet Education.
- **National Commission for Science and Technology (COSTECH)**: it is the principal advisory organ to the Government on all matters pertaining to scientific research, technological development and coordination of research activities in the country. Its specific functions

include: (i) formulate S&T policy and support its implementation, (ii) monitor and co-ordinate the activities relating to scientific R&D, (iii) disseminate scientific and technology information and (iv) advise the Government on prioritisation, resource allocation and regional or international collaboration.

- **Research and Development Advisory Committees**: the Committees advise COSTECH on coordination of scientific research in their area of competence, from a list including: (i) Agriculture and livestock; (ii) Natural Resources; (iii) Environmental Research, (iv) Industrial and Energy Research; (v) Public Health and Medical Research; (vi) Basic Sciences, (vii) Social sciences.
- **National Centre for Transfer of Technology and Development (CTTD)**: it is the principal organ of COSTECH responsible for matters relating to the transfer, adaptation and development of technology including the assessment and choice of imported technology.

Tanzania's institutional framework appears centralised, with all national bodies supporting research being directly or indirectly controlled by MoCST via COSTECH - with the exception of sectoral ministries funding their own research. The Commission also manages the key functions of research policymaking, monitoring, evaluation, funding, dissemination and commercialisation. Interviewees indicated that, at present, COSTECH is trying to achieve too much with too little resource, and as such it cannot adequately fulfil all its responsibilities. This has a knock-on effect on research policy implementation.

4. Agents

4.1 Stakeholder mapping

Tanzania's research system is dominated by publicly funded organisations (see Appendix B). According to the Tanzania Academy of Sciences, the main research actor in the country is the Ministry of Education, Science and Technology. Previously, this was the responsibility of the Ministry of Communication, Science and Technology (MoCST) supported by COSTECH, which had the double role of funder and adviser on all matters relating to science and technology.

The Ministry of Education has an indirect role in research, largely limited to its power to allocate funding to universities via accreditation by the Commission for Universities. Tanzania has 27 universities and 15 university colleges (see section 5.1). The country also has several research institutes, including 16 agricultural research institutions and research stations, 6 in animal sciences and animal diseases, 9 in human health, nutrition and medical sciences, 6 in natural resources and 7 in industry. Other important stakeholders include the Tanzania Academy of Science (TAAS), a non-political, non-sectarian, non-profit making, scientific body that supports, funds and disseminates research. Through its membership, TAAS cooperates with the Tanzanian Government, scientific organisations and the general public in the promotion, advancement and application of science, technology and innovation for socio-economic transformation and development of Tanzania. The Network of African Science Academies (NASAC), is an association of Science Academies in Africa, which

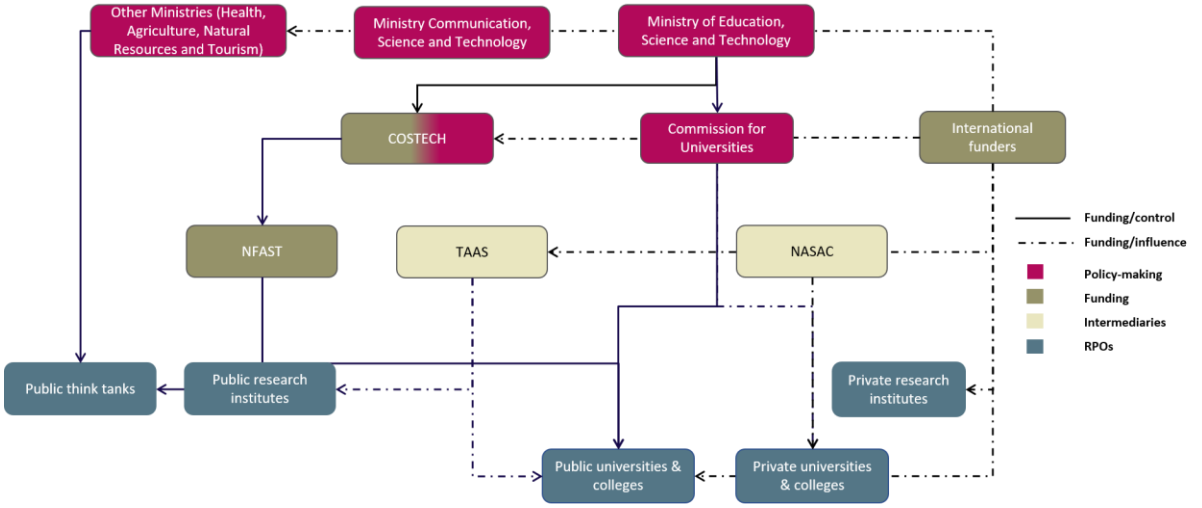
was highlighted by interviewees as an influential international intermediary. Appendix B lists the active stakeholders identified in this research.

4.2 Relations and interdependencies

Tanzania's national institutional layout for research is relatively clear, with the central position of COSTECH having remained almost unchanged since 1986. However, the ministry that COSTECH reports to has changed several times in the past decade and interviewees stressed that there is a lack of coordination at ministerial level, resulting in sectoral ministries having separate research policies and funding processes. The consultation also indicated that, while some think tanks have a direct connection with the government to inform decision-making, policy decisions are often perceived to be disconnected from the recommendations. Moreover, one interviewee suggested that the government ignores research findings that are not directly aligned with national research priorities. This may suggest that the government is either using research to legitimize its decisions, or only using research that supports the political agenda.

The government expects the business sector actors to take the lead on research capacity building, However, interviewees stated that more can be done to develop a clear policy direction, support framework or dedicated resources for private actors to take on a more active research role.

Figure 1. Stakeholder relationships in Tanzania's research system



Significant uncertainty regarding the roles and responsibilities of the various actors is another pressing issue within the Tanzanian research system. The consultation process revealed that interviewees at key roles in national research bodies were unaware of the country's latest national research policy and referred instead to Tanzania's STI policy published in 1996. The lack of communication from national to regional level has also emerged as a barrier to research capacity strengthening in Tanzania.

As Tanzania's only research funder, COSTECH is responsible for coordinating and promoting research and technology development, channeling national and external funds, managing competitive calls and distributing funding for research through NFAST and other grants. COSTECH issues permits for research, however if research is not aligned to Tanzania's national priorities, it is unlikely that the

findings of this research will ever be utilised or disseminated. COSTECH is also considered to focus predominantly on scientific research and as such leaves a gap in terms of the development of social sciences and the arts which is funded almost entirely by volunteers or international donors.

The consultation suggested that COSTECH performs an intermediary role between research organisations and the national government, working closely with think tanks such as the Science, Technology and Innovation Policy Research Organisation (STIPRO) and REPOA in this capacity. REPOA, STIPRO and other influential think tanks are being supported by the Think Tank Initiative (see Appendix B for an extended list of think tanks). The relationship between COSTECH and think tanks is complex yet well-developed, with the Commission relying heavily on these organisations for policy advice.

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

UNESCO data shows that Tanzania has 18.3 researchers per million people. This is far below the African average of 95.1 researchers per million. Data reported by UNESCO suggests that the vast majority of Tanzanian researchers are employed by higher education institutions (71.3%), a figure which increased dramatically from just 35% in 2010. Remaining researchers are reported to be employed by the Tanzanian Government (28.7%). This figure declined significantly since 2010 when 64% of researchers were reportedly employed in this sector. UNESCO reports no researchers employed in the business and private sectors. In this case, due to extreme variations in data reported per year, there are significant doubts regarding data quality. In Tanzania, almost 25% of researchers are female, which is below the African average of 31.6%.

32.8% of researchers in Tanzania have a doctoral qualification or equivalent which is in line with the majority of the countries involved in this study. The consultation highlighted that the relatively low proportion of qualified researchers is partly explained by the low numbers of undergraduates and postgraduates coming through the system. Equally, education at the primary and secondary levels does not appear to encourage enquiry-based learning where research skills are developed. A second issue affecting the number of postgraduates in Tanzania is the retention of researchers after the completion of their studies. Several interviewees suggested that young Tanzanian researchers leave the country to study and/or leave to develop their careers abroad in Namibia or Botswana and do not return to Tanzania. This has led to the brain drain phenomenon leaving a substantial knowledge gap

in Tanzania. This is primarily due to insufficient research funding and poor infrastructure which are major barriers to attracting and retaining research talent in the country.

B. Research funding

Tanzania has a Gross domestic Expenditure in Research and Development (GERD) equivalent to 0.5% of the GDP, which is half of the objective stated in the 1996 Science and Technology Policy but still more than twice the average amount for other low-income countries (0.23%). Data reported by UNESCO suggests that, on a per-capita basis, Tanzania's annual R&D expenditure is extremely high at USD671. This is the highest across the seven countries considered in this study and considerably higher than expenditures in high-income countries (the UK, for instance, spends $165 per researcher per year). In this case, there are serious doubts regarding the quality of data reported by UNESCO. Around 60% of GERD in Tanzania is spent by higher education institutions and the Tanzanian government is responsible for all the remaining research expenditure. No expenditure is currently recorded for the non-profit sector or for the business sector. Low private sector expenditure in R&D is common among Sub-Saharan African countries, but the lack of any reported expenditure from Tanzania businesses reinforces the picture of a highly centralized and public-sector driven research sector. However, questions regarding data collection in Tanzania arise. The NFAST was set up with an initial investment of 63.4million TShs (approximately USD100,000 at the time) of which 75% came from the Danish government through DANIDA and the rest from the Ministry of Education Science and Technology (formerly MHEST), the Zanzibari President and a charity walk. This is well below the 1 billion TShs target the government aimed for. COSTECH is also responsible for several scientific awards: the Tanzania Award for Scientific and Technological Achievements (TASTA), the National Award for Research in Science and Technology (NARST), the National Award for Environmental Management (NAEM) and the School Science Award (SSA).

42% of Tanzania's GERD comes from abroad – one of the highest percentages of all countries in this study. Whilst partnerships can have a positive impact on research capacity strengthening and international visibility, excessive reliance on external funding can create problems. Some problems were highlighted in interviews. First, external funding is only for a limited period and the end of support can undermine the long-term impact of the intervention if the national government does not continue to provide funding. Second, dependency on international funding creates opportunities for talented researchers to pursue their research careers abroad, exacerbating the brain drain. Third, external funding is perceived to be driven by international agendas, neglecting local expertise, expectations and policy priorities. Moreover, international research funding is often accompanied by a reluctance by external funders to let funding recipients manage their own research, which creates frustrations among local researchers.

C. Research organisations

The number of universities and university colleges in Tanzania is growing rapidly, probably due to increasing demand for education. In 2010, the R&D Policy identified 31 universities and colleges. In eight years, the number has grown to 27 universities (of which 11 are public and 16 are private) and 15 university colleges (of which 4 public and 11 private). The quality of Tanzania's universities is ranked 69th out of 137 countries, placing the country in the middle of a global ranking compiled by the World Economic Forum. This is a good achievement for a country with such low income, and places Tanzania

above many other Sub-Saharan African countries. Three of Tanzania's universities appear on Scimago's list of ranked higher education institutions. The highest ranked university is Muhimbili University of Health and Allied Sciences (679th out of 3,471 institutions). The Sokoine University of Agriculture and the University of Dar es Salaam rank 725th and 782nd respectively. Moreover, the Times Higher Education rankings show that the University of Dar Es Salaam performs relatively well in terms of its international outlook and industry income, but very poorly for research quality.

Consistent with the government's vision of universities as hubs for training and education, much of Tanzania's research happens in research institutes and non-profit organisations. Appendix B shows that most research institutes in Tanzania are publicly funded. These focus on areas of research that are aligned with government priorities, such as health, agriculture, fisheries, forestry, education, natural resource management and housing. A small number of private non-profit research centres operate in the country, including some specializing in industry-related research (Tea Research Institute of Tanzania, Tanzania Coffee Research Institute and Tanzania Technology Development Organisation). It is unclear what influence these research institutes have on government policy or economic productivity in the country.

5.2 Research culture and support services

A. Research culture

The consultation process found that there is a significant gap in research capacity at Tanzanian universities. This stems from the lack of research funding and infrastructure, a lack of clear career paths for researchers, and a lack of researchers exacerbated by the brain drain problem discussed above. It also stems from a view of universities as places of training and education. Although interviewees stated that a "publication equals promotion" attitude is common in Tanzania and does influence time-allocation from lecturers, academic staff are all salaried for teaching. The resulting tension between teaching and research for overstretched and unsupported academics has worsened already poor teaching conditions within Tanzanian universities (and, in turn, the quality of graduates) while failing to significantly increase research productivity.

Universities often seek international donor funding in order to undertake research while national funding remains grossly insufficient. However, the consultation suggested that research funded by international donors is often misaligned with national priorities, and it therefore remains unused in practice by policymakers. They also indicated that there seems to be very little scope for genuine change in this sense.

B. Capacity building

World Economic Forum figures indicate that Tanzania has an average availability of local specialized training services (score 3.9/7). However, the score is not specific to research training. The low proportion of PhD researchers in Tanzania with a doctoral qualification or equivalent (see section 5.1 A) suggests that Tanzania suffers from a similar lack of research capacity as other Sub-Saharan countries. Although the 2010 Research Strategy aims to put in place a mechanism for research staff training and retraining, the consultation suggested that the Government has shown some reluctance towards investing in research capacity nationally. Tanzania has traditionally relied on international

funding for research capacity strengthening which was particularly prevalent between 1980-90 from sources such as the IMF, World Bank and the Dutch Government. Since this funding was reduced in 1994, Tanzanian actors have done little to support research capacity strengthening nationally. Capacity development is not approached proactively, the general expectation is that capacity will grow naturally as research outputs are produced.

C. Research support and administration

While our consultation process highlighted a number of systemic issues within the Tanzanian research system, no evidence was available to validate any instances of internal mechanisms for strengthening research support and administration. In contrast, research support and capacity strengthening appear to be predominantly external activities. The Swedish International Development Cooperation Agency (SIDA) for example have a long-standing relationship with Tanzania and supports four Tanzanian institutions in this capacity: the University of Dar es Salaam, Muhimbili University of Health and Allied Sciences, Ardhi University and the Tanzania Commission for Science and Technology. No evidence was available from the consultation process to verify this.

D. Digital infrastructure and data

Tanzania is lacking in digital infrastructure. The country is ranked 126th out of 137 for access to internet. According to World Economic Forum data collected in 2016, only 9.2% of the population have mobile internet subscriptions and only 0.3 people per 100 of the population have a fixed-broadband subscription. The data also suggests that the quality of internet connection is poor, with broadband speeds measuring only 1.7 kilobytes per second per user. However, we are aware that both the spread and speed of internet connections are improving. The Tanzania Communications Regulatory Authority estimates that around half of the population now have mobile internet subscriptions.

There is no national research data repository in Tanzania. At a local level, institutions are doing what they can without any national coordination to group research data together in one place. For example, local institutions are coming together informally to define and collate discipline data. It is important to note, however, that these processes are neither regulated nor verified.

5.3 Research output and evaluation

A. Research publications

In terms of academic literature, Tanzania has a relatively low number of publications compared to other Sub-Saharan countries. For example, Tanzania reported 1,705 publications in 2018 which is substantially lower than the average for Sub-Saharan Africa (3,295 publications). This equates to 30.3 publications per million people, the joint lowest figure of all countries considered in this study along with Ethiopia. In 2018, Tanzania accounted for 2.22% of total research outputs across the African continent (while its population is almost 5% of Sub-Saharan Africa), ranking above only Rwanda (0.64%) in this study. However, just like many other Sub-Saharan countries, Tanzania punches above its weight in terms of citations, possibly due to the large number of international collaborations and the type of research undertaken in the country (e.g. empirical research). Between 2008 and 2012, 12.9% of Tanzania's papers ranked among the top 10% of cited papers. This is above the G20 average

of 10.2%. With an average number of citations at 17.08 per publication, Tanzania ranks 65th out of 239 countries, and the country's h-index ranking (which measures both the productivity and citation impact of scientific publications) ranks at 80th out of 239 countries.

B. Research evaluation & ethics

Tanzania has not developed national mechanisms for research quality evaluation yet. The consultation indicated that research institutions are grouping together to develop a methodology for collating data on grant applications, but otherwise both data and indicators for research evaluation are scant. Reportedly, COSTECH have only recently started to think about national indicators pertaining to research evaluation and ethics.

With regards to research ethics, COSTECH at present manages research clearance processes however there is no mention of an ethics body or policy. The National Institute for Medical Research implements a code of ethics in health research, which is recognised as a robust system. Interviewees indicated that no equivalent system for research ethics is available in relation to the wider research environment.

6. Research diffusion

This section focuses on the stakeholders and practices underpinning the dissemination of scientific research and its use by different stakeholder groups within the country and internationally.

6.1 Actors and networks

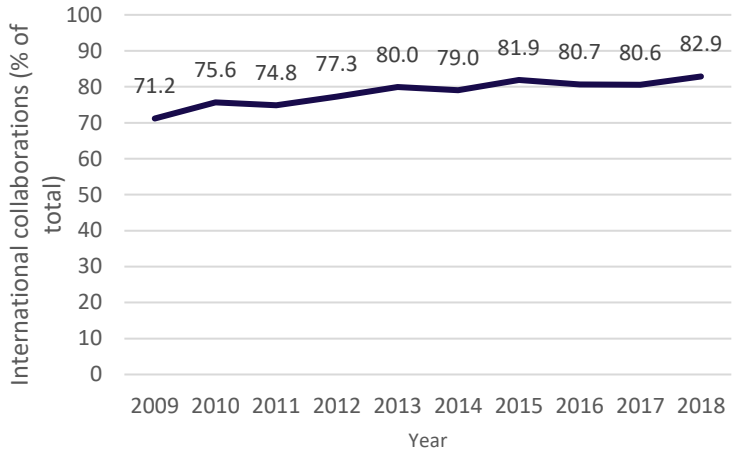
A. National users of research

National demand for research in Tanzania is limited. Interviewees stated that while the government commissions research from think tanks and research institutes (especially publicly funded ones, see Appendix B), it often fails to implement the recommendations ensuing from such research. Government procurement of technology is also limited, whilst businesses have more receptiveness to the absorption of technology than they have a desire to develop it. In fact, Tanzania has a significant way to go in terms of technology readiness. The World Economic Forum scores the country 2.6/7 in terms of overall technology readiness and only marginally better for its capacity for innovation (3.6/7). This is generally aligned to the average figure for Sub-Saharan Africa.

B. International exposure

Approximately 83% of papers produced in Tanzania in 2018 came about as a result of international collaborations. This figure has been relatively stable over the past ten years and equated to a persistently high percentage of research outputs. This is most likely exacerbated by Tanzania's funding models which favour international rather than internal research partnerships. International collaborations are mainly with USA, Belgium, Netherlands, Kenya and the UK. However, the consultation revealed that China and other Asian countries are entering the research sector both as funders and research partners, and they are finding receptive listeners in Tanzanian institutions. One interviewee stated that the new funders appear more collaborative than European and North American funders, who may over time be progressively marginalized as a result.

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

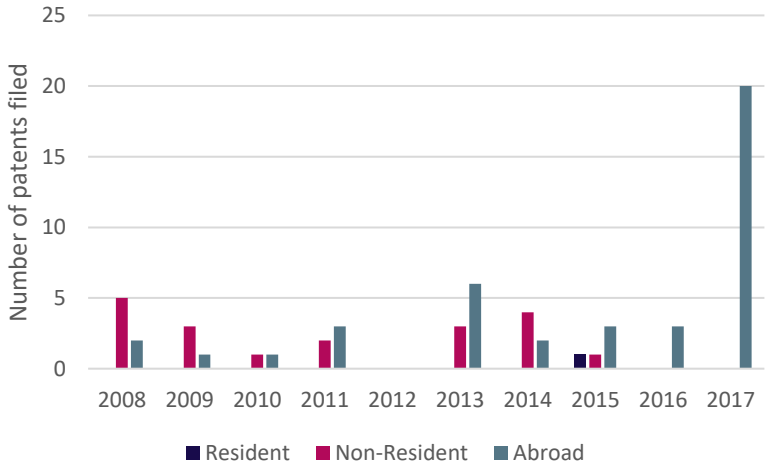


6.2 Knowledge exchange practices

A. Intellectual property

Only one patent application was filed via the African Regional Intellectual Property Organization (ARIPO) by Tanzanian residents in the last 10 years but 41 patent applications were filed abroad. No patents are recorded to have been granted between 2007 and 2017. In 2018, Tanzania ranked 107 out of 119 countries in terms of the number of patents per million people according to the World Economic Forum, and 13 out of 21 Sub-Saharan countries (implying that nine African countries had zero patent applications over the same period).

Figure 3. Number of patent applications filed in Tanzania.



Patents, trademarks and industrial design are protected by laws stretching back to the 1980s. COSTECH is responsible for enforcing intellectual property (IP) protection in research and to provide incentives for technology transfer but it operates under a weak national framework for intellectual property protection and commercialisation. The

Copyright Society and an Industrial Property Office (BRELA) is responsible for filing trademark and patent applications, however, Tanzania continues to rely significantly on its membership of ARIPO. No local system for registration of designs is currently available in the country.

B. Knowledge exchange support and administration

Knowledge exchange and commercialisation are among the top policy priorities for COSTECH. The Centre for Development and Transfer of Technology is the principal organ responsible for matters related to the transfer, adaptation and development of technology. It is tasked with helping research institutions protect their own IP and facilitate technology absorption among relevant social and economic actors. However, the consultation indicated that Tanzanian universities lack a culture of technology transfer, knowledge exchange or commercialisation. The University of Dar Es Salaam is one of the few universities with a technology transfer office, and does do some incubation, however the primary focus is to publish because researchers understand that this is how they can obtain a promotion. International donors do provide some support for incubation hubs; however, their focus tends to be more on facilitating the generation of income through consultancy services at universities rather than through the commercialisation of research outputs.

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.

Tanzania was one of the first African countries to recognise the positive role of knowledge and research for development. Yet the government ambition to create a productive research environment remains unachieved. Tanzania's weak public governance system, its limited civil liberties (especially the threats to academic freedom), and low levels of literacy act as a drag on research production. Economically, the country has a GDP per capita below the Sub-Saharan average, an economy largely based on subsistence agriculture and almost half the population living in poverty. Despite the country's rapid economic growth, both the socio-political (RSC1, 3.3/7) and economic (RSC2, 2.4/7) conditions are major stumbling blocks to the development of a fully functioning research system.

Scoring 4.5/7, Tanzania has developed a relatively good policy framework for research (RSC3) as seen in its distinct policies for research and science and technology, and regularly updated strategies setting out the country's research priorities. However, the objectives set out in the policy documents remain largely unmet, and many of the projected interventions have never been implemented. The main reasons for this gulf between policy and practice appear to be the chronic lack of funding and capacity affecting national research institutions (RSC4, 2.7/7) and a disjointed approach to research policy implementation caused by fragmentation and instability at ministerial level (RSC5, 3.2/7). Moreover,

centralisation has stifled the contribution of other research stakeholders, with private actors contributing very little to research funding and support, or to development of evidence-based policy.

Perhaps more so than other African countries, Tanzania lacks the capacity to train and retain research talent. Scoring just 2.2/7, the country appears to suffer from a severe drain of its intellectual resources (RSC6). Furthermore, all but a small minority of researchers are employed by government and HE institutions, with the business sector not providing any alternative career opportunity for S&T researchers. With a score of 1.3/7, a severe lack of research funding (RSC7) was mentioned as the main cause of the low number of researchers, alongside the lack of research infrastructure. However, other factors are likely to play a significant role, namely the opportunity to continue the career abroad provided by the large number of intellectual research collaborations in the country, and the limits to academic freedom imposed by the government. Tanzania's rapidly growing research sector is moderately strong when seen in comparison to other Sub-Saharan African countries (RSC8, 3/7), but like other African countries HE institutions contribute relatively little in terms of research quality and impact as they see their primary role as educational.

While the government appears to value research, proclamations have not been met by adequate financial or political support for research production, and the government has also been lukewarm in its use of research information products or technology products (RCS15, 3.5/7). In particular, the role of research in informing policy has been questioned by stakeholders, especially when this does not align with government priorities or if it is seen as an obstacle to the pursuit of political objectives. By contrast, firms have been slightly more open to the use of technology, confirming a trend observed in other Sub-Saharan African countries that see businesses trying to 'catch-up' by adopting existing technology rather than spending (presumably scarce) resources in innovation. It is therefore unsurprising that, despite the existence of a dedicated government department, Tanzania still lacks strong knowledge exchange and commercialisation support and administration (RSC18, 3.2/7).

Table 1. Scoring of research system components

Section	Research system component	Score	Component ID
National context	Social and political context	3.3	RSC1
	Economic context	2.4	RSC2
	Total	**2.9**	-
Policy and institutional framework	National policy for research	4.5	RSC3
	National institutions for research	2.7	RSC4
	Stakeholder composition & relationships	3.2	RSC5
	Total	**3.4**	-
Research inputs	Human capital	2.2	RSC6
	Research funding	1.3	RSC7
	Research organisations	3.0	RSC8
	Total	**2.2**	-
Research culture and support	Research culture	3.5	RSC9
	Capacity building	2.7	RSC10
	Research support	-	RSC11
	Infrastructure and data	2.0	RSC12

	Total	**2.8**	**-**
Research outputs and evaluation	Research publications	2.6	RSC13
	Research evaluation	2.0	RSC14
	Total	**2.3**	**-**
Knowledge exchange (KE) actors and networks	National users of research	3.5	RSC15
	International exposure	6.0	RSC16
	Total	**4.8**	**-**
KE practices	Intellectual property	1.5	RSC17
	KE support and administration	3.2	RSC18
	Total	**2.3**	**-**

8. Recommendations

8.1 Identification of priorities

This section identifies options for research capacity strengthening in Tanzania 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. Three areas appear important:

- Create research training opportunities for women. Tanzania appears to face an especially severe challenge in training and retaining researchers in the country – with research talent often attracted by better career options in high-income countries but also in neighbouring countries. At the same time, the number of women pursuing a career in research is lower than other African countries, as they make up just over a quarter of the country's researcher population. There seems to be an opportunity to encourage and support more women in pursuing a research career as a way of plugging both the talent gap and the gender gap in research.

- Support research infrastructure. One of the major hurdles to retaining qualified and experienced researchers is the lack of adequate research infrastructure, both physical and digital. DFID could help resource existing research institutes or help establish new ones that perform research linked to the national research agenda and economic priorities. While this type of intervention might generate measurable impact in a relatively short space of time, long-term impact on the research system would depend on these centres achieving financial sustainability (e.g. to maintain and continue to develop the research infrastructure) when DFID funding comes to an end.

- Support capacity and coordination among national institutions. Tanzania's national framework for research suffers from weak coordination between ministries and capacity gaps in national research bodies, especially COSTECH. There seems to be a clear opportunity to help COSTECH identify its critical needs with regards to its numerous functions (policymaking, funding, monitoring and evaluating). Support could then be given for the development of appropriate responses, including relevant organisational changes needed to improve the coordination and harmonisation of government action on research.

8.2 Conclusions

The Needs Assessment has indicated that the gulf between policy and practice is especially large in Tanzania. Over 80% of research publications come from international collaborations, and the country relies on international funding for over half of its research expenditure. While this gives international funders some leverage, the consultation has revealed frustration with international collaborations and internationally-set research priorities – with major tensions arising around the definition of research priorities and the management of international research funds.

Interventions that systematically strengthen the capacity of researchers (especially female researchers) and those that support the development of effective research infrastructure in selected institutes can go hand in hand with creating opportunities to train and retain capacity in the country. These interventions are likely to have measurable impact within the lifetime of a project, but long-term effects on national research capacity depend on the intervention's ability to leverage national support. Planning research capacity strengthening (RCS) interventions in research areas that are aligned to national priorities and in collaboration with COSTECH and other relevant national stakeholders is key. This could strengthen relationships between international funders and key figures within the national body in charge for research. Moreover, it could encourage buy-in by national authorities and enhance the sustainability of the intervention, especially if the activities align with the national priority areas for research.

Working directly with the government may prove challenging for international donors, especially given the social and political context discussed in this report and existing frustrations with encroaching international agendas. But supporting regulatory quality and government effectiveness is essential to the functioning of Tanzania's research system. Stakeholders have been open about the lack of funding and capacity affecting government departments, so international funding could be an effective carrot to encourage high-level involvement and more harmonious collaborations where national priorities and sensitivities are valued and respected.

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
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 consider performance of the sub-rating "academic freedom" when rounding up the overall score for freedom of expression.	FH score 1-2 = Needs Assessment 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.
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
Internet speed	We consider internet speeds of around 2MB per second sufficient to browse the net for research, considering download and upload times for documents (score 4). Lower speeds are insufficient for any research activities, higher speeds are necessary for data-intensive research.	0-500kb/s =1; 501-1MB/s =2; <1-2MB/s =2; <2-5MB =4/ <4-10MB/s =5; <10-15MB/s =6; <15MB/s =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
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 50% as optimal, while lower proportions are rated negatively.	1-10%=1; 11-18%=2; 19-26% =3; 27-34% =4 35-42%=5 43-50%=6; >51%=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
National context					
Social and political indicators (RSC1)					
Social and political factors	Working language	English, Kiswahili	-	No direct impact on research performance	[1]
	Total population	56.3million	-	No direct impact on research performance	[2]
	Urban population (% of total)	33.8%	3	Tanzania has a low proportion of urban dwellers	[2]
	Type of government	Presidential	-	No direct impact on research performance	[3]
	Political stability	26/100	2	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Rule of law	35/100	3	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Regulatory quality	30/100	2	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Government effectiveness	28/100	2	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Voice and accountability	37/100	4	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Corruption (ranking)	99/180	3	See table 3. Ranking goes from 1 (best) to 180 (worst)	[5]
	Access to information	73/150	4	See table 3. Score goes from 0 (worst) to 150 (best)	[6]
	Freedom of expression	7/16	4	See table 3. Rated	[3]
	Adult literacy rate (% population aged 15+)	78%	4	Literacy rates are lower than the global average.	[7]
	Gender Development Index	0.928	5	Women's achievements in health, education and command are lower than men's, underlying gender inequality in line with the African average.	[8]
Economic indicators (RSC2)					
Economic development	GDP per capita USD	$1,050	1	See table 3.	[9]
	Agriculture, value added (% of GDP)	28.7%	-	No direct impact on research performance	[9]
	Manufacturing, value added (% of GDP)	7.7%	-	No direct impact on research performance	[9]
	Population living in poverty ($1.9/day)	49.1%	1	See table 3.	[9]
Digital infrastructure	Access to internet (ranking)	126/137	6	See table 3.	[10]
	Individual using Internet/100 people	13	-	Scored under 'Access to internet'	[10]
	Broadband internet subscription/100 people	0.3	-	Scored under 'Access to internet'	[10]
	International internet bandwidth, kb/s per user	1.7	1	Broadband speed is very slow and inadequate for all types of research. See table 3	[10]

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
	Mobile internet subscriptions/100 pop	9.2/100	1	Mobile internet subscriptions are very uncommon in Tanzania.	[10]
Competitiveness	Global Competitiveness Index (ranking 2018)	113/137	5	See table 3	[10]
	Overall technology readiness	2.6/7	2	See table 3	[10]
	Capacity for Innovation	3.6/7	3	See table 3	[10]
	Innovation index (score)	27/100	2	See table 3	[11]
Policy and institutional framework					
National policy for research (RSC3)					
National policies	Existence of a national research policy	YES	6	Tanzania has a robust research policy which is directly linked to national economic development.	Interviews
	Existence of sector-specific research policies	YES	6		Interview
	Research policy updated in the last 10 years	YES	6	See section 3.1	[11]
	Existence of an appropriate Strategy for STI	YES	5	See section 3.1	Interviews
	Capacity development is part of the Strategy	NO	2	See section 3.1	Interviews
	Country has appropriate indicators tracking R&D	NO	2	See section 5.2	Interviews
National institutions for research (RSC4)					
National institutions	The country has a ministry or department for research	YES	6	COSTECH is Tanzania's department for research	Interviews
	The ministry/department for research is sufficiently resourced	NO	2	There was widespread agreement among interviewees that COSTECH are trying to achieve too much with not enough resources.	Interviews
	The country has one or more national research funders	NO	2	COSTECH is Tanzania's only national research funder.	Interviews
	The research funders have sufficient financial resources	NO	1	See section 5.1	Interviews
	Quality of the research funder management capacity	Poor	2	See section 5.1	Interviews
	The country has a national research ethic body	NO	5	See section 5.2	Interviews
Stakeholder composition and relationships (RSC5)					
Stakeholder composition	Clarity of relationships between national actors	Good	6	See stakeholder table	Interviews
	Clarity of decision-making and accountability processes	Somewhat poor	3	See section 4.2	Interviews
	Level of coordination between government	Neither poor nor	4	No suggestion that government is not joined-up and	Interviews

UKaid from the British people

COMPONENT	INDICATOR		VALUE	SCORE	DETAILS	SOURCE
	department		good		indeed, the national research strategy was formulated through consultation across 15 sectors.	
	Cohesion between policy mechanisms		Low	2	They have a good strategy but they lack the skills and resources to implement policy.	Interviews
	Level of participation in decision-making/standard-setting		Below average	3	Government consults with think tanks but doesn't follow their advice because subsequent policy *seems* to be disconnected from reality/recommendations.	Interviews
	Quality of monitoring & enforcement mechanisms (M&E)		Very poor	1	There are no mechanisms, tools or processes dedicated to M&E of policy.	Interviews
Research inputs						
Human capital (RSC6)						
Human capital	Total R&D personnel per million people (FTE)		38.8	1	See table 3	[12]
	Researchers per million inhabitants (FTE)		18.3	2	See table 3	[12]
	Researchers (FTE) - Business enterprise %		-	-	See table 3	-
	Researchers (FTE) - Government %		28.7%	2	See table 3	[12]
	Researchers (FTE) - Higher education %		71.3%	5	See table 3	[12]
	Researchers (FTE) - Private non-profit %		-	-	See table 3	-
	Researchers (FTE) – Female %		24.5%	1	See table 3	[12]
	Researchers (FTE) with ISCED 8 %		32.8%	2	See table 3	[12]
Research funding (RSC7)						
Research funding	Total GERD (in current PPP$)		$623,754			[12]
	GERD per capita (%GDP)		0.5%	2	See table 3	[12]
	GERD per researcher FTE (in current PPP$)		$671	-	Indirect measure (GERD/number of research). Not scored as high numbers may be due to inefficiencies.	[12]
	GERD financed by abroad (% total)		42%	1	See table 3	[12]
	GERD performed by	business (% total)	-	1	Indirect measure (GERD/number of research). Not scored as high numbers may be due to inefficiencies.	-
		gov (% total)	38.7%			[12]
		HE (% total)	61.4%			[12]
		private non-profit (% total)	3.8%			[12]
Research organisations	Average quality of research organisations		69/137	4	See table 3	[10]
	Global ranking of Muhimbili University of Health and Allied Sciences		679/3471	2	See table 3	[13]
	Global ranking of Sokoine University of		725/3471		See table 3	[13]

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
	Agriculture				
	Global ranking of University of Dar es Salaam	782/3471		See table 3	[13]
Research culture and support					
Research culture (RSC9)					
Research culture	Perceptions of the utility of research	Neither poor nor good	4	Awareness is high on paper but limited in practice. See section 4.2	Various
	Time allocated to research	Below average	3	Academic staff are expected to do research but the focus is on learning and teaching and support huge cohorts of students. See section 4.2	Interviews
Capacity building (RSC10)					
Capacity building	Overall research training capacity	Very low	2	See section 4.2	Interviews
	Local availability of specialized training services (not research specific)	3.9/7	4	Perception of the availability of high-quality, professional training services	[10]
	Funding for Research Capacity Strengthening	Very low	2	See section 5.1	Interviews
	% HEI with PhD programmes	N/A	-	N/A	-
Research support (RSC11)					
Research support	Level of access to proposal writing support	N/A		N/A	Interviews
	Existence of institutional policies	N/A		N/A	Interviews
	Quality of administrative support	N/A		N/A	Interviews
Infrastructure and data (RSC12)					
	Is there a central repository for research data?	NO	2	There is no national data repository. Some data at local level.	Interviews
	Quality of research infrastructure	Poor	2	See section 4.2	Interviews
Research output and evaluation **Products of scientific research (publications and patents) and incentives for producing research**					
Research publications (RSC13)					
Research publications	Total # of publications (2018)	1705	-	Not scored, dependent on population size	[14]
	Publications per million people (2018)	30.3			
	Total # of citable publications	16072	-	Not scored, dependent on population size	[14]
	Citations per publication (1996-2018)	17.08	-	Scored by ranking (below)	[14]
	Citations per publication ranking (1996-2018)	65/236	1	See table 3	[14]
	H index ranking	80/136	4	See table 3	[14]

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
	# Journals listed in SciMago	1	1	See table 3	[14]
	Scimago country ranking 2018	86/239	2	See table 3	[14]
	Percentage of papers in 10% most-cited papers (2008–2012)	12.9%	5	The G20 average is 10.2%	[15]
	% of total publications for Africa	2.22%	-	Relative to country population, not scored	[14]
Research evaluation (RSC14)					
Research evaluation	Existence of national mechanisms for research quality evaluation	NO	-	See section 5.3	Interview
	Quality of incentives for research production	Very poor	2	Publication equals promotion, but incentives are ineffective because academic staff are all salaried for teaching.	Interview
Knowledge exchange (KE) actors and networks					
National users of research (RSC15)					
National users of research	Firm Level Technology absorption	4.1/7	4	See table 3	[10]
	FDI and Technology Transfer	4.0/7	4	See table 3	[10]
	Gov't procurement of technology products	3.5/7	3	See table 3	[10]
	Government use of research information/products	Low	3	Other than policy/strategy development, there is little evidence to suggest government has utilized research outputs/outcomes	Interview
International exposure (RSC16)					
International exposure	International collaboration 2018 (% of total)	82.87%	6	See section 6.1	[14]
	Main foreign partners	4/5 Northern	-	USA, UK, Kenya, Switzerland, South Africa	[14]
Knowledge exchange practices					
Intellectual property (RSC17)					
Intellectual property	Country has a body in charge of intellectual property protection	NO	2	See section 6.2	[16]
	Country is member of a regional IP organisation				[16]
	Number of patents applications per million people (global ranking)	107/119	1	See section 6.2	[10]
	Number of patents applications per million people (African ranking)	13/21	-	Scored by global ranking only	[10]
KE support and administration (RSC18)					
Knowledge exchange	Country has joined a regional initiative for the	YES	6	Member of Southern African Development Community	

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
support and administration	promotion of STI			(SADC); and Member of East African Community (EAC).	
	University-Industry collaboration (score)	3.5/7	3	See table 3	[10]
	University-Industry collaboration (ranking)	61/137	3	There is an implementation/intervention gap between Government (research) and industry (commercialisation).	[10]
	Existence of appropriate institutional policies for KE	NO	2	See section 6.2	Interview
	Quality of incentives for research diffusion	Poor	2	The expectation is for academics to publish, but there is no clear incentive to do so. See section 4.2	Interview
	Existence of commercial office	NO	2	See section 6.2	Interview

Appendix B – Tanzania stakeholder table

Table 5. Non-exhaustive list of the MAIN research stakeholders in the country.

	Tanzania		International	
	Public	**Private**	**Public**	**Private**
Policymakers	• Ministry of Education, Science and Technology Ministry of Defence and National Service • The Ministry of Health and Social Welfare (MoHSW) • Ministry of Industry and Trade • Ministry of Agriculture, Livestock and Fisheries • Ministry of Natural Resources and Tourism			
Intermediaries	• Tanzania Commission for Science and Technology (COSTECH) • Environment for Development Initiative (EfD) • International Growth Centre	• The Economic and Social Research Foundation	• African Economic Research Consortium • Council on Health Research for Development • East African Research and Innovation Management Association (EARIMA)	

			• Institute for Lifelong Learning (UNESCO) • International Growth Centre Tanzania	
Research funders	• Tanzania Commission for Science and Technology (COSTECH)		• Department for International Development • International Development Research Centre • Swedish Development Agency • UNESCO	• Bill & Melinda Gates Foundation • Comic Relief • Rockefeller Foundation • Wellcome Trust • Alliance for a Green Revolution in Africa (AGRA) • Rufford Small Grants Foundation (RSGF) • International Network for Availability of Scientific Publications (INASP)
Universities	• 11x public universities • 4 public university colleges	• 16x private universities • 11 private university colleges		
Think tanks & research institutes	• Institute of Kiswahili Studies • Tanzanian Livestock Research Institute (TALIRI) • East Africa Centre for Research and Innovation in Social Work • Centre for Education and Development in Health (CEDHA) • Agricultural Research Institute Mikocheni	• Ifakara Health Research and Development Centre (IHI) • Primary Health Care Institute, Iringa • Tea Research Institute of Tanzania (TRIT) • Tanzania Coffee Research Institute (TaCRI)	• International Growth Centre • World Bank	

	• National Environment Management Council (NEMC) • National Housing and Building Research Agency • National Institute for Medical Research • Tanzania Automotive Technology Centre • Centre for Agricultural Mechanization and Rural Technology • Tanzania Atomic Energy Commission • Tanzania Fisheries Research Institute (TAFIRI) • Tanzania Forestry Research Institute (TAFORI) • Economic and Social Research Foundation (ESRF) • Research for Poverty Alleviation (REPOA) • Tanzania Gender Networking Programme (TGNP) • Society for Women and Aids in Africa -Tanzania (SWAAT) • Tanzania Industrial Research and Development Organisation • Tanzania Industrial Studies and Consulting Organisation	• Tanzania Technology Development Organization (TaTEDO)		

	• Tanzania Wildlife Research Institute (TAWIRI) • Tea Research Institute • Technology Development and Transfer Centre (TDTC) • Tropical Pesticides Research Institute • National Social Welfare and Training Institute • Tanzania Bureau of Standards • Tanzania Engineering Manufacture and Design Organisation • Ungozi Institute • Twaweza • Ifakara Health Institute (IHI)			

Appendix C – Interviewees

Name	Organisation
Prof Forunata Songora Makene	Economic and Social Research Foundation
Dr Tausi Mbaga Kida	Economic and Social Research Foundation
Vivian Kazi-Mateng'e	Economic and Social Research Foundation
Donald Mmari	Research on Poverty Alleviation
Erik Thomas	Science, Technology and Innovation Policy Research Organisation
Dr Gussai Sheikheldin	Science, Technology and Innovation Policy Research Organisation
Dr Musambya Mutambala	Science, Technology and Innovation Policy Research Organisation
Dr Asifa Nanyaro	Tanzania Academy of Sciences
Prof Esther Mwaikambo	Tanzania Academy of Sciences

Appendix D – Peer reviewers

The following table includes a list of individuals who peer reviewed the present report and whose support we gratefully acknowledge.

Name	Organisation
Ajoy Datta	On Think Tanks
Robin Drennan	The University of the Witwatersrand

Appendix E – Key data sources

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