

AFRICAN INNOVATION ECOSYSTEMS STUDY (AIESYS)

Output 1

Output 1: Synthesis by country of innovation ecosystem facilitation initiatives

Updated: 7 May, 2021

AIESyS Team

Julius Mugwagwa
Carla Washbourne
Dr Anne Marie Kagwesage
Remy Twiringiyimana

Katrina Barker
Chisom (Gabriella) Ezeani
Oluwatobi Karim
Arda Ozcubukcu



Please cite this report as:

Mugwagwa, J., Washbourne, C-L., Kagwesage, A.M., Twiringiyimana, R., Barker, K., Ezeani, C., Ozcubukcu, A (2021) African Innovation Ecosystems Study (AIESyS) Output 1: Synthesis by country of innovation ecosystem facilitation initiatives. UCL and UK Foreign Commonwealth and Development Office

TABLE OF CONTENTS

| | |
|--|-----------|
| <i>Key Terms</i> | 3 |
| <i>List of Abbreviations</i> | 6 |
| <i>Executive summary</i> | 10 |
| <i>Context</i> | 20 |
| <i>Conceptual Framework for the African Innovation Ecosystems Study (AIESyS)</i> | 21 |
| <i>Methodology</i> | 28 |
| <i>Existing innovation ecosystem support and development initiatives</i> | 30 |
| Southern Africa | 31 |
| Angola..... | 31 |
| Botswana | 33 |
| Malawi | 38 |
| Namibia..... | 41 |
| South Africa | 45 |
| Zambia | 49 |
| Zimbabwe | 52 |
| West Africa | 56 |
| Cameroon | 56 |
| Ghana..... | 59 |
| Nigeria..... | 62 |
| <i>Acknowledgements</i> | 67 |
| <i>References</i> | 68 |

Key Terms

Accelerator:** Facilities, short-term funding and support. Accelerator is broadly defined by BriterBridges and AfriLabs (2019) as a “structure that offers cohort-based and fixed term programmes (usually between 3 to 9 months) to support growth stage ventures to achieve scalability and self-sufficiency, by offering advisory services, mentorship, workshops, networks and usually investments in cash or in-kind”.

Active Tech Hub:** Tech Hub with active digital presence over the past two quarters.

Co-working spaces:** Facilities but not specific support programmes. As defined by BriterBridges and AfriLabs (2019), a co-working space is a “shared physical workspace that provides office facilities and a community to start-ups, small companies and independent workers, offering reasonable and flexible contracts for its users and encouraging peer-learning, networking capacity development, and collaboration”.

Ecosystem*1: A dynamic framework consisting of a set of stakeholders, including start-ups, hubs, investors, academic institutions, public institutions, corporations, who interact and engage with each other to seize new opportunities, support innovation and strengthen the overall business environment for entities at different stages, sectors, and geographical locations.

Emerging digital Start-up: The newly established venture with the capability to solve problems through digital technologies.

Entrepreneurial innovation hub*: Drawing on Daniels et al. (2021), an entrepreneurial innovation hub is defined as an open space for technologists, investors, tech companies and hackers, facilitating networking platforms to support entrepreneurship, capacity building and knowledge sharing in various domains.

Entrepreneurial or business ecosystem:** The urban and sub-urban dimension, for instance of economic and innovation activities, interactions between actors and socio-institutional environment. Drawing on a generic definition by (Audretsch et al., 2019): “...organized attempts to establish environments that are conducive to increasing the success for newly established ventures”.

Fablabs:** Digital fabrication laboratories. Defined by Fablabs.io, as a “place to play, to create, to mentor and to invent: a place for learning and innovation...”

Hackathon*: A tech-focused event taking place across a set of timeframes which can usually span between one day to a week, and that gathers specialists in computer programming, digital creation, technology or software development to collaborate on specific ideas or concepts to find solutions to a problem or to design, develop and create minimum viable products (MVPs). As defined by Eric Ries, MVP is the “version of a new product which allows a team to collect the maximum amount of validated learning about customers with the least effort”.

¹ * As defined by BriterBridges and AfriLabs (2019)

Hackerspace and Makerspace*: A physical facility or lab fitted with machinery, technological tools and other equipment to help communities and individuals co-create and explore ideas, create prototypes and test products, as well as develop technical skills and knowledge.

Hub*: A centre, structure or network comprising of actors supporting or facilitating the development of an environment conducive to entrepreneurship or innovation. According to (De Beer et al., 2017), hubs are categorised in three types: *technology communities (clusters)*, *companies and government-backed ventures (country hubs)*. Cities are also often defined as hubs when they represent important nodes for business and investment.

Incubator**: Facilities, in-kind support at idea/early-stage. Incubator is broadly defined by BriterBridges and AfriLabs (2019) as a “support structure that helps early-stage start-ups transform from idea to venture, by offering advisory services, resources, workshops and hands-on training that guide entrepreneurs in defining and refining their business models and value propositions with the goal of becoming sustainable business. They [incubators] sometimes have a limited pool of cash to support businesses”.

Informal sector: Defined by Tong et al.(2021), informal sector refers to individuals and/or private micro-businesses whose activities are neither organised nor recognised by the authorities.

Innovation city: a geographic concentration of different and specialized innovation clusters, such industrial clusters (Otsuka and Sonobe, 2018) business incubators, and knowledge clusters (a concentration of universities and research organization), with the aim to facilitate development strategy of a city, a country or a region. However, the terms ‘innovation city’ and ‘innovation hub’ tend to be used interchangeably. For instance, the Kigali Innovation City (KIC) is being developed as pan-African tech innovation hub².

Innovation cluster: As defined by Porter (1998), a cluster is a concentration of interconnected and competing firms and organisations, producing similar or related products and/or services in a specific geographical location. These actors form an Innovation Cluster when they cooperate to allow the flow of knowledge and/or technology through formal or informal interactions at individual or organizational level.

Innovation ecosystem: denoting all of the different players involved in innovation processes - such as governments, people, businesses, activities and products. Like ecosystems in nature, “innovation ecosystems” are complex, dynamic and continually evolving. Generically defined by Granstrand and Holgersson (2020): “the evolving set of actors, activities, and artefacts, and the institutions and relations ... that are important for the innovative performance of an actor or a population of actors”. The ability of actors’ collaborative networks to adapt themselves to a non-

² <https://www.africa50.com/investing-for-growth/projects-investments/kigali-innovation-city/>
[Accessed:20.04.2021]

linear environment, within a particular innovation ecosystem, implies that “they assume certain features of complex adaptive systems - agility, self-organization, self-governance, and synergy effects” (N Smorodinskaya et al., 2017).

Innovation: Viewed through the lenses of NSI/NIS conception, ‘Innovation is defined as “an interactive learning process” (Lundvall, 2010, p. 340). Innovation starts with a good idea, but necessarily includes the creation of new products, tools or processes that are tested and taken up and used by their target audiences.

National Innovation System (NIS) or National System of Innovation (NSI): “The elements and relationships which interact in the production, diffusion and use of new, and economically useful knowledge... and are either located within or rooted inside the borders of a nation state” (Lundvall, 2010, p. 2). NSI is one of the frameworks mostly used to study innovation policy in high income countries (HICs), and low and medium income countries (LMICs) alike (Daniels et al., 2017). Aside from NSI, Innovation Systems can have regional, sectoral, and (or) technological delineations. They can also focus on economic bottom of the pyramid (BoP) end users e.g. inclusive innovation, frugal innovation etc. (Chataway et al., 2014).

Technology (Tech) Hubs^{*}:** active organisation with physical address, providing facilities, financial or in-kind support to tech-entrepreneurs, or tech start-ups.

Technology Parks or Techno-parks: Defined by (Wdowiarz-Bilska, 2019): “Building complexes fulfilling functions of services, offices, laboratories, and industries, located in landscape arranged areas”, usually in urban settings. The term ‘Technology park’ is in most instances used synonymously as other terms which describe innovation centres such as: science park, science and technology park, research park, techno-polis and city of science. Techno parks are also broadly viewed as “vehicles for university-industry cooperation” (Daniels et al., 2017).

³ **As defined by (Dosso et al., 2021) and BriterBridges (2019)

List of Abbreviations

ACE: Agricultural Centres of Excellence, Zimbabwe
AfDB: African Development Bank
AI: Artificial Intelligence
AICS: African Institute of Computer Science, Cameroon
AIESyS: African Innovation Ecosystem Study
AIO: African Innovation Outlook
ANC: African National Congress, South Africa
ARC: Agricultural Research Council, South Africa
ARET: Agricultural Research and Extension Trust, Malawi
ARIPO: African Regional Intellectual Property Organization
ASARECA: Association for Strengthening Agricultural Research in Eastern and Central Africa
ASTII: African Science, Technology and Innovation Indicators Initiative
ATPS: African Technology Policy Studies Network
AU: African Union (AU)
BAH: Botswana Agricultural Hub
BERD: Business enterprise expenditure on R&D
BIH: Botswana Innovation Hub
BITRI: Botswana Institute for Technology Research and Innovation
BIUST: Botswana International University of Science and Technology
BMZ: German Federal Ministry for Economic Cooperation and Development
BoP: Bottom of the Pyramid
BUAN: Botswana University of Agriculture and Natural Resources
CAPRISA: Centre for the AIDS Programme of Research in South Africa
CBC: Cattle Business Centres, Zimbabwe
CEE: Citizen Economic Empowerment
CGIAR: Consultative Group on International Agricultural Research, Malawi
CPN: Computer Professionals Registration Council of Nigeria
CSIR: Council for Scientific and Industrial Research, South Africa
DANIDA: Danish International Development Agency
DCMS: UK government's Department for Digital, Culture, Media, and Sports
DeSIRA: Development Smart Innovation through Research in Agriculture, Malawi
DST: Department of Science and Technology, South Africa
DTIC: Department of Trade Industry and Competition, South Africa
EC: European Commission
ECOWAS: Economic Community of West African States
ETSSP: Education and Training Strategy Sector Plan
EU: European Union
FABI: Forestry and Agricultural Biotechnology Institute, University of Pretoria, South Africa
FAO: Food and Agricultural Organisation
FCDO: The Foreign, Commonwealth and Development Office
FIRO: Federal Institute of Industrial Research, Nigeria
GDP: Gross Domestic Product
GERD: Gross Expenditure on R&D
GII: Global Innovation Index
GIRC-Centre: Ghana Innovation and Research Commercialisation Centre

GIZ: “Deutsche Gesellschaft für Internationale Zusammenarbeit”, Germany
GSMA: Global System for Mobile Communications Association
HICs: High Income Countries
ICRAF: World Agroforestry Centre
ICT: Information and Communication Technology
IDEA: Information Developers Entrepreneurship Accelerator, Nigeria
IGP: Innovation Grant Program, Zimbabwe
IKS: Indigenous Knowledge Systems
INAPEM: National Institute to Support Small and Medium Enterprises, Angola
INGOs: International non-governmental organisations
IP: Intellectual Property
IT: Information Technology
KFW: “Bank aus Verantwortung”, Germany
LMICs: low and medium income countries
LUANAR: Lilongwe University of Agriculture and Natural Resources
MESTI: Ministry of Environment, Science Technology and Innovation, Ghana
MGDS: Malawi Growth Development Strategy
MHEST: Ministry of Higher Education and Science and Technology, Angola
MIAC: Ministry of International Affairs and Cooperation, Botswana
MICF: Malawi Innovation Challenge Fund
MINADER: Ministry of Agriculture and Rural Development, Cameroon
MINMIDT: Ministry of Mines, Industry and Technological Development, Cameroon
MINRESI: Ministry of Scientific Research and Innovation, Cameroon
MSMEs: Small and Medium-sized Enterprises
MUST: Malawi University of Science and Technology
MVPs: Minimum Viable Products
NAP: National Adaptation Plan, Botswana
NARDI: National Agricultural Research and Development Institution, Botswana
NBM: National Bank of Malawi
NBRI: National Botanical Research Institute, Namibia
NCC: National Competition Commission, Cameroon
NCC: Nigerian Communications Commissions, Nigeria
NCRST: National Commission on Research, Science and Technology, Namibia
NCST: National Commission for Science and Technology, Malawi
NDP: National Development Plan 2030, South Africa
NDPs: National Development Plans
NDS: National Development Strategy 2021-2025, Zimbabwe
NEPAD: New Partnership for Africa’s Development
NFTRC: National Food Technology Research Centre, Botswana
NGOs: Non-governmental Organisations
NHSRC: National Health Science Research committee, Malawi
NIPC: Nigerian Investment Promotion Commission
NIS: National Innovation System
NITDA: Digital Technology for National Economic Development while the National Information Technology Development Agency, Nigeria
NOTAP: National Office for Technology Acquisition & Promotion, Nigeria
NPOs: Non-for-Profit Organisations
NRCM: National Research Council of Malawi, Malawi
NRF: National Research Foundation, South Africa
NSC: National Senior Certificate, South Africa

NSI: National System of Innovation
NSTP: National Science and Technology Policy, Malawi
NUST: Namibia University of Science and Technology
NUST: National University of Science and Technology, Zimbabwe
ODL: Open and Distance Learning
OECD: Organisation for Economic Co-operation and Development
OHADA: Organisation for the Harmonization of Business Law in Africa
POP: Point of Presence
PPP: Public-Private Partnership
PSDP: Malawi Government's Private Sector Development Project
R&D: Research and Development
RDI: Research, Development and Innovation
RSTI: Research, science, technology and innovation, Namibia
RUBIC: Rhodes University Biotechnology Innovation Centre, South Africa
SADC: Southern Africa Development Community
SAIS: Southern Africa Innovation Support Programme
SAMRC: South African Medical Research Council
SANBIO: Southern African Network on Biosciences
SARIMA: Southern African Research and Innovation Management Association
SAVP: Southern African Venture Partnership
SET: Science, engineering and technology
SIRDC: Scientific and Industrial Research and Development Centre, Zimbabwe
SMEs: Small and Medium-sized Enterprises
SPII: Support Programme for Industrial Innovation, South Africa
SSA: Sub-Saharan Africa
STI (ST&I): Science, Technology and Innovation
SU: Stellenbosch University, South Africa
SWOT: Strength, Weakness, Opportunity and Threats
TEKES: The Finnish Funding Agency for Technology and Innovation
TEVET: Technical, Entrepreneurial and Vocational Education and Training, Malawi
THRIP: Technology for Human Resource Industry Programme, South Africa
TIA: Technology Innovation Agency, South Africa
TVET: Technical and vocational education and training
UAN: "Universidade Agostinho Neto", Angola
UB: University of Botswana
UCL STEaPP: University College London, Department of Science, Technology, Engineering and Public Policy
UCT: University of Cape Town, South Africa
UN: United Nations
UNAM: University of Namibia
UNCEF: United Nations Children's Fund
UNCTAD: United Nations Conference on Trade and Development
UNDP: United Nations Development Programme
UNESCO: United Nations Educational, Scientific and Cultural Organisation
UNIDO: United Nations Industrial Development Organisation
UR CASS: University of Rwanda, College of Arts and Social Sciences
USAF: Universal Service and Access Fund, South Africa
UTF: University Technology Fund, South Africa
UWC: University of the Western Cape, South Africa
VAR: Virtual Augmented Reality

WB: World Bank

WEF: World Economic Forum

WHO: World Health Organisation

WIPO: World Intellectual Property Organisation

YIN: Young Innovators of Nigeria Social Organization

ZAGP: Zimbabwe Agricultural Growth Programme

ZCHPC: Zimbabwe Centre of High Performance Computing

ZICTA: Zambia Information and Communications Authority

ZINGSA: Zimbabwe National Geospatial and Space Agency

Executive summary

Output 1 is the first report of the African Innovation Ecosystems Study (AIESyS). The study seeks to better understand the range of existing innovation ecosystem support interventions and programmes in Southern and West Africa. It takes a wide approach to innovation ecosystems and explicitly includes work beyond digital and financial sectors and innovations. It focuses on innovation ecosystems and support initiatives in 10 African countries: South Africa, Angola, Botswana, Namibia, Malawi, Zambia and Zimbabwe in Southern Africa; and Nigeria, Ghana and Cameroon in West Africa, with a view to identify best practice, gaps and opportunities for the design of potential interventions to improve ecosystem facilitation methodologies. It also seeks to identify collaboration and partnership opportunities for a wide range of national, regional and global development partners and stakeholders across the region.

- Output 1: explores the nature of contemporary innovation ecosystems and sets out the context and framing for the study.
- Output 2: provides recommendations for ways to support innovation ecosystem facilitation at and beyond country level, addressing gaps, challenges and blockages and focussing on building on existing strengths.

Output 1 sets out the background to, and conceptual framework of, AIESyS and provides details of the methodology which was followed to generate data feeding into both Output 1 and Output 2. Output 1 provides a high-level review of literature (policies, programmes, reports and academic papers) on innovation ecosystems, going on to present country cases based on this review and supplemented by data collected in an anonymous, online survey (which is described and analysed comprehensively in Output 2), covering a wide range of ecosystem actors across the 10 countries, and semi-structured interviews conducted with key stakeholders working in and across different innovation ecosystems. The details of these are covered in the 'Methodology' section of this report.

The bulk of Output 1 is devoted to an exploration of existing innovation ecosystem support and development initiatives, providing detailed insights for each of the study countries. The cases presented are supported by further data and analysis which can be seen in full in the appendices.

Background and context

The report begins by establishing how innovation is crucial for increasing productivity, economic growth and advancing livelihoods and why, increasingly, governments (and other stakeholders) are focusing on innovation policy as being key to economic development. It explains how innovation starts with a good idea, but necessarily includes the creation of new products, tools or processes that are tested and taken up and used by their target audiences. This study appreciates that innovation ecosystems combine people, processes and resources in diverse and complex ways and, as such, adopts the broad definition of an innovation ecosystem

defined by Ove Granstrand & Marcus Holgersson (2020⁴) as ‘the evolving set of actors, activities, and artefacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors’. The review presents the idea that a functioning innovation ecosystem can make taking a new product, tool or process to market more straightforward (and profitable). If the innovation ecosystem is not functioning well there are multiple disincentives to innovation development, which can have long-term negative impacts on local and national economies.

This report briefly explores the recent history of research and practice in innovation ecosystems, noting that their mapping emerged in the middle of the past decade as a methodological approach for strengthening understandings on the contribution to or influence of innovations to economic development of the African continent. It then sets out the conceptual framework for the AIESyS study, following the emergence of the concept of innovation ecosystems from the early 2000’s, complementing the broader work on innovation systems which have been commonly discussed in academic works since at least the early 1990s (Lundvall, 1992; Nelson, 1993; Edquist, 1997; Malerba, 2005). It also explores the challenges implicit in bringing an innovation ‘to market’ and sets out some of the known challenges for innovations in general – such as the importance of support and facilitation at particular stages of the innovation (venture) life cycle - and of innovation ecosystems across the African continent including an exploration of the varying fortunes of (tech-) hubs which saw a rapid surge in establishment over the last decade.

Summary overview of existing innovation ecosystem support and development initiatives

The figures below are all based on aggregated responses to the AIESyS survey, as part of the primary data gathering of the overall study, which provide helpful framing to the areas covered in Output 1. The survey data is described and analysed comprehensively in Output 2.

Figure 1 presents a summary of the sectors and thematic areas perceived to have the strongest innovation ecosystems across the countries surveyed. The strongest sectors include ‘Digital’ and ‘Agriculture’, though ‘Health / medical’ and ‘Entrepreneurship / knowledge based’ also appear at medium or high levels across the countries studied. ‘Physical’ and ‘Social’ sciences and ‘Climate change’ were represented at a low level across all of the countries studied. Respondents from Malawi, Namibia, South Africa and Zimbabwe did not highly rank any of these sectors (or ‘other’ sectors) in their country-level innovation ecosystems. Other sectors / thematic areas identified as ‘other’ include: ‘Manufacturing’, ‘Start-up’ and ‘Financial’.

Figure 2 presents a summary of factors which are perceived as having enabled strong sectoral innovations. ‘Government / public sector support’, ‘Private / business sector support’ and ‘International support’ are ranked consistently highly, while ‘Non-profit’ and ‘Partnership support’ less so. Some countries illustrate a narrower focus in

⁴ Granstrand and Holgersson, (2020). Innovation Ecosystems: A Conceptual Review and New Definition in *Technovation* 90-91 102098.

these factors (e.g. ‘Government...’ in Angola) while others rank a number of factors more-or-less equally (e.g. Malawi, Nigeria).

2.1 Which sectors or thematic areas in your country have the strongest innovation ecosystems?

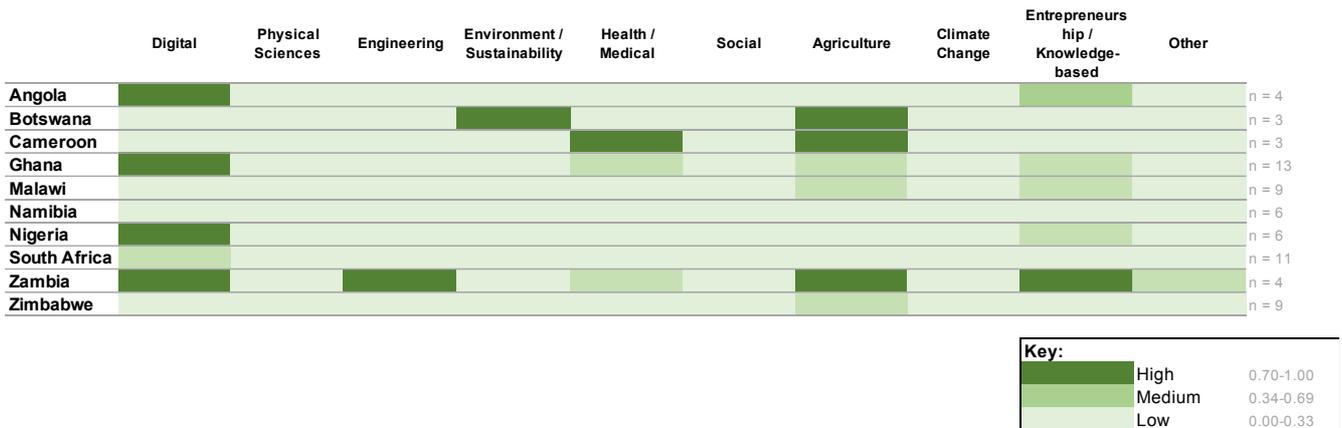


Figure 1: Heatmap of sectors / thematic areas perceived as strong in country-level innovation ecosystems

2.2 What factors have enabled strong sectoral innovations?

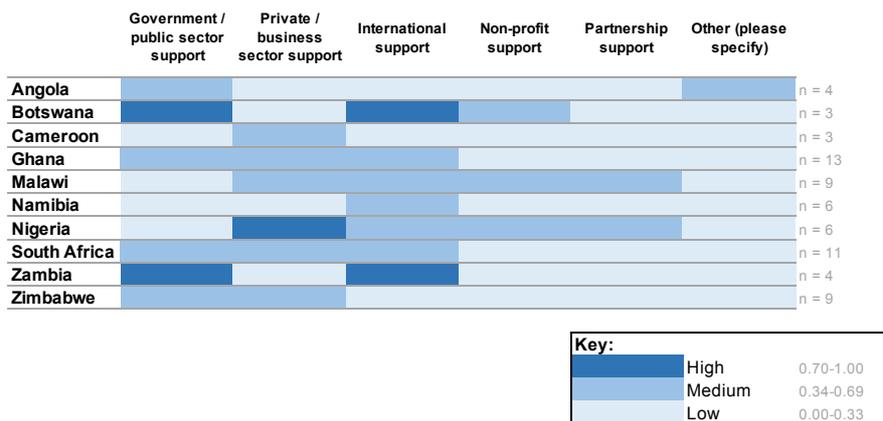


Figure 2: Heatmap of factors perceived as enabling strong sectoral innovations⁵

Figure 3 presents an overview of successful ‘types’ of innovation ecosystems that the respondents are familiar with in their countries. Innovation hubs were highly represented and viewed as successful by many respondents with the exception of Botswana, Cameroon and Zambia. Innovation clusters were moderately well represented in Botswana and Ghana. Very few responses highlighted other types of innovation ecosystem, and those that were indicated include: ‘Entrepreneurial innovation hub’, ‘Emerging Digital Start-ups’, ‘Informal sector’, ‘Universities’, ‘Private/Government partnerships’ and specific named examples such as the ‘African Drone and Data Academy’.

⁵ Unlike the Non-profit and International support, Partnership support includes activities (or initiatives) that partly involve stakeholder commitment for resource contribution (in kind, cash, or human infrastructure). Partnership support can involve Government-International organisation-Academia-Community as it is the case of DeSIRA Initiative in Malawi; or Government-Industry-Local NGO-International Organisation-Academia for the case of Young Innovators Nigeria (YIN) (See details in Appendix_1).

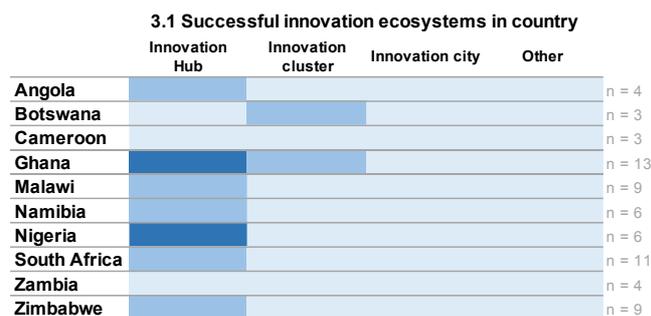


Figure 3: Heatmap of successful innovation ecosystem types

Figure 4 presents an overview of the key types of actors for sustaining or building on ecosystem strengths. ‘Government / Policymakers’, ‘Industry / Entrepreneur / Spin-Off’, ‘Academic / research institution’ and ‘Collaborative Space Organisation’ were all very highly represented in the survey responses, with ‘International Development Organisations’ and ‘Development Finance Institutions’ seeing moderate to high representation. ‘Think Tanks or Advisory Bodies’, ‘Non-Profit Organisations’ and ‘Regional / Continental Organisations’ were not highly ranked as actors in building or sustaining country-level ecosystems.

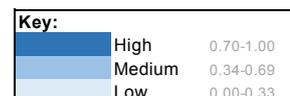
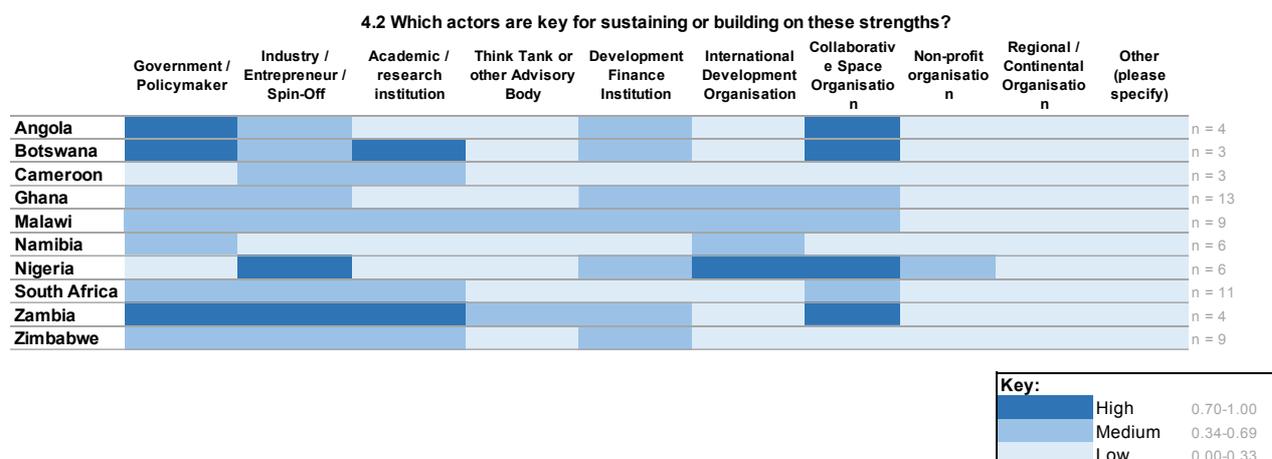


Figure 4: Heatmap of key actors in sustaining / building on strengths in innovation ecosystems

The summaries below provide an overview at country-level of existing innovation ecosystem support and development initiatives, highlighting areas of existing expertise including best practice and indicating further collaboration opportunities, building on successes and minimising unnecessary duplication. Key statistics are drawn from the Global Innovation Index (GII 2020) (WIPO 2020). GI 2020 scores countries according to seven key pillars of innovation including: Five pillars for innovation inputs sub-indices and Two pillars of the innovation output sub-indices (see Page 28 for further details). For Angola, which is not captured in GI2020, the section on innovation overview was informed by AU’s most recent report on innovation, the African Innovation Outlook (AIO III 2019) (AU 2019).

Southern Africa

Angola

Angola's National Policy for Science, Technology and Innovation, which aims to develop and organise the national system for STI, is formulated and executed by the Ministry of Higher Education, Science, Technology, and Innovation. The systems for quality, standardisation and intellectual property are in place and supervised by the Ministry of Industry and Commerce, which also implements policies to incentivise the private sector in relation to STI. The development programmes in the country are centred around developing science and technology, capacity-building for private sector and supporting Micro, Small and Medium-sized Enterprises (MSMEs). However, funding for STI by the government is very limited and STI activities are mainly funded by international organisations and donors. The international organisations Angola participates in include the UN system and the AU as well as the Southern African Development Community (SADC).

There are a few state and private universities in Angola while the limited number of research institutes focus on agricultural, veterinary and medical research. The main higher education institute is Universidade Agostinho Neto which accommodates the National Centre for Scientific Research. The private sector is mostly underdeveloped with limited existing innovative activities undertaken mainly to improve product quality. Governmental entities to support private sector growth exist, but support for entrepreneurial activities is limited and therefore these activities are supported by the private sector itself. Funding for the private sector is mainly available from financial and microfinance institutions, however these aren't very accessible to MSMEs.

Angola has very few innovation ecosystems. The main ecosystems are developing around the tech industry and the entrepreneurial space, which have many overlapping stakeholders. As illustrated in the ecosystem map examples in Appendix 2, these ecosystems are predominantly driven by the private sector with relatively limited involvement of government, academia, and the international organisations.

Botswana

GII 2020 ranks Botswana 5th in the Sub-Saharan African (SSA) region. However, relative to its GDP, Botswana is performing below expectations for its level of development.

The majority of innovation ecosystems and facilitation mechanisms in Botswana are government-led and government-funded. The state driven approach to innovation aligns with Botswana's national STI policies and its Vision 2036 goals, where an emphasis is placed on Botswana's aim to transition from a resource-based economy to a knowledge-based economy.

The key facilitation mechanism in Botswana's state-driven innovation ecosystem is the establishment and development of parastatals overseen by various

government ministries. A key parastatal being the Botswana Innovation Hub, an innovative and networked organisation that promotes and fosters science, technology, entrepreneurship and commercialisation.

Strengths of Botswana's innovation ecosystem include political stability, political will to develop a fully functioning innovation ecosystem, the existence of fully developed national STI policies and a high expenditure on education that has catalysed education access at all levels.

Malawi

According to GII 2020, with the classification as a 'lower-income' country, Malawi's current scores for innovation are described as "above expectations for level of development."

Malawi has a nascent innovation ecosystem. A significant number of innovation initiatives that are currently ongoing within the country are focused on agriculture, due to the fact that Malawi has a strong agriculture-based economy. These initiatives are mainly driven and funded by international organisations/ donors, with a lack of involvement from the private sector and limited intervention by the government.

Key policy frameworks that have driven development in Malawi include the Malawi National Development Strategy 1997-2020, and the Malawi Growth Development Strategy (MGDS III) 2017-2022. Despite the existence of a National Science and Technology Policy (NSTP), which has been in place since 2002, there remain many shortcomings with regards to sustainability, collaboration, regulation and innovative capacity within the ecosystem.

Namibia

Namibia ranks 9th within the Sub-Saharan African (SSA) region in GII 2020. Relative to GDP, Namibia is performing below expectations for its level of development.

Namibia does not have a policy specifically dedicated to innovation, but multiple policy frameworks which address various challenges surrounding STI, such as the National Policy on Research, Science and Technology and Vision 2030. These policies, which are formulated and implemented by the National Commission on Research, Science and Technology (NCRST), put emphasis on building an innovation system and developing a skilled workforce. Intellectual property, standardisation and quality systems are already in place and managed by the Ministry of Industrialisation, Trade and SME Development. The development programmes offered by the government are concentrated around industry and trade, while programmes supporting the development of STI are very limited. STI activities are financed through the National Research, Science and Technology Fund, which is overseen by NCRST, as well as funding from sectoral ministries and international organisations such as the AU, UN and the SADC which Namibia is a member of.

The main R&D institutions in Namibia are the University of Namibia and Namibia University of Science and Technology (NUST), with both universities having dedicated research centres and initiatives. In industry, some of the state-owned enterprises are key actors in R&D while foreign companies introduce innovations, share knowledge and attract investment. Associations play a role in building platforms for innovation and influence policies on technology development. A handful of NGOs also work in the space of STI and development.

Innovation ecosystems largely exist within the public sector and academia, NUST accommodating the only Tech Innovation Hub in the country. The University provides labs, centres and a Business Innovation Institute to facilitate innovation through partnerships and knowledge exchange. Being based in Windhoek, the Southern Africa Innovation Support Programme (SAIS) also drives STI activities and has linkages with the academia and government.

South Africa

According to GII 2020, South Africa ranks 14th among the 37 upper middle-income group economies and ranks 2nd within the Sub-Saharan African (SSA) region. Relative to GDP, South Africa is performing above expectations for its level of development.

South Africa exhibits an extensive and diversified mix of government-led/government-funded as well as stakeholder-led/funded innovation ecosystems and facilitation mechanisms. Private sector, NGOs, Partnership support, and international support were marked as facilitators of the innovation ecosystem by various respondents to the AIESyS survey. This dynamic environment has resulted in South Africa ranking 14th among the 37th upper middle-income group economies and 2nd among the 26 economies in Sub-Saharan Africa. Moreover, compared to other economies in Sub-Saharan Africa, South Africa performs above average in all seven Global Innovation Index (GII 2020) (WIPO 2020) pillars.

The South African Business Innovation Survey, 2014-2016 highlighted that innovation was pervasive across all sectors, but especially in engineering and tech, manufacturing, and trade. More than two thirds (69.9%) of South African businesses were innovation-active, meaning that they took some scientific, technological, organisational, financial, or commercial steps towards the implementation of an innovation. They engaged in the four types of innovation measured in almost equal shares: product innovation (48.2%), organisational innovation (42.0%), marketing innovation (41.7%), and process innovation (34.6%) (HSRC, Department of Science and Innovation, and Department of Statistics 2020).

Zambia

According to GII 2020, with the classification as a 'lower middle-income' country, Zambia's current scores for innovation are listed as not strong enough/ not in line with the current level of development.

Zambia's innovation ecosystem is currently in its nascent stage. Currently, the primary focus of this ecosystem has been within the areas of fintech and agriculture, with the aim to drive forth economic growth and the country's national development objectives, as outlined in Zambia Vision 2030 and the 7th National Development Plan 2017-2021. Another key framework pertaining to innovation in Zambia is the STI Policy and Implementation Plan, launched in December 2020. This plan centres around increasing investments into "incubation centers" and "in the capacity of – and resources available to – innovators."

In terms of development of the innovation ecosystem itself, this appears to be driven largely by Zambia's technology hubs, the first and largest of which is BongoHive (launched in 2011). BongoHive, among other hubs such as Jacaranda Hub and WEAC, collaborate together alongside support initiatives to drive innovation, whilst strengthening different aspects critical to the health of the ecosystem, including technology and skills development, youth and women's participation.

Zimbabwe

According to the GII 2020, with the classification as a 'lower middle-income' country, Zimbabwe's current scores for innovation are declared as "in line with level of development."

Zimbabwe's innovation ecosystem is in its nascent stage. Currently, notable efforts are being made by the government and through research and academic institutions to advance the innovation ecosystem in order to fulfil the country's development agendas – Vision 2030 and the National Development Strategy 2021-2025 – as well as the national Science, Technology and Innovation Policy 2012.

Significant focus has been placed on innovation activities within the agricultural sector. There has also been strong focus on educational reform, exemplified through the government's introduction of Education 5.0 in 2018, which aims to promote innovation and industrialization. Through this framework, the country has commissioned the establishment of technology hubs at a number of universities, including the University of Zimbabwe, to provide researchers within these institutions a critical link with industry, as well as the opportunity to hone their skills and bring their ideas to market.

West Africa

Cameroon

According to the GII 2020, Cameroon ranks 26th among the 29 lower middle-income group economies and ranks 17th within the Sub-Saharan African (SSA) region. Relative to GDP, Cameroon is performing below expectations for its level of development.

The majority of innovation ecosystems and facilitation mechanisms in Cameroon are private sector led with support from international actors. In policy terms,

Emergence 2035 / Vision 2035 sets out objectives for poverty reduction, becoming a middle-income country, industrialisation and fostering national unity, which includes elements implicitly and explicitly linked to R&D and innovation. Cameroon doesn't have any sectoral strategy on STI instead the concept is integrated in the Document de Stratégie du secteur de l'Education et de la Formation.

The epicentre of Cameroon's innovation ecosystem is Silicon Mountain, in Buea in the south. Silicon Mountain is the headquarters of the country's largest innovation hub/incubator ActivSpaces and is home to numerous start-ups and a community of entrepreneurs. In 2019, a new tech hub Silicon River, in Yaoundé, was announced by the Cameroonian government. It will be modelled after Silicon Mountain and received an estimated 1.92 billion CFA francs (\$ 20.6 million) from the Ministry of Scientific Research and Innovation's budget. Cameroon ranks above the SSA average in three out of the seven GII pillars: Human capital & research, Business sophistication and Knowledge & technology outputs, ranking 41st in the number of graduates in science & engineering in the GII.

Ghana

Ghana ranks 10th within the Sub-Saharan African (SSA) region in GII 2020. In relation to its GDP, Ghana's performance is below expectations compared to its level of development.

The Ministry of Environment, Science, Technology and Innovation is the main authority responsible for the formulation of the National STI Policy which aims to transform Ghana into a developed country with a strong STI capacity driving the development of the economy. The Ministries of Trade and Industry, Finance and Education also complement the National STI Policy through their sectoral policies. Governmental agencies and authorities support the national STI system by coordinating research, developing the MSME sector, promoting investment, managing the quality system and creating an attractive business environment. The government offers several programmes to support STI and the industry. Although there is no dedicated STI or national research fund, the STI system is mainly financed by the Consolidated Fund which is overseen by the ministry of finance. Public-private partnerships are also encouraged to finance STI activities.

Ghana has many higher education institutions including technical universities and polytechnics. The Council for Scientific and Industrial Research is the foremost national science and technology institution carrying out research for national development and assist the government with policy formulation and implementation. In the industry, enterprises of different sizes play a role in innovative activities while foreign companies contribute to innovation through knowledge and skill provision as well as attracting investment. Governmental entities assist the industry by facilitating technology transfer and financing SMEs. Numerous NGOs also work in the space of STI and development.

Several innovation ecosystems exist in Ghana with most managed or supported by international actors providing access to international networks and resources. These ecosystems are weakly linked to national innovation systems through the implementation of projects by public universities and governmental funding. The

development of these ecosystems is mostly driven by the civil society, foreign profit and non-profit organizations as well as foreign governmental organisations.

Nigeria

According to the GII 2020, Nigeria ranks 25th out of 29 lower-middle income economies and 15th within the Sub-Saharan African (SSA) region. In relation to its GDP, Nigeria's performance is below expectations regarding its level of development.

Nigeria's innovation ecosystem exhibits a mixture of government led funding and private led funding. However, its innovation ecosystem appears to be primarily private sector driven, with some federal and government state support.

Currently, Nigeria has several STI policies that posit economic diversification as central to reducing its dependency on the oil and gas sector. These include the National Science, Technology and Innovation Policy, 2011, which sets out ambitious strategies for STI promotion, capacity building, sectoral R&D, intellectual property, technology transfer, information management systems and female participation in research; and the National Science, Technology Innovation Roadmap 2030 that sets out the long-term framework for science and technology. The document sets specific goals for a number of knowledge sectors and focuses on linking research to all areas of national development.

Despite these moves, it appears that the innovation ecosystems noted above, have been, and continue to currently be, largely driven by both industry and foreign investors and donors.

Context

Background

Innovation is crucial for increasing productivity, economic growth and advancing livelihoods. Increasingly, governments (and other stakeholders) are focusing on innovation policy as key to economic development. Innovation starts with a good idea, but necessarily includes the creation of new products, tools or processes that are tested and taken up and used by their target audiences. There are many different players involved in work relevant to innovation that are grouped together under the term 'innovation ecosystem'. An **innovation ecosystem** is defined as “the evolving set of actors, activities, and artefacts, and the institutions and relations ... that are important for the innovative performance of an actor or a population of actors” (Granstrand and Holgersson, 2020). A functioning innovation ecosystem can make taking a new product, tool or process to market more straightforward (and profitable). If the innovation ecosystem is not functioning well there are multiple disincentives to innovation development, which can have long-term negative impacts on local and national economies.

Overall Objective

The overall objective of the African Innovation Ecosystem Study (AIESyS) project is to provide a synthesis of innovation ecosystem development and support initiatives in 10 African countries: South Africa, Angola, Botswana, Namibia, Malawi, Zambia and Zimbabwe in Southern Africa; and Nigeria, Ghana and Cameroon in West Africa. It intends to support planning to improve ecosystem facilitation efforts across multiple national and regional stakeholders. The work will take a wide approach to innovation ecosystems and include work beyond digital and financial sectors and innovations. Ultimately the aim is to identify ways to achieve better-connected ecosystems that deliver improved uptake of innovations and outcomes for stakeholders and best practice approaches to strengthening networks for facilitating cross-border innovation partnerships across the regions.

Specific objectives

AIESyS seeks to better understand the range of existing innovation ecosystem support interventions / programmes (e.g. facilitation and networking) in Southern and West Africa. This is with a view to identify best practice, gaps and opportunities for the design of potential interventions to improve ecosystem facilitation methodologies, as well as, new collaboration and partnership opportunities for a wide range of national, regional and global development partners and stakeholders across the region.

A number of organisations are active in the Southern and West African ecosystems, covering different aspects and thematic areas of work. However, much of the analysis and assessment of innovation ecosystems and facilitation has focused on the digital and financial sectors. Information is required about ecosystem facilitation using a wider innovation and sectoral lens. The various ecosystem stakeholders [government; private sector incubators, accelerators, business support organisations; Non-governmental Organisations/Non-for-Profit Organisations

(NGOs/NPOs); academic institutions] would benefit from understanding how and where there are opportunities for working together in collaborative and cross-sector ways, to create real inclusion and economic development. This work is proposed to identify and synthesise what is already happening, to have a detailed analysis of current strengths, and to identify gaps, challenges and opportunities to strengthen ecosystem facilitation taking a wide view of innovation. This work will include an assessment of ecosystem facilitation support initiatives, challenges gaps and opportunities for the supporting and strengthening regional cross-border innovation partnerships.

Conceptual Framework for the African Innovation Ecosystems Study (AIESyS)

The concept of innovation ecosystems emerged in early 2000s to meet the demands of emerging knowledge-based economies, in which the production of innovations and the associated development processes are increasingly non-linear and network-based⁶. This concept has remarkably enriched the idea of innovation systems, coined in the industrial era in the research streams of Freeman, Lundvall, Nelson, and their followers (Lundvall, 1992; Nelson, 1993; Edquist, 1997; Malerba, 2005). In the 1990s, national or regional innovation systems were seen as static structures regulated by government bodies, with successful performance depending on a critical mass of involved actors and intentional infrastructure (WEF, 2015). As a departure, innovation ecosystems of the 2000s are considered dynamic and agile collaborative structures that enjoy self-governance as a necessary prerequisite for interactive innovation (Banwell et al., 2012). This approach is now applied in innovation policies of many developed and developing nations.

For AIESyS Project, we adopt the broad definition of an innovation ecosystem by Ove Granstrand & Marcus Holgersson (2020⁷) as ‘the evolving set of actors, activities, and artefacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors’. According to Smorodinskaya et al. (2017), ‘the ability of (actors) collaborative networks to adapt themselves to a non-linear environment implies they assume certain features of complex adaptive systems-agility, self-organization, self-governance, and synergy effects’. The term innovation ecosystem symbolizes the newly emerging, network mode of arranging business activity and economic governance, which enables companies and territories to master innovation-led growth and benefit from rapid technological changes. This mode requires horizontal and inclusive economic thinking, as well as enabling certain organizational continua, relevant for interactive innovation and dispersed patterns of production.

We are also in agreement with emerging arguments in literature that innovation ecosystems cannot be referred to as subjects of decision and action (N Smorodinskaya et al., 2017). Rather they are special organizational spaces, tailored

⁶ World Economic Forum (WEF), The Global Competitiveness Report 2015–2016, World Economic Forum, Geneva, 2015.

⁷ Granstrand and Holgersson, (2020). Innovation Ecosystems: A Conceptual Review and New Definition in Technovation 90-91 102098.

to co-creation of values through collaboration. They constitute a sophisticated milieu of actors, assets and linkages, generated by collaborative activities of networks. Such networks of various forms, sizes and profiles can play the role of modern-type organizations meant for a collective decision-making and collective action, and innovation ecosystems should be seen as the native environment of such networks. However, since collaborative networks and their ecosystems are functionally inseparable (in terms of interactive co-creation of value), both terms may be perceived and used interchangeably. This admission corresponds to findings in literature on complexity, viewing collaborative networks as complex adaptive systems that are inseparable from their changing environment by definition.

The innovation ecosystems concept emphasises that innovation now means not only technological innovation but, in a broader notion, an “ecosystem” (environment) conducive to the generation of ideas and their implementation in the form of new products, services, and processes in the global marketplace [WEF, 2015]. Literature further describes this approach with three important details: the wider-scope of innovation, the innovation-conducive environment, and various studies on ecosystems. These are elaborated briefly below:

Firstly, regarding the scope of innovation, new ideas can be generated by formal scientific research and development (R&D); they can also result from non-R&D activities that do not require fixed research costs yet increase the efficiency with which a good or service is produced (such as innovations in managerial and organizational techniques, personnel, accounting, work practices, etc.) The implementation of such ideas may be commercial and non-commercial (the latter often treated as “softer” innovation).

Secondly, an innovation-conducive environment, comprised of ecosystems and networks, can increase the likelihood that “softer” innovation takes place. This environment encourages collaboration, connectivity, critical and creative thinking, diversity, and confrontation across different visions and angles. By bringing new products and services to market, such ecosystems and networks foster productivity though embedded technology, with efficiency gains.

Thirdly, to achieve a complete picture of an innovation-conducive environment, one needs to consider economic literature (which focuses more on system incentives to spur idea generation at the aggregate level) and business literature (which identifies important factors that generate innovative companies and/or motivate them to innovate). *In this study we also propose to consider social science, arts and humanities literatures to explore the behaviours and attitudes which shape actions and interactions within systems and networks.* Building on the preliminary literature review summary below, we will carry out an extensive review of key literatures in these domains to inform our conceptual framework for this study.

Table 1: Literature reviews on the variety of ecosystems, 2005-2021

| Reference | Scholarly domain of review | Main review messages |
|-------------------|--|--|
| Peltoniemi (2005) | Literature review and conceptual analysis of | Dynamics of conscious choice and limited |

| | | |
|--------------------------------|--|---|
| Peltoniemi (2006) | business ecosystem as an organizational population model | knowledge of an individual organization and from the interconnected-ness and feedback loops of an organization's population; differences in cluster and value networks |
| Pilinkienė and Mačiulis (2014) | Literature review of ecosystem analogies: industrial ecosystem, innovation ecosystem, business ecosystem, digital business ecosystem, entrepreneurship ecosystem | Ecosystem analogies have various scopes and objectives having an impact on microlevel, associated with actions of internal actors; (eco)system can be a significant determinant of sustainable economic development |
| Gawer (2014) | Review of management research on technological platforms: industrial economics and engineering design | Platforms operate along an organizational continuum, including firms, supply chains, and industry ecosystems |
| Gawer and Cusumano (2014) | Platform-based ecosystem innovation; review of research on internal and external platforms | A critical issue for managers is to learn to manage the evolution of their industry platforms and accompanying ecosystems and make interrelated technological and business decisions |
| Valkokari (2015) | Review of types of business, innovation and knowledge ecosystems and the relationships between them | In order to survive and thrive in an ecosystem, a variety of forms of interaction are required; the interaction between various types of ecosystems is an unexplored area |
| Suominen et al., (2019) | Looking at and comparing the conceptual roots and operations of innovation systems and ecosystems literature | The literature on national, regional and technological innovation systems, as well as literature on corporate competitiveness and the ecosystem approach, has both shared and divergent intellectual roots |

| | | |
|---|---|--|
| Aarikka-Stenroos, Peltola, Rikkiev, & Saari, 2016 | Systematic content analysis of articles of innovation and business ecosystems | Multidisciplinary perspectives exist on ecosystem phenomenon; research gaps exist, including a gap in policy-making; the business ecosystem stream is dominant |
|---|---|--|

Source: Nataliya Smorodinskaya et al. (2017); Watkins et al.(2015); among others

Among the key messages emerging in our preliminary review *is the manifestation of innovation ecosystems as networks of sustainable linkages between individuals and organizations*, which emerge from a shared vision of desired transformations and provide an economic context (milieu) to catalyse innovation and growth (Russell et al., 2015). As applied to the variety of inter-firm or inter-organizational networks, this definition implies innovation ecosystems are oriented either to the direct co-creation of innovations or to the formation of innovation-supportive milieu (Wessner, 2005). Further, literature review shows innovation ecosystems being treated both as business networks and as communities meant for innovation. They may assume different scale and design, functioning as regional innovation hubs, nation-wide innovation communities, local inter-firm networks, very small network-based ad-hoc groups of individuals, or global wide networks (Banwell et al., 2012).

However, neither geography nor industry sector expose the essence of innovation ecosystems as compared to systems. Noticeably, in management studies, one of the primary motivations for addressing the ecosystem concept has been the desire to explore self-organizing properties of natural ecosystems (EC, 2007). In studies on innovation dealing with generation and implementation of new ideas, ecosystems are usually considered a means for co-creation and market introduction of inventions (WEF, 2015).

Literature on economic competitiveness incorporates the idea of ecosystems in the context of the broad impact of digital technologies (IT, ICT) on the changing nature of innovation process, especially regarding implications of non-linear innovation for alternative organizational designs. Such thinking is reflected in modern production systems at all levels (firms, clusters, regions, national economies, global economy). The literature broadly coalesces around the point that, in the age of non-linear innovation and digital technologies, innovation can be better nurtured within a special, innovation-conducive environment. Such an environment may be seen as an ecosystem meant for co-creation of value through collaboration. Our conceptual frameworks below will help us to explore these collaborations in selected countries in Southern and West Africa

What do we know about mapping innovation ecosystems in Africa and what knowledge contribution is AIESyS making to the discourse?

The mapping of innovation ecosystems in Africa emerged in the middle of the past decade as a methodological approach for strengthening understandings on the contribution to or influence of innovations to economic development of the African

continent. The pioneering mapping exercise by the World Bank (WB) suggested that there were 173 technology hubs and incubators in 2016⁸. According to the WB, these (technological) innovation ecosystems were classified into four categories: *Government-led, Civil society-led, Academic institution-led, and Hybrid*, with the civil society-led ecosystems constituting the biggest share (118 hubs and incubators). A study by the Global System for Mobile Communications Association (GSMA) revealed that there were 314 active technology hubs (tech hubs) in the Africa in 2016⁹. Another mapping survey by Brighter Bridges in partnership with the GSMA Ecosystem Accelerator programme suggests a surge of tech hubs, amounting to 618 as of second quarter of 2019, and further increased to 643 hubs by October 2019.

It is apparent from the aforementioned research that the African continent has seen a rapid increase of tech hubs, at approximately the rate of 50% since 2016. The 643 hubs included co-working spaces, incubators, accelerators, hybrid hubs (affiliated to universities and/or governments), makerspaces and tech-parks. More than 75% of the 643 hubs (around 500 hubs) were seen to be providing “some degree of in-kind or cash support”, while 25% of the hubs “only offer[ed] coworking facilities” (BrighterBridges and AfriLabs, 2019, p. 6). The same research spotted “over 110 hubs that had shut operations ... due to bankruptcy, pivoting, or the expiration of their mandate” (BrighterBridges and AfriLabs, 2019, p. 5). According to (Dosso et al., 2021), in the same period of about three years (2016-2019), more than 25% of these tech hubs have closed the doors. Dosso goes on to propose a range of possible reasons underpinning tech hubs failures, inter alia “*lack of professionalism, the low maturity and diversity of business models, the misalignment between organizational goals and the capabilities or business structures, between the goals and the needs of the operational environment or with local societal need*” (Daniels et al., 2021, p. 171).

Why do (tech-) hubs fail in Africa?

According to BrighterBridges and AfriLabs (2019), the failure of the aforementioned 110 hubs mainly stems from “*uncertainty around sustainability and business models that are partially dependent on external donors*” (BrighterBridges and AfriLabs, 2019, p. 14). The lack of understanding of local needs by external investors (and funders), and competition over a shared limited market are also identified as possible causes of hubs failure (De Beer et.al. 2017). This echoes and reiterates, to some extent, the claim submitted by (Dosso et al., 2021). Noting that civil society-led and donor-funded innovation ecosystems make the biggest part of Africa’s innovation ecosystems, it is suggested that the donor-funded hubs, for instance, are likely more prone to failure prior to growth, partly due to the nature of their fixed (short) term programmes or interventions. Aside from this, recent literature on programme-based innovation ecosystems in Africa brings to light deficiencies in conceptualization as contributing factors to innovation ecosystem failure. For instance, the study of the conceptualization of digital health innovation ecosystem in South Africa highlights possible failure of the ecosystem partly due to lack of adaptive and coordination capabilities, as well as local integration with respect technology transfer (Herselman

⁸<https://blogs.worldbank.org/digital-development/importance-mapping-tech-hubs-africa-and-beyond> [Accessed: 04.03.2021]

⁹<https://www.gsma.com/mobilefordevelopment/programme/ecosystem-accelerator/things-learned-tech-hubs-africa-asia/> [Accessed: 04.03.2021]

et al., 2016). Additionally, the silos approach of innovation actors such as government, academia and industry, hinders the creation of new business and venture milieus, which in part hinders the formation of innovation ecosystem in digital technologies (mobile applications) in Botswana (Nyamaka et al., 2020).

Through this AIESyS study, we argue that current discourses on possible causes of innovation ecosystems in general and hubs in particular, need to be further nuanced and expanded in light of evolving contextual realities within and across countries and sectors. We also bring attention to R&D-based innovation financing theory and allied concepts, drawing parallels between innovation ecosystem growth and ‘venture growth’ as illustrated in Fig. 5 below.

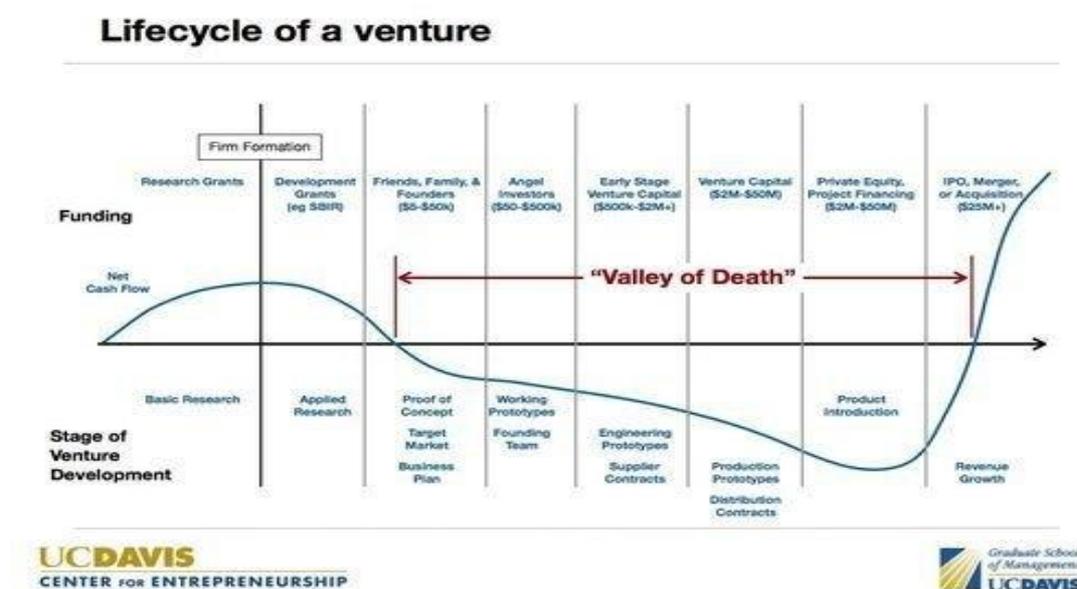


Figure 5: Stages of Venture Development

Source: <https://www.greentechmedia.com/articles/read/into-the-valley-of-death#gs.OvgTFgc> [accessed: 20.03.2021]

Although the support and facilitation mechanisms for innovation ecosystem development go beyond provision of financial resources, we suggest that all the types of innovation ecosystems, maybe with the exception of accelerators, are deprived of support while they are in the deep uncertainty of the ‘valley of death¹⁰’ in their paths to growth and sustainability. Support and facilitation mechanisms should partly seek to address the valley of death challenge through “transitional activities and de-risking of early commercialisation [or non-commercialisation] stages” (Mugwagwa et al., 2019), if innovation ecosystems are to be successful and sustainable beyond external funding/support stages. Efficient and effective knowledge sharing, accountability and governance mechanisms are also key for

¹⁰ According to Valley of death Hargadon (2010), “the **Valley of Death** refers to the severe financial risks that start-ups face as they struggle to grow from small teams to viable ventures”. <https://www.greentechmedia.com/articles/read/into-the-valley-of-death#gs.OvgTFgc> [Accessed: 20.03.2021]

ameliorating failure along the continuum in addition to the creation of capacities for networking (collaborative capabilities, Lai, 2011) while mechanisms for identifying useful knowledge, knowledge gaps and potential for future development (absorptive capacity, Giuliani, 2005) should be a key input for the co-workspaces and other partnership arrangements.

Changing STI landscape

A recent case-study of five youth-led innovation hubs and communities in West Africa suggests that, 'incubators play a critical bottom-up catalytic role for youth entrepreneurship' (Daniels et al., 2021, p. 190). Drawing from empirical evidence, the same study suggests that entrepreneurial communities and networks - whether nascent or mature, digital economic or social impact - are shaping the technology and innovation ecosystems in the major cities and urban areas in West Africa.

Identified gap

Drawing from Strength, Weakness, Opportunity, and Threats (SWOT) analysis of some of the five studies of innovation ecosystems, the aforementioned study stresses the need of 'science for policy', on the one hand for greater grasp of the impact of these ecosystems to the economy and to the society, and on the other hand to devise possible enabling mechanisms for sustainability of these ecosystems. In addition, the study notes that innovation ecosystems tend to operate within the formal economic settings, while it is widely claimed that the African economy is predominantly informal. The study therefore recommends further policy research to explore answers to the question: *How do innovation hubs and communities interact with actors in informal sectors, and what are policy framework that enable greater impact of innovation ecosystems to the most economically and socially vulnerable groups?*

Our study builds on some of these insights from previous studies to explore innovation ecosystem development and facilitation measures in 10 African countries.

Methodology

The study informing this report was undertaken as an initial part (Output1) of the response to the Invitation to Tender (ITT) issued by the UK Government's Foreign, Commonwealth and Development Office (FCDO), to conduct a scoping study and mapping of innovation ecosystem development and support initiatives in Southern and West Africa. The project, referred to as the African Innovation Ecosystems Study (AIESyS), was conducted as a partnership between the University College London, Department of Science, Technology, Engineering and Public Policy (UCL STEaPP) and University of Rwanda, College of Arts and Social Sciences (UR CASS). An AIESyS project inception meeting with FCDO team was held virtually on 25th January, 2021 to discuss the conceptual framework and methodological aspects of the study, with the aim to draw the lines (links and delinks) between Output 1 (this report) and the related but separate second report (Output 2).

Data collection and Analysis

This report (Output 1) stemmed largely from secondary data based on desk studies carried out to comprehensively review relevant policy documents, programme reports and academic papers on innovation ecosystem development and support services in the 10 African countries. The analysis of collected data was largely qualitative – content and thematic analysis - to understand how innovation ecosystems are currently understood, used and supported. Tabulation was used to analyse any quantitative data generated in the study. Stakeholder mapping and country-level innovation ecosystems evolutions were analysed through the use of heatmaps.

Box 1: Data collection for Output 1

Review

- Review of literature (policies, programmes, reports and academic papers)
- Survey of innovation ecosystem actors

Analysis and reporting

- Analysis of collected data
- Quantitative – numerical and statistical analysis regarding value, extent and function of innovation ecosystem
- Qualitative – content and thematic analysis to understand how innovation ecosystems are currently understood, used and supported
- Stakeholder mapping
- Network mapping of a selection country-level innovation ecosystems

Anonymous online survey

- Reported substantively in Output 2, but used to frame some key issue areas in Output 1
- To gather views and experiences from a wide range of people involved in innovation ecosystems. Survey consisted of multiple choice and written-response questions.

Country selection

Insights from 10 countries are included in AIESyS. From our initial review, we found elements of interest in all of the country-level innovation ecosystems and great potential for understanding regional innovation ecosystems. On the basis of our research resource, linguistic skills, previous country engagements and the broad scope of the proposed work, all 10 countries were included in the study: Angola, Botswana, Malawi, Namibia, South Africa, Zambia, Zimbabwe in **Southern Africa**; and Cameroon, Ghana, and Nigeria in **West Africa**.

Limitations to the study

AIESyS provides a detailed overview of innovation ecosystems through the combination of insights drawn from the public domain, survey responses and interviews with key stakeholders. All activities were conducted online, due to the constraints of the COVID-19 pandemic. There are some notable limitations to this approach, the most significant being that materials on innovation ecosystem facilitation were not always easily searchable in the online environment or identifiable or accessible on the digital platforms of key stakeholders. Surveys and interviews sought to snowball the overall sample size of the study and bring to light activities with limited digital footprint, though this representation cannot be comprehensive.

Existing innovation ecosystem support and development initiatives

The following sections summarise overarching insights on innovation ecosystems in Southern and West Africa, country-by-country, highlighting key insights regarding their governance, policy and institutional capacities. Although the state of innovation systems, ecosystems and facilitation mechanisms differ based on every country's idiosyncrasies, the overview of innovation performance for each of the 10 countries (with the exception of Angola) was developed drawing on the World Intellectual Property Organisations (WIPO)'s recent report on countries' performance in innovation, the Global Innovation Index (GII 2020) (WIPO, 2020). GI 2020 scores countries (from score 0 to 100) and ranks countries from 1st to 131st according to seven key pillars of innovation including: **Five pillars for innovation inputs sub-indices**: Institutions (*political environment, regulatory environment, business environment*), Human capital & research (*education, tertiary education, R&D*); Infrastructure (ICTs, general infrastructure, ecological sustainability), Market sophistication (*credit, investment, trade, competition and market scale*), and Business sophistication (*knowledge workers, innovation linkages, knowledge absorption*); and **Two pillars of the innovation output sub-indices**: Knowledge & technology outputs (*knowledge creation, knowledge impact, knowledge diffusion*), Creative outputs (*intangible assets, creative goods and services, online creativity*).¹¹ For Angola, which is not captured in GI2020, the section on innovation overview was informed by AU's most recent report on innovation, the African Innovation Outlook (AIO III 2019) (AU, 2019). A more detailed, illustrative case study / example drawing on this data for the case of South Africa can be seen in Appendix 1. However, the full treatment of all country case studies in this way was seen as beyond the scope of this output.

More detailed examples of specific innovations ecosystems for each country can be found in the appendices to this report. These examples also serve to highlight areas where significant investment and/or progress has already been made, highlighting existing expertise and potentially good practice upon which to build further collaboration opportunities to "enable the pooling of resources, building on successes and minimising unnecessary duplication" (FCDO ITT).

Box 2: Format of country-level summaries:

1. Overview
2. Governance, policy and institutional capabilities
 - 2.1 Policy structure landscape
 - Policy frameworks and plans (*Driving long-term development vision, main innovation policies and instruments*)
 - Development Programmes/Projects/Initiatives
 - 2.2 Stakeholder landscape
 - Governance structure (*Key structures/organs*)
 - Academia / Research
 - Industry / Private
 - Non-Governmental Organization
 - 2.3 Involvement in regional and international organisations
 - 2.4 Financing of Innovation

Southern Africa

Angola

National Innovation System and Ecosystems Overview

1. Overview

Angola is a lower middle-income country. According to the African Innovation Outlook (AIO III 2019), Angola's government expenditure on R&D is the lowest in Africa along with Lesotho, which is only 0.01% of GDP. Its higher education expenditure on R&D is also one of the lowest in the region with 0.013% of GDP (AU, 2019). Angola's R&D workforce is weak and mostly concentrated in higher education and government while there are no R&D personnel in business and private non-profit sectors. The number of researchers per million habitants is also the lowest (7 per million) along with Democratic Republic of Congo. Still, among the countries with available data, the percentage of innovative firms is the second highest (85.4%) in Angola and it also is the second country in the region that seeks the highest number of patents.

2. Governance, policy and institutional capabilities

2.1 Policy structure landscape

Policy frameworks and plans

(Driving long-term development vision, main innovation policies and instruments)

The National Policy for Science, Technology and Innovation (2011) is Angola's main policy framework which inserts science, technology and innovation (STI) in the Development Strategy of the country and aims to organise and develop the National System for Science, Technology and Innovation. It puts emphasis on the promotion of training of human resources and developing the infrastructures to create and reinforce the capacity of higher education and research institutions. It also emphasises the co-operation between national institutes for scientific research and technological development and aims to set up research networks and establish bilateral and multilateral agreements. Promotion of scientific culture and internet access are highlighted to raise awareness of STI in the country. Partnerships with the productive sector or business and support for professional mobility are also highlighted to accelerate industrial development through technology transfer. Finally, an increase in public-private funding for STI activities with the creation of a financial instrument is proposed to ensure proper funding. The policy framework also mentions the National Strategy for Science, Technology and Innovation; however, this document couldn't be found.

Development Programmes / Projects / Initiatives

Science and Technology Development Project,¹² which is funded by the African Development Bank (AfDB) and implemented by the Ministry of Higher Education and

¹² <https://projectsportal.afdb.org/dataportal/VProject/show/P-AO-IA0-006>

Science and Technology (MHEST), supports the Government's efforts to develop science and technology and promote innovation at a national level. AfDB also funds the Institutional Capacity Building for Private Sector Development Project which aims to support enterprise competitiveness and entrepreneurship. Although Angola is not a focal country in the Southern Africa Innovation Support (SAIS) Programme funded by the Government of Finland and aimed at strengthening innovation ecosystems, it participates as a collaborative partner on some SAIS funded initiatives. Specific financial programs (e.g. Projevem) for Small and Medium-sized Enterprises (SMEs) and young entrepreneurs are also offered by the Angolan government through financial institutions.

2.2 Stakeholder landscape

Governance structure

(key structures/organs)

MHEST is the main authority for the preparation, conduction, execution and control of the policies in the fields of STI. Ministry of Industry and Commerce formulates and implements industrial policies such as tax incentives and exemptions. Angolan Institute of Industrial Property, which is under the Ministry of Industry and Commerce, implements the Intellectual Property (IP) systems. The Ministry of Industry and Commerce also supervises the Angolan Institute for Standardization and Quality, which promotes, organises and develops the Angolan quality system as well as ensuring the national quality policy. The Private Investment and Export Promotion Agency, which is supervised by the Ministry of Economy and Planning, is responsible for the implementation of the national policy related to private investment and its promotion as well as international competitiveness of Angolan companies.

Academia / Research

The main higher education institute in Angola is the Universidade Agostinho Neto (UAN) and it accommodates the National Centre for Scientific Research. There are six other state universities around the country, which used to be part of UAN but later became autonomous. Several private universities also exist such as Catholic University of Angola and Lusíada University. Examples of Angola's research institutes include the Angola Medical Research Institute and the Agronomic Research Institute.

Industry / Private

Different sizes of enterprises exist, however the extent they're involved in innovation activities is unclear. The existing innovation activities are undertaken mainly to improve the quality of products rather than increasing their variety.¹³ The private sector is mostly underdeveloped except for petroleum and diamond sectors,¹⁴ but there are entities to support private sector growth – the main one being the National Institute to Support Small and Medium Enterprises (INAPEM). The leading business association in Angola is the Angolan Industry Association and includes memberships from both industry and agricultural sectors. Angolan Community of Exporting and

¹³ https://au.int/sites/default/files/documents/38122-doc-aio_3rd_edition_final_eng_repro.pdf

¹⁴ https://unctad.org/system/files/official-document/sdtestict20081_en.pdf

Internationalised Companies is an association for companies with international activities and it promotes exports and international partnerships with Angolan companies. With regards to the entrepreneurial space, multiple organisations providing business development support to turn innovative ideas into business models exist.

Non-Governmental Organizations

The number of NGOs that undertake innovation activities in Angola is very limited. The Angola Academy of Science, which was only launched in December 2020, is expected to support and advise the government in directing science and technology policies for the achievement of sustainable development goals.¹⁵

2.3 Involvement in regional and international organisations

Angola is a member of the African Union (AU), the United Nations (UN) and the Southern African Development Community (SADC). It is involved in the African Science, Technology and Innovation Indicators Initiative (ASTII) and its New Partnership for Africa's Development (NEPAD) of the AU. Within the UN system, it participates in the United Nations Conference on Trade and Development (UNCTAD), the United Nations Industrial Development Organisation (UNIDO) and the United Nations Educational, Scientific and Cultural Organisation (UNESCO). Angola also has bilateral cooperation with a few countries including the US, the EU and China.

2.4 Financing of innovation

Although funding systems and financial instruments are mentioned in Angola's National Policy for Science, Technology and Innovation (2011), specific information on these governmental funding mechanisms couldn't be found. Funding for innovation related activities including start-ups in the private sector is available from financial and microfinance institutions. The National Development Fund is administered by Banco de Desenvolvimento de Angola, which is the public bank of Angola. International organisations and donors such as the WB and AfDB also provide funding for STI activities in Angola.

Ecosystem map examples can be seen in Appendix 2.

Botswana

National Innovation System and Ecosystems Overview

1. Overview

The GII 2020 ranks Botswana 89th out of 131 countries, and 5th among the 26 economies in Sub-Saharan Africa (SSA). Additionally, Botswana, ranks 30th among the 37 upper middle-income group economies. However, relative to its GDP,

¹⁵ <https://www.un.org/technologybank/un-technology-bank-and-network-african-science-academies-launch-angola-academy-science>

Botswana is performing below expectations for its level of development. For the five pillars of the innovation input sub-index, Botswana was ranked: 60th for *institutions*, 53rd for *human capital & research*, 103rd for *infrastructure*, 96th for market sophistication, and 99th for business sophistication. Regarding the two pillars of innovation output sub-index, Botswana was ranked the 89th for knowledge & technology outputs, and 111th for creative outputs, revealing a weakness in these sectors

Botswana's best performance in *institutions* and *human capital & research* can partly be attributed to the following two factors: (a) Botswana is one of Africa's most stable and democratic countries. It has achieved this status through the adoption of prudent policies and legislation that promote political stability, zero tolerance for all forms of corruption, and by adhering to the principles of good governance and equitable distribution of its natural wealth, especially diamonds. As such, the GII 2020 report indicates that Botswana shows institutional strengths in the indicators of political and operational stability (21) and rule of law (43). (b) Botswana's government has aggressively reprioritised its economic strategies to focus on building a strong private sector as well as public institutions. Hence, in Sub-Saharan Africa, Botswana ranks 1st in education spending (1) and strength in Government funding/pupil (7). The high expenditure on education has facilitated access to education at all levels, and consequently a clear increase in the country's literacy rate. In addition to improving educational access, Botswana has also put in place policy measures to enhance the quality of education through the Education and Training Strategy Sector Plan.

2. Governance, policy and institutional capabilities

2.1 Policy structure landscape

Policy frameworks and plans

(Driving long-term development vision, main innovation policies and instruments)

Botswana has a number of policy frameworks and plans that drive the country's long-term development and innovation. Broadly, Botswana draws its developmental agenda on the Africa Agenda 2063 which is Africa's blueprint and master plan for transforming Africa into the global powerhouse of the future. It serves as the continent's strategic framework that aims to deliver on its goal for inclusive and sustainable development. Specifically, Vision 2036 guides Botswana's transformational agenda that defines the aspirations and goals of Botswana. It aims to transform Botswana from an upper middle-income country to a high-income country by 2036 and sets out a compelling vision of what Botswana's future will look like. It follows and builds on Botswana's first national vision (1996-2016). The National Development Plan 11 (2017-2023) is another policy framework document with a focus on inclusive growth and the realisation of sustainable employment creation and poverty eradication.

The National Policy on Research, Science, Technology and Innovation (2011) and the related implementation Plan (2012) focuses on the development of a co-ordinated and integrated approach to STI planning and implementation, development of STI indicators, in accordance with the guidelines of the OECD's Frascati and Oslo

Manuals. It also provides a framework for the launch of regular participatory foresight exercises and the strengthening of institutional structures responsible for policy monitoring and implementation.

The PPP Policy and Implementation Framework provide a means to promote the efficient allocation and use of economic resources of Botswana's Government and the private sector. The Citizen Economic Empowerment (CEE) Policy aims at building capacity for the private sector to grow.

In line with capacity development, an Education and Training Strategy Sector Plan (ETSSP) exists with the mandate to strengthen the match between qualifications and labour requirements, thereby ensuring that education outputs are more closely aligned with future education needs. Botswana's critical sector strategic priorities in education includes: improving the quality and relevance, improving equitable access, improving learning outcomes, focus on life-long learning, strengthening skills development, developing new and alternative pathways for education, improving planning and budgeting of the sector, utilisation and integration of ICT, improving monitoring and evaluation of the sector.

The National Human Resource Development Strategy (2009 – 2022) aids government-supported innovation actors with the innovation transition. The strategy aims to raise the vision and understanding of the nation by encouraging its citizens to creatively reflect and engage in the development of Botswana, toward the realization of their individual capacities and potentials; to provide a strategic framework to guide the direction Botswana should take, to ensure strategic alignment between the nation's ambitions and individual capabilities and potentials; and to use education and skills development of a poverty alleviation tool for household in economics stabilizer at the national level.

Development Programmes / Projects / Initiatives

The small, medium and microenterprises policy provides a framework for institutions whose research will be required to advance research-based knowledge, science and technology. Further, the policy expects these institutions to provide small, medium-sized and micro-enterprises supported to promote technology acquisition, adaptation and transfer.

The National Adaptation Plan (NAP) for Botswana was established in alignment with the Global Network created in 2014 to support developing countries in advancing their national adaptation processes and help accelerate adaptation efforts around the world. To achieve this, the Network facilitates sustained South–South peer learning and exchange, supports national-level action on NAP development and implementation, and enhances bilateral support for adaptation and climate-sensitive sectors through donor coordination.

2.2 Stakeholder landscape

Governance structure *(Key structures/organs)*

Key actors from the government include the Ministry of Tertiary Education, Research, Science and Technology [for Botswana Innovation Hub (BIH)], Ministry of Agricultural Development and Food Security [for Botswana Agricultural hub (BAH)], Ministry of International Affairs and Cooperation (MIAC), Ministry of Investment, Trade and Industry, Ministry of Transport and Communications.

The Ministry of Tertiary Education, Research, Science and Technology (for BIH) exists to provide and build knowledge and innovation through the development and implementation of Policy on Tertiary Education, Research, Science and Technology to transform Botswana into a knowledge based society through effective stakeholder collaboration.

The Ministry of Agricultural Development and Food Security (for BAH) broadly has the mandate to improve food security and champions agricultural development through local production, reduction of import bill, diversification of the sector, value addition, employment, promotion of consumption of local foodstuff, as well as establishment of agriculturally based poverty eradication projects. The ministry implements its mandate through six departments and one division.

MIAC has the prime responsibility of managing and coordinating Botswana's foreign policy and advancing the country's national interests abroad. In pursuit of this important mandate, the ministry works closely with other ministries, and through its diplomatic representatives abroad (High Commissions and Embassies), to engage the international community in the interest of the country and its people. The ministry derives its mandate from the Constitution of Botswana.

The Ministry of Investment, trade and Industry is to create a conducive environment for the promotion of Investment and development of Sustainable Industries and Trade, with a view to diversifying and growing the economy, creating wealth and employment, so that there is prosperity for all. The Ministry of Transport and Communications was established to drive the development and utilisation of Information Communication Technologies (ICTs) and integrated

Academia / Research

The main actors in the Botswana's academia/research space include: National Food Technology Research Centre (NFTRC), National Agricultural Research and Development Institution (NARDI), University of Botswana (UB), Botswana Institute for Technology Research and Innovation (BITRI), Botswana University of Agriculture and Natural Resources (BUAN), Botswana International University of Science and Technology (BIUST).

NFTRC promotes the development of the food industry in Botswana through research and development of food products and processes using indigenous raw materials. It ensures Provision of food quality testing, food safety standards and nutritional adequacy, commercialisation of local food products and provision of related technical assistance to the food and agricultural industry. NARDI, as a research institute, is responsible for the development of the Botswana's research agenda and generating improved crop and livestock production technologies to

enhance the development of a productive and environmentally friendly agricultural sector. It would do this through supporting the work of BAH.

The University of Botswana is linked with varied hubs through governance structure and research & development contribution. In particular, the Botswana Innovation Hub and Education Hub. BITRI was established in 2012 as a Government of the Republic of Botswana company limited by guarantee, to conduct needs-based research and development in focused areas, in accordance with national priorities. BITRI falls under the Ministry of Tertiary Education, Research, Science and Technology.

BUAN is a learning institution that offers programs from Certificate, Diploma, Degree, Master's Degree and PhD in Agriculture and Natural Resources. The Botswana International University of Science and Technology is a Government of Botswana supported institution established through the BIUST Act (CAP 57:05) as a research intensive university that specialises in Engineering, Science and Technology at both undergraduate and postgraduate.

Industry / Private

BIH, Botswana Education Hub and Clean Tech Centre of Expertise constitute the main innovation actors in the private sector space. BIH is mandated to coordinate the establishment of a functional and integrated national innovation ecosystem. Key to this, is the creation of the Innovation Fund that promotes innovation through provision of seed/early stage funding to companies or organizations registered with the BIH which may subcontract part of the development work to universities and research organizations. In addition, the Innovation Fund serves to encourage companies and organizations awarded funding to transfer skills to citizen employees by providing cash grants to be utilized for institutional training and on the job training programmes.

Noting that Botswana spends a significant proportion of public funds on educating its citizens overseas, the government's education hub policy is designed to increase capacity within the national education system through the expansion of existing institutions and also through the creation of new ones. This expansion strategy is focused on developing programs and institutions relevant to both national and regional economic and social needs. Through targeted promotional efforts of the national education system in neighbouring countries and with a focus on programs of study and research related to regional needs, the government hopes to attract an increasing number of international students from the Southern African region to all levels of the national education system. The Clean-Tech Centre of expertise is within the BIH and aims to promote locally relevant environmentally sound business development and PPP projects in Botswana with potential for technology transfer, adoption and employment creation.

Non-Governmental Organisations

Botswana has a number of local and international NGOs that support innovation such as the National Commission for UNESCO, European Union (EU) and others. Botswana is one of the countries covered by the UNESCO Regional Office for

Southern Africa. It also hosts SADC, a key regional partner for UNESCO. Also, the EU has a Delegation to Botswana and SADC, with a domain of activities focused on trade, development and political co-operation with Botswana and the SADC region.

2.3. Involvement in regional and international organisations

Botswana evidences the prerequisite stakeholders, essential to developing a functional regional innovation ecosystem. This includes varied regional actors, with minimal involvement of internationals. Regionally, the Southern African Network on Biosciences (SANBIO), The NEPAD initiative, ATPS, SADC, the Southern Africa Innovation Support Programme (SAIS), funded by the Finnish Government, SARIMA and ARIPO for capacity building.

2.4. Financing of Innovation

ATPS focus on Funding and capacity building for STI activities at the individual and institutional level, the Finish Government funds the SAIS, while SARIMA and ARIPO fund capacity building.

Ecosystem map examples can be seen in Appendix 2.

Malawi

National Innovation System and Ecosystems Overview

1. Overview

According to GII 2020, Malawi ranks 111th out of a total of 131 countries. For the five pillars of the innovation input sub-index, Malawi was ranked: 106th for *institutions*; 124th for *human capital & research*; 128th for *infrastructure*; 58th for *market sophistication*; and 92nd for *business sophistication*. Furthermore, for the two pillars of the innovation output sub-index, Malawi received the following ranking: 92nd for *knowledge & technology outputs*; and 107th for *creative outputs*.¹⁶

These rankings indicate that the least strong aspects of Malawi's innovation system are *human capital & research* and *creative outputs*, followed by *knowledge & technology outputs*, *infrastructure*, *business sophistication*, *market sophistication*, and the strongest aspect which is *institutions*.

Overall, Malawi ranked 103/131 for its innovation outputs, and 114/131 for its innovation inputs¹⁷. With the classification as a 'lower-income' country, Malawi's current scores for innovation are described as "above expectations for level of development."¹⁸

2. Governance, policy and institutional capabilities

¹⁶https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf p. 284

¹⁷https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf p. 284

¹⁸https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf p. xxv

2.1 Policy structure landscape

Policy frameworks and plans

(Driving long-term development vision, main innovation policies and instruments)

Key policy frameworks that have driven development in Malawi include the Malawi National Development Strategy 1997-2020, and the Malawi Growth Development Strategy (MGDS III) 2017-2022¹⁹. The former focuses on the vision of Malawi of becoming a “technologically driven middle-income economy”²⁰ by 2020; the process to develop a successor plan of the Vision 2020 is currently underway, as reported on July 31st 2020.²¹ The MGDS III focuses on driving the country forward to become “a productive, competitive and resilient nation through sustainable agriculture and economy growth, energy, industrial and infrastructure development.”²²

Malawi also has a National Science and Technology Policy (NSTP) 2002, which outlines the aim to integrate STI in national development and provide guidance on coordination mechanisms.²³ The framework states that the Government of Malawi should spend 1% of GDP on R&D; a target that has been met.²⁴ Furthermore, the NSTP places responsibility on the National Commission for Science and Technology to: “(1) encourage local scientists and technologists to publish results of their research work in local journals whose publication would be supported by Government; (2) develop science disciplines in the university system that would lead to the establishment of journals specific to those disciplines; and (3) establish and strengthen professional associations and societies to enhance discipline-oriented R&D.”²⁵ According to UNESCO, progress on these objectives has been made (see Section 2.4).²⁶

Development Programmes / Projects / Initiatives

MGDS III also outlines specific ST&I strategies, including the following:

(1) Supporting inclusive agricultural innovation systems for research, technology generation and dissemination. This includes: fostering collaboration among DARS, national universities, private sector, and others in the development of agricultural technologies; promoting demand-driven and participatory research involving farmers and consumers; establishing mechanisms for protecting intellectual property rights in agricultural research, and others.

(2) Education reforms that focus on innovation, skills development, S&T and entrepreneurship. This includes: introducing and intensifying computer lessons in schools; promoting awareness of science, technology and innovation; reviewing the

¹⁹<https://www.afidep.org/publication/malawi-growth-development-strategy-mgds-iii-2017-2022/>

²⁰ <https://www.commonwealthgovernance.org/countries/africa/malawi/national-development-plan/>

²¹ <https://www.worldbank.org/en/country/malawi/overview>

²²<https://www.afidep.org/publication/malawi-growth-development-strategy-mgds-iii-2017-2022/>

²³

https://www.malawinatcom.mw/index.php?option=com_content&view=category&layout=blog&id=31&Itemid=284

²⁴ <https://en.unesco.org/news/unesco-maps-research-and-innovation-malawi?language=en>

²⁵ <https://www.ncst.mw/wp-content/uploads/2014/03/State-of-ST-Companion-doc.pdf>

²⁶ <https://en.unesco.org/news/unesco-maps-research-and-innovation-malawi?language=en>

science curriculum to include practical components; promoting the use of ICT in Open and Distance Learning (ODL); developing a TEVET system that is capable of promoting innovation and applied research; developing a research findings dissemination system; creating a conducive environment for research and development; ensuring adequate funding for research and training in higher institutions; enforcing the provision of patents and rights for innovations; mobilizing resources for ICT research; undertaking research in ICT, and reviewing the ICT curriculum.

2.2 Stakeholder Landscape

Governance structure

(Key structures/organs)

Key actors from the government include the Ministry of Education, Science and Technology in charge of formulation, guidance and coordination of STI activities, the National Commission for Science and Technology (NCST) in charge of Coordinating and advising government and other stakeholders on all science and technology matters of S&T-led growth and development, and the Ministries of Information, Industry and Trade, Agriculture, and Health.

The Ministry of Information has the mandate related to the formulation and implementation of ICT Policies, Coordination and Management of ICT Development and services. The Ministry of trade and Industry Develops policies to create an economic regulatory environment conducive to promoting industry, trade and tourism, while the Ministry of Agriculture is in charge of Formulation and implementation of agricultural policies, implementation of DeSIRA initiative through six departments: DARS, ADDs, DoF, DADOs, DAES, ATCC. The Ministry of Health focuses on Formulation and implementation of health policies. The National Health Science Research committee (NHSRC) is responsible for the Coordination and regulation of R&D in the health sector. The Ministry of Justice and Constitutional Affairs is responsible for intellectual property rights and National Research Council of Malawi (NRCM) remains the principal entity of the government on all matters relating to scientific research and technological development.

Academia / Research

Actors from academia include the University of Malawi, Department of Computer Science which partners on the mHealth4Africa initiative, the Malawi University of Science and Technology (MUST) which focuses on S&T education, research and entrepreneurship, Agricultural Research and Extension Trust (ARET) which is a Premier institution in tobacco research and technology dissemination in Malawi, the Forestry Research Institute the focuses on forestry research, Lilongwe University of Agriculture and Natural Resources (LUANAR) focussing on Research and training for agricultural sector human capital, STI&I in agriculture and the Malawi Agriculture Policy Advancement and Transformation Institute, which is an independent agriculture policy think tank engaged with government, private sector, civil society in policy analysis, outreach, capacity building and coordination to address key challenges in agricultural sector.

Industry / Private

There are also a number of innovation hubs and private sector actors involved in facilitating Malawi's innovative capacities. Such as the UNICEF Innovation Hub which is a collaborative space for the development of innovative products and services and Polytechnic Design Studio, a Hub for local innovators to come together and discuss, design and build their ideas. mHub is an incubator for technology start-ups, with focus on capacity-building of young technology entrepreneurs and the National Bank of Malawi (NBM) provides funding for the Annual ICT Innovation Awards, and the 'best student' awards at MUST.

Non-Governmental Organizations

INGOs and multilaterals play a key role in driving innovation through funding and technical assistance, including the organisations such as the EU, GIZ, USAID, UNICEF, and the World Agroforestry Centre (ICRAF).

2.3 Involvement in regional and international organisations

Malawi is involved in regional and international organisations such as the African Union, the Southern African Development Community, the African Technology Policy Studies Network, AfriLabs and others.

2.4 Financing of innovation

The government of Malawi contributes approximately 1% of its GDP to R&D, which according to UNESCO is “one of the highest ratios in Africa”²⁷, despite remaining low in real terms. Nonetheless, it is reported that “Malawian scientists publish more in mainstream journals – relative to GDP – than researchers in any other country with a similar population size”²⁸, indicating its potential to harness STI for economic growth and diversification. In terms of direct funding for innovation, the Malawi Innovation Challenge Fund (MICF) was established as an operational tool of the Malawi Government's Private Sector Development Project (PSDP) in 2014. This fund is supported by the UNDP, UK Aid, and KFW, and provides grant finance for innovative initiatives in the agricultural, manufacturing and logistics sectors of Malawi.

Ecosystem map examples can be seen in Appendix 2.

Namibia

National Innovation System and Ecosystems Overview

1. Overview

Namibia, which is an upper middle-income country, ranks 104th on GII 2020 with a score of 22.51, while it ranks 9th within SSA region. Its innovation score performs

²⁷ <https://en.unesco.org/news/unesco-maps-research-and-innovation-malawi?language=en>

²⁸ <https://en.unesco.org/news/unesco-maps-research-and-innovation-malawi?language=en>

below the expectations compared to its level of development. Overall, Namibia's strongest pillars are "institutions" and "creative outputs", and it stands out for the strong use of its IP systems.

Namibia scores 32.20 in innovation inputs, ranking 101st globally and 7th in SSA. In the "institutions" pillar, in which Namibia scores relatively high (62.1), its political and regulatory environment scores much better than its business environment which is weak compared to Namibia's income group. Namibia scores the worst in the "human capital & research" pillar with a score of 13.6 and a rank of 115. Its tertiary education is especially weak for its income group. Its "infrastructure" score (26.4) is also lower compared to its income group, with its general infrastructure being especially weak and ICTs being weak compared to its income group. In the "market sophistication" pillar, it scores 41.0, while it only scores 17.9 in the "business sophistication" pillar in which Namibia scores low compared to its income group. Namibia's weakness in this pillar is a result of its low score in the "knowledge workers" and "knowledge absorption" sub-pillars.

Namibia's innovation output score is 12.82 and it ranks 104th globally while it ranks 10th in SSA. It scores particularly weak in the "knowledge & technology outputs" with a score of 7.3. In this pillar, Namibia's "knowledge impact" and "knowledge diffusion" are especially low, and these sub-pillars perform badly within its income group as well. Finally, Namibia scores 18.3 in the "creative outputs" pillar.

2. Governance, policy and institutional capabilities

2.1 Policy structure landscape

Policy frameworks and plans

(Driving long-term development vision, main innovation policies and instruments)

Namibia has developed a number of policy frameworks and plans to address various challenges surrounding STI. Policies relevant to innovation include the National Policy on Research, Science and Technology (1999), Namibia's Industrial Policy and National Competition Policy (2020-2025). All these policies are anchored to Vision 2030, which is the overall national development policy framework which emphasises the role of STI in achieving Namibia's objectives and aspirations while the NDPs are to implement this vision.

Vision 2030 puts emphasis on the education system for developing a skilled workforce and outlines how a research and innovation system should be built. The current NDP, NDP5,²⁹ aims to increase R&D expenditure from 0.35% in 2015 to 1% by 2022. It focuses on the development of infrastructure and a national strategy for resource mobilisation with specific means of leveraging funds from public, private and international sources in order to create an enabling environment for innovation. It emphasises the Government/University/Industry partnerships and integration of ICT in all sectors to promote innovation. Mobilisation of funds for innovation in the transition to a low carbon and climate resilient economy is also highlighted through

²⁹ https://www.namport.com.na/files/files/NDP5%20MAIN%20DOCUMENT_FINAL%202017%20%20small.pdf

multilateral financing mechanisms (e.g. the Green Climate Fund, Global Environment Facility) and bilateral relationships and partnerships with the private sector.

Development Programmes / Projects / Initiatives

Namibian government offers a number of programmes to support industry and trade. These include the Industrial Development Programme³⁰, International Trade Programme³¹, Investment Promotion Programme³², Commerce Programme³³, and SMEs Programme³⁴. Namibia also offers a free trade zone, Walvis Bay Export Processing Zone, for export-oriented manufacturing operations.

Regarding research, science, technology and innovation (RSTI), National Commission on Research, Science and technology (NCRST) provides a programme, National RSTI Programme, to operationalize and instrumentalise the role of RSTI in driving Namibia's economic development. Namibia University of Science and Technology (NUST) provides the Inclusive Collaborative Local Tech Innovation Hub which is a two-year seed funding from the Finnish Embassy and capacity development initiative. The Finnish Government also funds the Southern Africa Innovation Support Programme which Namibia is part of.

2.2 Stakeholder landscape

Governance structure

(Key structures/organs)

The NCRST, which is under the Ministry of Higher Education, Training and Innovation, is the main authority formulating, coordinating and implementing STI policies. Equally, Ministry of Industrialisation, Trade and SME Development is the main authority formulating and implementing industrial policies such as regulations for manufacturing and tax incentives for enterprises. It implements intellectual property systems through the Business and Intellectual Property Authority, while Namibia Standards Institution under the same ministry is responsible for developing, promoting and enforcing standards and quality in the industry. Other agencies linked to the Ministry of Industrialisation, Trade and SME Development includes the Namibia Industrial Development Agency which promotes private sector driven industrialisation and the Namibia Competition Commission Agency safeguards and promotes competition in the Namibian economy. Sectoral ministries such as the Ministry of Health and Social Services can also play a role in STI through their involvements in policy formulation and R&D within their given sectors.

Academia / Research

The main public R&D institutions in Namibia are the University of Namibia (UNAM) and Namibia University of Science and Technology (NUST). Both universities have dedicated research centres and initiatives such as the Multidisciplinary Research

³⁰ <http://www.mti.gov.na/industrial.html>

³¹ <http://www.mti.gov.na/trade.html>

³² <http://www.mti.gov.na/investment.html>

³³ <http://www.mti.gov.na/commerce.html>

³⁴ <https://sme.mti.gov.na/namibian-sme/>

Centre in UNAM and the Renewable Energy and Energy Efficiency Institute in NUST. Examples of other public R&D institutions include but not limited to the National Botanical Research Institute (NBRI) and the Habitat Research and Development Centre. The coordination of R&D activities is led by the NCRST.

Industry / Private

Enterprises of different sizes – small, medium and large - play a role in innovative activities of the country. Some of the state-owned enterprises are key actors in R&D and innovation such as NamPower, the national power utility company, who leads projects such as the Otjikoto Biomass Power Station.³⁵ Although foreign enterprises have their R&D mostly in their home countries and do not adequately invest in R&D in Namibia,³⁶ they introduce innovations, share new knowledge and skills and attract investment.

Associations play a role in building platforms for innovation and influence policies for R&D and technology development.³⁷ These include the Namibian Manufacturers' Association that represents enterprises both as a watchdog and mouthpiece, the Engineering Professions' Association that is involved in the development of education and infrastructure, and the Namibia Chamber of Commerce and Industry that provides advocacy and support for businesses. NUST has centres and institutes to support innovation in different sectors. Namibia Business Innovation Institute implements innovation and provide support to transform innovative ideas into sustainable businesses and social solutions. Centre for Enterprise Development facilitates capacity building initiatives for the public, private and NGO sectors.

Non-Governmental Organizations

Namibia has a handful of NGOs that work in the space of RSTI and development. These include Namibia Development Trust which plays an active role in community development, an "Organization for Women in Science for the Developing World" chapter which provides training, career development and networking opportunities, and learned societies in individual disciplines.

2.3 Involvement in regional and international organisations

Namibia is a member of the UN, AU, and SADC. It is involved in the ASTII and NEPAD of the AU. Within the UN system, it participates in UNCTAD, UNIDO and UNESCO. Namibia also has bilateral relations with a few countries such as the US, China and Finland.

2.4 Financing of Innovation

NCRST administers the National Research, Science and Technology Fund for STI activities while funding is also available for sectoral R&D activities from sectoral ministries. Banks such as the Development Bank of Namibia and other microfinance

³⁵https://www.nampower.com.na/public/docs/projects/otjikoto/Biomass%20Project%20Fact%20Sheet_10Jun20_v2.2%20-%20published.pdf

³⁶ https://www.ncrst.na/files/downloads/4ed_NCRST-Review%20Report-Jul%202016-FINAL.pdf

³⁷ Ibid.

institutions provide funding for innovation related activities including start-ups in the private sector. International organisations and donors such as the World Bank and African Development Bank also provide funding for STI activities. The Namibia Investment Centre, which operates within the Ministry of Industrialisation, Trade and SME Development promotes direct foreign investment and facilitates an enabling investment environment.

Ecosystem map examples can be seen in Appendix 2.

South Africa

National Innovation System and Ecosystems Overview

1. Overview

According to GII 2020, South Africa ranks 60th out of 131 countries, and 14th among the 37 upper middle-income group economies while being 2nd among the 26 economies in SSA. Relative to GDP, South Africa is performing above expectations for its level of development. South Africa has high scores in four out of the seven GII pillars: Institutions (55th), Market sophistication (15th), Business sophistication (50th), and Knowledge & technology outputs (62nd), which are above average for the upper middle-income group. Conversely, South Africa scores below average for its income group in three pillars: Human capital & research (70th), Infrastructure (79th) and Creative outputs (70th). Compared to other economies in SSA, South Africa performs above average in all seven GII2020 pillars of innovation sub-indices. South Africa performs best in Market sophistication and its weakest performance is in Infrastructure. South Africa ranks 22nd worldwide in a new indicator to the GII2020, Global brand value, led by telecoms companies MTN and Vodacom, and followed by banks First National Bank, ABSA and Standard Bank.

2. Governance, policy and institutional capabilities

2.1 Policy structure landscape

Policy frameworks and plans

(Driving long-term development vision, main innovation policies and instruments)

South Africa draws on a number of policy frameworks and plans towards the country's long-term development and vision of becoming a knowledge-based economy. The steering role of STI for South Africa's aspired inclusive economic growth, job creation, and socio-economic reform is stipulated in the Government of South Africa (GoSA)'s revised STI policy of 2019, known as White Paper on STI (GoSA, 2019, p. 3), and the 2012 National Development Plan 2030 (NDP)(GoSA, 2012).

South Africa's 2019 White Paper on STI was conceptually developed through participation of four main stakeholders including government (policymakers), industry, academia and civil society. The active involvement of civil society – as forth actor in addition to the triple helix of government, industry and academia – in South

Africa's STI policy design process partly demonstrates positive implication of STI policy (and related policy instruments) to South Africa's envisaged development agenda (Twiringiyimana et al., Forthcoming).

Development Programmes / Projects / Initiatives

Within the DSI the Biotechnology Unit plays the driving role in the country's Bioeconomy Strategy (2013), in collaboration with other leading actors such as the Agricultural Research Council (ARC). Technology and Human Resources for Industry Programme (THRIP) - a flagship R&D instrument of the Department of Trade Industry and Competition (DTIC) and NRF³⁸ - is a government-academic-private sector partnership established to respond to the shortage of high-level technical skills required by industry and to improve the competitive edge of South Africa's industry through the development of advanced technologies. THRIP was previously administered by the NRF, but is now being administered by DTIC. DTIC also administers the Support Programme for Industrial Innovation (SPII), another innovation and technology funding instrument which funds projects from technology development, technology and market validation, process/product development and market ready³⁹.

2.2 Stakeholder landscape

Governance structure

(Key structures/organs)

Additional to the responsibilities of setting STI policy and strategy - under the ministry of science, technology and higher education - the Department of Science and Innovation (DSI) formally known as Department of Science and Technology (DST), is mandated to oversee the coordination and/or research and innovation (R&I) funding in collaboration with other multiple agencies such as the National Research Fund (NRF) (Twiringiyimana et al., Forthcoming).

The National Research Foundation (NRF), a government mandated research and science development agency funds research, the development of high-end human capacity and critical research infrastructure to promote knowledge production across all disciplinary fields. Part of research and science funding instruments include the provision of science, engineering and technology (SET) bursaries in various domains including the Indigenous Knowledge Systems (IKS)⁴⁰.

The Technology Innovation Agency (TIA) serves as the key institutional intervention to bridge the chasm between research and development from higher education institutions, science councils, public entities, and private sector, and commercialisation. TIA also offers financial and non-financial support. In early 2010, the Biotechnology Innovation Centres (BICs), (which were created as funding

³⁸ <https://www.nrf.ac.za/division/aric/instruments/technology-and-human-resources-industry-programme-thrip>

³⁹ <http://www.thedtic.gov.za/financial-and-non-financial-support/incentives/spii/>

⁴⁰ <https://www.nrf.ac.za/bursaries/opportunities>

[Accessed:22.04.2021]

vehicles in the early 2000s to make strategic investments into the biotech sector in South Africa), together with the Innovation Fund, were incorporated into the TIA.

The Centre for Proteomic and Genomic Research (CPGR) originated from an initiative by the then Department of Science and Technology (DST) (now the Department of Science and Innovation DSI). Public funding to create the CPGR was initially provided by the BICs which were incorporated into TIA in 2010, to achieve enhanced levels of operational efficiency and alignment of national strategies.

Other government actors include the department of Higher Education, the department of Health, the department of Agriculture. The South African Medical Research Council (SAMRC) is the largest local funder of health research, medical diagnostics, medical devices and therapeutics, while the Agricultural Research Council (ARC) has the mission to be a premier science institution that conducts research with partners, develops human capital and fosters innovation to support and develop the agricultural sector.

Academia / Research

South Africa has 26 universities and several specialist centres/research institutions, such as the Rhodes University Biotechnology Innovation Centre (RUBIC), which was established in 2014 as a *'brand new academic home of the discipline of Biotechnology, providing a trans-disciplinary research and learning environment in the field'*.

The Forestry and Agricultural Biotechnology Institute (FABI), a post-graduate research institute at the University of Pretoria, was established in 1997, based on a recognition that the future of forestry and agriculture in South Africa will strongly depend on the incorporation of new and emerging technologies into these industries.

The Centre for the AIDS Programme of Research in South Africa (CAPRISA) was created in 2001 and formally established in 2002 under the NIH-funded Comprehensive International Program of Research on AIDS (CIPRA) by five partner institutions; University of KwaZulu-Natal, University of Cape Town, University of Western Cape, National Institute for Communicable Diseases, and Columbia University in New York.

Stellenbosch University LaunchLab is building the next generation of sustainable, high-impact companies tackling the world's toughest challenges in Agriculture, Climate & Health with a heavy dose of engineering and data science.

The Council for Scientific and Industrial Research (CSIR), is a leading scientific and technology research organisation that researches, develops, localises and diffuses technologies to accelerate socioeconomic prosperity in South Africa.

Industry / Private

South Africa has a number of venture capital firms and SMEs that contribute to the development of innovation ecosystem. Venture capital firms include Knife Capital, Kalon Venture Partners, CRE Venture Capital. The South Africa SME Fund Invested

R1.2bn into South Africa's only biotech fund (One Bio) and Silicon Cape, an NPO and an ecosystem enabler for tech-enabled start-ups in the broader Cape Region of South Africa.

Non-Governmental Organizations

A number of non-governmental organisations are involved in driving innovation in South Africa. The Cape Innovation and Technology Initiative (CiTi) is a non-profit Company with a mission to build a future-proof, inclusive society through technology and innovation. AfricaBio, an independent non-profit stakeholders' association, represents the interests of all stakeholders involved in the biotechnology sector throughout Africa, and promotes the use of biotechnology as a means to upliftment. AfricaBio focuses on the agriculture, health, industrial, environmental and marine biotech. The Academy of Sciences of South Africa is the official national Academy of Science of South Africa and represents the country in the international community of science academies.

2.3 Involvement in regional and international organization's

The South African government is active in international collaboration on research and innovation. It is involved in the Southern Africa Innovation Support Program (SAIS), a regional initiative funded by the Ministry for Foreign Affairs of Finland, in partnership with STI Ministries of South Africa, Botswana, Namibia, Tanzania and Zambia, and SADC Secretariat, all supporting the growth of new businesses through strengthening innovation ecosystems and promoting cross-border collaboration (e.g. through pilot programs in South Africa, such a biotech start-up incubator run by CiTi and TechVillage). SANBio, a regional initiative supported by South Africa and Finland, focuses on bio-innovations and a variety of capacity development and collaborative projects. South African scientific publications are co-authored with scientists from various SADC countries. Between 2013 and 2017, the major co-authors for South Africa were Zimbabwe (1 113), Namibia (578), Botswana (560) and Malawi (555).

2.4 Financing of Innovation

The NRF distributes a large portion of its funding budget to researchers, via research grants, infrastructure grants, travel grants, scholarships and fellowships. Grants include funding initiatives that are awarded by the organisation, as well as those that are administered by the NRF on behalf of the Department of Science and Innovation (DSI) and other entities. In 2020, The University Technology Fund (UTF) approved seven investments into university companies— including investments from the University of Cape Town (UCT), the University of the Western Cape (UWC), and Stellenbosch University (SU), taking the total amount invested since February to R28.1 million. Since the inception of the H2020 Programme in 2014, South African STI organisations acquired more than €33.273 million in funding from the EU. This represents a share of 0.068% of the Programme's funding received by 216 organisations.

Funding Raised by South African start-ups, by year⁴¹

In 2020, the total amount of investment that went into start-ups from Nigeria, Kenya, South Africa and Egypt was US\$625,659,000. This accounted for 89.2 per cent of the total amount for the continent. In terms of South Africa this represents 81 start-ups funded at a total of US\$142,523,000, which represents 20.4% of the African total. This was up 2.5 per cent on the 79 that was raised in 2019, which made up 25.4 per cent of the total that year. South Africa was the 3rd most attractive after Nigeria (85) and Egypt (82). The average amount of funding raised by South African start-ups also leapt significantly in 2020, growing 90.4 per cent to US\$1,759,543 from US\$924,296 in 2019.

Ecosystem map examples can be seen in Appendix 2.

Zambia

National Innovation System and Ecosystems Overview

1. Overview

According to GII 2020, Zambia ranks 122nd out of a total of 131 countries. For the five pillars of the innovation input sub-index, the following rankings given: 122nd for *institutions*; 111th for *human capital & research*; 107th for *infrastructure*; 85th for *market sophistication*; and 91st for *business sophistication*. Furthermore, for the two pillars of the innovation output sub-index, Zambia received the rankings: 123rd for *knowledge & technology outputs (knowledge creation, knowledge impact, knowledge diffusion)*; and 126th for *creative outputs*.

Zambia's innovation outputs – *creative outputs* and *knowledge & technology outputs* – received very low scores, indicating that these capacities are particularly weak. This is followed by *human capital & research*, *business sophistication*, *infrastructure*, *market sophistication*, and the strongest aspect which is *institutions*.

Overall, Zambia ranked 128/131 for its innovation outputs, and 109/131 for its innovation inputs⁴². With the classification as a 'lower middle-income' country, Zambia's current scores for innovation are listed as not strong enough/ not in line with the current level of development.⁴³

2. Governance, policy and institutional capabilities

2.1 Policy structure landscape

Policy frameworks and plans

(Driving long-term development vision, main innovation policies and instruments)

⁴¹<https://disrupt-africa.com/funding-report/>

⁴²https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf p. 344

⁴³https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf p. xxv

Key policy frameworks driving development in Zambia include the Zambia Vision 2030⁴⁴ and the Zambia 7th National Development Plan 2017-2021⁴⁵. The overall aim of the Zambia Vision 2030 is for the country to become “a prosperous middle-income nation by 2030”⁴⁶, with science, technology and innovation named as key contributors to the attainment of this framework’s objectives. Key science and technology goals outlined include: (1) to acquire and upgrade infrastructure required for training in science and technology and R&D academic institutions by 2030; (2) to build and sustain human resource capacities and capabilities by 2030; (3) to promote the development of enterprise using outputs from S&T and R&D activities by 2030; (4) to strengthen linkages between productive sectors and research institutions by 2030; and (5) to establish and strengthen practical application of S&T in all areas.

Zambia’s 7th National Development Plan 2017-2021 follows the overall objective to “create a diversified and resilient economy for sustained growth and socio-economic transformation driven, among others, by agriculture.”⁴⁷ The plan notes that one of the key challenges of Zambia, detrimental to progress, is low levels of innovation, as was expressed through the GII 2016. Accordingly, the following science, technology and innovation strategies are proposed: improve ICT infrastructure for service delivery (ICT common infrastructure development, ICT innovation park establishment, broadband infrastructure expansion); enhance R&D and innovation capacity (laboratory infrastructure development, infrastructure upgrading, quality assurance enhancement, financing improvement); undergo continuous review of curriculum (focus on contemporary global market skills needs i.e. science, mathematics, technology, innovation, entrepreneurship); enhance the role of STI (S&T human capital development, S&T infrastructure development, STI financing, STI quality assurance enhancement, STI coordination enhancement). Nonetheless, Zambia’s GII scores for 2020 remain below the expected level, suggesting more work must be done to improve the country’s innovative capacities, particularly with regards to innovation outputs.

Another key framework pertaining to innovation in Zambia is the STI Policy and Implementation Plan, launched in December 2020. This plan centres around increasing investments into “incubation centers” and “in the capacity of – and resources available to – innovators.”⁴⁸ It also outlines the need for the establishment of “innovation hubs”, “innovation high tech centers,” and “science and technology parks”, as well as technology transfer offices in universities, and links with industry.⁴⁹ However, key aspects missing from this plan are the “incentive regime” and “regulatory factors that affect entrepreneurs’ perceptions of risk and reward and thus their willingness to invest in growth.”⁵⁰ Furthermore, while the Ministry of Higher Education and the National Science and Technology Council are named as implementing institutions, neither the Ministry of Commerce, Trade and Industry, nor the private sector, are referenced.

⁴⁴https://www.mcti.gov.zm/?wpfb_dl=43

⁴⁵<https://www.zambiaembassy.org/document/seventh-national-development-plan-2017-2021>

⁴⁶https://www.mcti.gov.zm/?wpfb_dl=43

⁴⁷<https://www.zambiaembassy.org/document/seventh-national-development-plan-2017-2021>

⁴⁸<https://openknowledge.worldbank.org/handle/10986/33806>

⁴⁹<https://openknowledge.worldbank.org/handle/10986/33806>

⁵⁰<https://openknowledge.worldbank.org/handle/10986/33806>

2.2 Stakeholder Landscape

Governance structure

(key structures / organs)

Key actors include the Zambia Ministry of Higher Education, the National Technology Business Centre (NTBC) and the National Science and Technology Council, which are the institutions responsible for implementing the STI Policy and Implementation Plan 2020. Others include the Zambia Information and Communications Authority (ZICTA), which regulates Zambia's ICT sector and is currently a key partner on the National Innovation Initiative 2020 as well as the BongoHive technology hub.

Academia / Research

The Zambia Agriculture Research Institute is the country's largest research entity, providing scientific leadership in the generation and transfer of improved and appropriate technologies for the agricultural sector. University of Zambia which is Zambia's largest higher education institution provides education and research in ST&I; Copperbelt University with a focus on R&D, education in ST&I. Social Enterprise Academy provides practical learning programmes that support people developing and growing social enterprises.

Industry / Private

BongoHive Technology and Innovation Hub provides start-up and entrepreneurship capacity-building and accelerator programmes; Jacaranda Hub supports the training of young people in ICT and entrepreneurship. Asikana network as a social enterprise thrives to increase the interest of women and girls in technology while Tech Watch News is a media platform providing news coverage on technological innovations in various sectors.

Non-Governmental Organisations

There are also a number of international non-governmental organisations (INGOs) and international development agencies involved in driving innovation through funding and technical assistance, including UNDP – through their Accelerator Lab, GIZ, and the German Federal Ministry for Economic Cooperation and Development (BMZ), which are leading innovative initiatives in the agricultural sector.

2.3 Involvement in regional and international organisations

Zambia is involved in a number of regional and international organisations such as African Union, Southern African Development Community, African Technology Policy Studies Network, AfriLabs, Southern Africa Innovation Support Programme, Southern African Venture Partnership (SAVP).

2.4 Financing of innovation

The most recently reported figure for Zambia's R&D expenditure as a percentage of GDP is from 2008, and sits at 0.28% according to the World Bank.⁵¹ In terms of

⁵¹ <https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS>

direct funding for innovation, through the Zambia Compact – an agreement between the Government of Zambia and the Millennium Challenge Corporation – the Innovation Grant Program (IGP) was established with a total portfolio amount of USD 6 million. The aim of this programme is to promote the development of innovative and effective methods to “strengthen and expand water supply networks, create sanitation programs and infrastructure, improve drainage and solid waste management, and provide employment opportunities for the urban poor.”⁵² All creative approaches produced through this grant programme are to then “be replicated by the GOZ or private actors.”⁵³ International organisations also play a role in funding innovation; this includes the UNDP through their Accelerator Labs programme, which is operational in Zambia and most recently initiated a funding opportunity through an ‘Innovation Challenge’ for small waste management businesses in Lusaka and Ndola.

Ecosystem map examples can be seen in Appendix 2.

Zimbabwe

National Innovation System and Ecosystems Overview

1. Overview

According to the GII 2020 Zimbabwe ranks 120th out of a total of 131 countries. For the five pillars of the innovation input sub-index, Zimbabwe was ranked as follows: 128th for *institutions*; 93th for *human capital & research*; 131st for *infrastructure*; 84th for *market sophistication*; 108th for *business sophistication*. Furthermore, for the two pillars of the innovation output sub-index, Zimbabwe saw the following ranking: 101st for *knowledge & technology outputs*; and 112nd for *creative outputs*.

These rankings indicate that innovation outputs - *creative outputs* and *knowledge & technology outputs* – are the weakest aspect of Zimbabwe’s innovation system. This is followed by the innovation inputs, with *infrastructure* and *business sophistication* as the weakest, followed by *human capital & research*, *institutions*, and the strongest aspect which is *market sophistication*.

Overall, Zimbabwe ranked 108/131 for its innovation outputs, and 123/131 for its innovation inputs⁵⁴. With the classification as a ‘lower middle-income’ country, Zimbabwe’s current scores for innovation are declared as “in line with level of development.”⁵⁵

2. Governance, policy and institutional capabilities

2.1 Policy structure landscape

⁵² <https://www.mcc.gov/resources/story/section-zmb-star-report-innovation-program>

⁵³ <https://www.mcc.gov/resources/story/section-zmb-star-report-innovation-program>

⁵⁴ https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf p. 345

⁵⁵ https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf p. xxv

Policy frameworks and plans

(Driving long-term development vision, main innovation policies and instruments)

Key policy frameworks driving development in Zimbabwe include the Zimbabwe Vision 2030⁵⁶ and the National Development Strategy (NDS) 2021-2025⁵⁷. Outlining the country's long-term development objective to become an upper middle-income country by 2030, Vision 2030 focuses on "promoting innovation, entrepreneurship, equitable development and prosperity for all, under a market economy that leverages on Zimbabwe's natural resources and abundant human skills."⁵⁸ Objectives around innovation in this framework pertain to economic growth and productivity: focus on fostering innovation through pursuit of a private sector led market economy; increasing use of ICT, innovation, technological advancement and R&D to boost productivity in the manufacturing sector.

Zimbabwe's NDS 2021-2025, which focuses on delivering the objectives of Vision 2030, describes human capital development and innovation as "the engine which will drive the NDS and the country's progress towards Vision 2030"⁵⁹, creating the right conditions for a knowledge-based economy. The NDS details explicit strategies for the improvement of science and technology innovation ecosystems, including the following: capacitate national strategic technology institutions such as Zimbabwe National Geospatial and Space Agency (ZINGSA) and Zimbabwe Centre of High Performance Computing (ZCHPC); establish and strengthen innovation hubs at all state universities; operationalize industrial parks to commercialize prototypes; establish diplomatic technology transfer initiatives; establish a Heritage Technology Institute; Implement the National Science and Technology Innovation System; Introduce Science Academies, Technical High Schools, Biotechnology, Robotics and Coding Clubs for improved foundational innovation ecosystems with a view to establishing linkages and trade-offs across sectoral value chains; develop and implement a policy on adoption and adaptation of emerging technologies: big data analytics, artificial intelligence (AI) and virtual augmented reality (VAR); and capacitate HTEIs on Intellectual Property Rights.

Another key policy framework around ST&I in Zimbabwe is the Science, Technology and Innovation Policy 2012, with the overall vision to "make science and technology an integral part of individual and national development."⁶⁰ Six primary goals to guide all core activities include: (1) strengthen capacity development in STI; (2) learn and utilize emergent technologies to accelerate development; (3) accelerate commercialisation of research results; (3) search for scientific solutions to global environmental challenges; (4) mobilize resources and popularise science and technology; (5) foster international collaboration in STI.

⁵⁶<http://www.zim.gov.zw/index.php/en/government-documents/category/1-vision-2030>

⁵⁷http://www.zimtreasury.gov.zw/index.php?option=com_phocadownload&view=category&id=64&Itemid=789

⁵⁸http://www.zimtreasury.gov.zw/index.php?option=com_phocadownload&view=category&id=64&Itemid=789

⁵⁹http://www.zimtreasury.gov.zw/index.php?option=com_phocadownload&view=category&id=64&Itemid=789

⁶⁰<https://www.healthresearchweb.org/files/Zimbawescienceandtechpolicydocumentnew.pdf>

2.2 Stakeholder Landscape

Governance structure

(key structures / organs)

Key actors from the government include the Ministry of Higher and Tertiary Education, Science and Technology Development; the Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement; and the Ministry of Information and Communications Technology, which are all driving forth initiatives pertaining to innovation in Zimbabwe. This includes progress made in adopting the Education 5.0 model (which adds innovation and industrialisation to teaching, research and outreach focus areas), the ZADP, and the ICT Innovation Drive, respectively.

Academia / Research

Actors from academia include the Research Council of Zimbabwe responsible for registering all foreign researchers (non-Zimbabwean national) wishing to conduct research the country, the National Biotechnology Authority which is a research institute specialised in biotechnology R&D and the National University of Science and Technology (NUST), the second largest public research university. The Scientific and Industrial Research and Development Centre (SIRDC) provides technological solutions for sustainable development for Zimbabwe and the region. Agricultural Research Council, Matopos Agricultural Research Centre facilitate, coordinate, promote and review agricultural R&D while the Medical Research Council of Zimbabwe is responsible for ethical oversight, training, monitoring and community activities in medical research.

Industry / Academia

There are also a number of innovation hubs and community platforms to facilitate innovation. For instance, Muzinda Hub in Harare provides youth with access to software training/ IT programming/ digital skills training, and facilitates work placements. Others provide co-working space and start-up network e.g. GBI Business, Harare); and incubation space for young people to contribute to the SDGs through sustainable energy ideas (e.g. Green Innovation Hub, Harare) and others.

Non-Governmental organisations

The private sector and NGOs such as ATPS, UNDP, UNESCO, EU and others also play a key supporting role in funding, facilitating, or implementing innovative programmes initiated by the government.

2.3 Involvement in regional and international organisations

Zimbabwe is a member state for UN, AU and SADC, among others. Zimbabwe is also involved in partnerships with the EU. However, the partnership with the WB is currently only limited to technical assistance and analytical work through Trust Funds. The collaboration of Zimbabwe with UNICEF is coordinated through UNICEF-Zimbabwe office.

2.4 Financing of innovation

The establishment of an Innovation Fund – also called the ICT Innovation Drive – of up to USD 25 million was announced in September 2016 by Zimbabwe’s Ministry of Information and Communications Technology. This fund, managed by the national telecommunications company POTRAZ, was officially launched in early 2018 with the purpose of funding young innovators within the ICT sector. Other aims of the fund include (1) increasing R&D as well as ICT uptake by young innovators; (2) establishing innovation hubs; (3) promoting a culture of innovation and development in Zimbabwe.⁶¹ This initiative is in line with the objectives of Zimbabwe’s Vision 2030 Framework, to promote ICT, innovation and technological advancement as driving forces behind national development.

Ecosystem map examples can be seen in Appendix 2.

⁶¹ <https://www.techzim.co.zw/2018/03/potraz-finally-launches-the-ict-innovation-drive-to-provide-funding-for-innovators-in-the-ict-field/>

West Africa

Cameroon

National Innovation System and Ecosystems Overview

1. Overview

According to GII 2020, Cameroon ranks 119th out of 131 countries, 26th among the 29 lower middle-income group economies, and 17th among the 26 SSA countries on the list. Cameroon scores below average for its income group in all pillars.

Compared to other economies in SSA, Cameroon performs above average in three out of the seven GII pillars: Human capital & research (113th), Business sophistication (100th), and Knowledge & technology outputs (94th); and performs below average in four pillars: Institutions (119th), Infrastructure (113th), Market sophistication (117th) and Creative outputs (123rd). Relative to GDP, Cameroon is performing below expectations for its level of development.

Cameroon is party to the Organisation for the Harmonization of Business Law in Africa (OHADA), a set of laws and regulations to streamline business regulations in 17 African countries. Despite being a member of OAPI, intellectual property is poorly protected, given weak enforcement mechanisms. There are no restrictions on currency conversion by foreign investors or heavy restrictions on access to FOREX for investment purposes. The National Competition Commission (NCC) in the Ministry of Commerce is the authority that is meant to enforce competition rules. However, competition in many sectors is restricted, in part due to the pervasive presence of over 130 companies.

In addition, the government has come under criticism for preferential treatment given to French companies, such as Total in the oil sector, Lafarge in the building material sector and SocGen in investment banking. Nearly 90% of the population is employed in the informal economy. Cameroon produces more innovation outputs relative to its level of innovation investments.

2. Governance, policy and institutional capabilities

2.1. Policy structure landscape

Policy frameworks and plans

(Driving long-term development vision, main innovation policies and instruments)

A number of policy frameworks and plans drive the innovation development in Cameroon. The AU Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024) places science, technology and innovation at the epicenter of Africa's socio-economic development and growth.

The Mission of STISA-2024 is to “Accelerate Africa’s transition to an innovation-led, Knowledge-based Economy”. The vision 2035 drives innovation with four objectives: poverty reduction, become a middle-income country, industrialisation, foster national

unity. Cameroon does not have any sectoral strategy on STI. The concept is instead integrated in the Education and Training Sector Strategy document.

Development Programmes / Projects / Initiatives

The National Committee for Development of Technologies has set up the following sub committees for the proliferation of sector-specific technologies: The Information Communication Technologies, The Commission for Industrial Transformation Technologies, Energy, Mines and Environmental Technologies, Science and Technology Policies, Agricultural Biosciences and Technologies.

2.2. Stakeholder landscape

Governance structure

(Key structures / organs)

The Ministry of Innovation and Scientific Research in Cameroon (Ministère de la Recherche Scientifique et de l'Innovation du Cameroun (MINRESI)) coordinates thematic research activities and oversees the National Research Policy. The African Institute of Computer Science (AICS), an Inter-State School created by Decision of the Heads of State in 1971 in Fort-Lamy (current N'Djamena) in Chad and endowed with a diplomatic Statute, for Headquarters Libreville in Gabon.

The Ministry of Higher Education governs and coordinates research in universities across the country. The Institute of Geological and Mining Research (IGMR) under the tutelage of MINRESI is a specialized institute that implements Government policy on scientific and technical research. Specifically, and the mission of IGMR is to elaborate and carry out research projects to generate and manage information in geology, hydrology, energy and mining in Cameroon.

The Institute of Agricultural Research for Development (IRAD) contributes on research activities in the agriculture domain. The Institute for Medical Research and Studies of Medicinal Plants works on research programmes in medical disciplines in order to improve health conditions and deepen understanding of pathological and epidemiological aspects.

Other actors from the government include the Ministry of Industry and Technological Development (Ministère des Mines, de l'Industrie et du Développement Technologique (MINMIDT)), the Ministry of Agriculture and Rural Development (Ministère en charge de l'Agriculture et du Développement Rural (MINADER)), the Ministry of Finance, and the National Society of Investment (Société Nationale d'Investissement du Cameroun (SNI)).

Academia / Research

The following universities partake in research: University of Dschang: collaborating BecA institute, University of Ngaoundere, University of Yaounde I, University of Buea which acts as a regional institute for BecA-ILRI, University of Bamenda, Catholic University of Cameroon, Cameroon Christian University, Catholic University Institute of Buea, the Biosciences Eastern and Central Africa International Livestock

Research Institute (BEACA-ILRI) HUB BEACA-ILRI. The Hub's mission is to mobilise bioscience for Africa's development, by providing a centre for excellence in agricultural biosciences.

EITD Research (Research for Enterprise, Industries, Technology and Development) is a dynamic independent research and policy education institution working on development issues related to technology, enterprise and industries since 1992. In addition, EITD Research provides field services and technical support, develops and circulates information on a wide range of issues, and makes public policy recommendations.

Industry / Private

BUEA Cameroon Silicon Mountain: Some agrochemical companies (Jako, Syngenta, Agrochem, Arysta Life Sciences, DuPont and Senachem, etc.) fund research specifically on the bio-efficacy of pesticides and effects of fertilizers, with a large focus on export crops such as bananas, cotton, oil palm, rubber, cocoa, as well as other important crops for domestic consumption such as maize, yams, cassava, and vegetables.

ActivSpaces exists to help young techies and technology entrepreneurs in Cameroon bring their ground breaking ideas to light. ActivSpaces was created in 2010 and is registered as a non-profit Association in Cameroon. ActivSpaces currently operates two hub locations in Buea and Douala respectively.

Non-Governmental Organizations

The Association for Strengthening Agricultural Research in Eastern and Central Africa ([ASARECA](#)) is a sub-regional not-for-profit association. It was established in 1994 by ten member States represented by their National Agricultural Research Institutes (NARIs) – Cameroon joined in July 2020.

The Digital-Transformation Alliance Digital-Transformation Alliance's Action Line have been strategically chosen: '– Digital Economy, Digital Transformation (Industry/Infrastructure/Health/etc), Digital/Smart Cities.

2.3 Involvement in regional and international organisations

The Association for Strengthening Agricultural Research in Eastern and Central Africa ([ASARECA](#)) aims at increasing the efficiency of agricultural research in the region so as to facilitate economic growth, food security and export competitiveness through productive and sustainable agriculture, by bringing together the National Agricultural Research Institutes (NARIs) of ten countries.

The Organisation for coordination and fight against Endemic diseases (L'Organisation de Coordination pour la lutte contre les Endémies en Afrique Centrale (OCEAC), is known for the use of STI, through the research institute of Yaoundé (Institut de Recherche de Yaoundé – CEMAC), which has the mandate to accommodate fundamental epidemiological social science research related to health systems.

2.4. Financing of Innovation

International organisations seem to make up the majority of the funding for innovation and research in Cameroon. Among the main donors are the African Development Bank (AfDB), The French cooperation, the European Union (EU), the Food and agricultural Organisation (FAO), International Atomic Energy Agency, the World Bank.

Ecosystem map examples can be seen in Appendix 2.

Ghana

National Innovation System and Ecosystems Overview

1. Overview

Ghana, which is a lower middle-income country, ranks 108th GII 2020 with a score of 22.28, while it ranks 10th within the SSA region. Its innovation score performs below the expectations compared to its level of development. Overall, Ghana's strongest pillars are "infrastructure" and "creative outputs" ranked 96th and 90th respectively, whereas its weakest pillars are "institutions" and "business sophistication" where the country was ranked 121st and 113th respectively. Ghana scores 30.20 in innovation inputs overall, ranking 113st globally and 14th in SSA. In the "institutions" pillar, in which Ghana was ranked 121st scoring 46.3, its regulatory environment scores weakly compared to Ghana's income group. Ghana's score in the "human capital & research" is 17.2, while it's 32.5 in the "infrastructure" pillars ranking 104th and 96th respectively. Ghana scored 37.1 in the "market sophistication" pillar, and 17.9 in the "business sophistication" pillar, ranking 111th and 113th respectively.

Ghana's scores are generally within the expected range and it doesn't score particularly strong or weak in any of the sub-pillars that are the average of specific criteria under these sub-pillars.

2. Governance, policy and institutional capabilities

2.1 Policy structure landscape

Policy frameworks and plans

(Driving long-term development vision, main innovation policies and instruments)

Ghana has a number of policies and plans relevant to the improvement of the national science, technology and innovation systems. The main policies include the National Science, Technology and Innovation (STI) Policy (2017-2020), Industrial Policy and the National Trade Policy. The National STI Policy aims to transform Ghana into a developed country with a strong STI capacity in which STI drive the social and economic development for the sustainable transformation of the economy. Ghana's Industrial Policy puts emphasis on technology and innovation and presents it as one of the four components necessary to achieve the long-term vision, while the

National Trade Policy aims to stimulate innovation and technology development through intellectual property systems.

The National STI Policy focuses on restructuring the governance of STI to better implement and evaluate STI policies. To promote STI in Ghana, it promises to strengthen the dissemination of research and recognise deserving scientists and technologists with awards. Development of new curricula and training programmes, as well as special programmes for women's participation in science and technology are also highlighted to improve Ghana's STI capabilities. The policy puts emphasis on the development of new infrastructure such as centres of excellence, technology incubators and industrial parks to strengthen national engineering design and manufacturing capacity. To promote cooperation and flow of scientific and technological information, bilateral and multilateral programmes with local and international partners are highlighted. Finally, the financing of the STI is promised to be improved by accelerating the allocation of a minimum of 1% of GDP.

Development Programmes / Projects / Initiatives

Ghana offers several programmes to support STI as well as industry and trade in the country. These include the National Entrepreneurship & Innovation Programme which aims to provide an integrated national support for start-ups and small businesses⁶²; Rural Enterprises Programme which seeks to upscale and mainstream a district-based MSE support system⁶³; Business Resource Centres, 37 of which have already been set up to provide business advisory services in various districts⁶⁴; Industrial Parks and Special Economic Zones Project which provides infrastructure and incentives to foster development, economic activities and industrial cluster formations for networking and spill over effects⁶⁵; Free Zones Programme which aims to promote economic development in Ghana⁶⁶; One District One Factory Initiative which creates the necessary conducive environment for the businesses to access funding from financial institutions and other support services to establish factories⁶⁷. Ghana also participates in regional programmes and initiatives such as the Science Granting Councils Initiative and collaborate as a partner on initiatives funded by the Southern Africa Innovation Support Programme.

2.2 Stakeholder landscape

Governance structure

(Key structures / organs)

Ministry of Environment, Science, Technology and Innovation (MESTI) is the main authority responsible for the formulation of the National STI policies, while the Ministries of Trade and Industry, Finance and Education also complement the National STI Policy through their sectoral policies. Implementation of the STI policies are undertaken by the Council for Scientific and Industrial Research, which is

⁶² <http://neip.gov.gh/>

⁶³ <https://rep.org.gh/who-we-are/>

⁶⁴ <https://allafrica.com/stories/202009150232.html>

⁶⁵ <https://moti.gov.gh/industrialpark.php>

⁶⁶ <http://www.ghanareview.com/directory/freezones.html>

⁶⁷ <https://1d1f.gov.gh/about-us/>

mandated to coordinate R&D activities nationwide and assist the government in the formulation of S&T policies for national development.

There are also governmental agencies and authorities supporting the national STI system. Ghana Innovation and Research Commercialisation Centre (GIRC-Centre) is the coordinating agency ensuring that all the research is based on national priorities with no duplication and outputs properly disseminated. The Ghana Enterprises Agency (used to be called The National Board for Small Scale Industries) is responsible for the coordination, promotion and development of MSME sector. The Ghana Investment Promotion Centre formulates investment promotion policies and plans to attract foreign and local investments. The Ghana Standards Authority is responsible for the management of the nation's quality infrastructure, and the Ghana Free Zones Authority is responsible for the creations of an attractive business environment through the provision of competitive free zone incentives.

Academia / Research

Ghana has 10 Public Universities, 8 Technical Universities, 2 Polytechnics, 38 Colleges of Education, 8 Technical Institutes and 60+ private Universities.⁶⁸ The Council for Scientific and Industrial Research, which is responsible for policy formulation and implementation, also carries out scientific and technological research for national development with its 13 specialised research institutes, including but not limited to the Science and Technology Policy Research Institute and Industrial Research Institute. The Ghana Atomic Energy Commission is another R&D institute advising the government on STI and has 6 atomic and nuclear research institutes operating.

Industry / Private

Enterprises of different sizes – small, medium and large, play a role in innovative activities of the country. Foreign companies also contribute to innovation through knowledge and skill provision and attracting investment. Associations provide platforms for networking and business development and influence policies to advance the growth and development of industries. These include the Association of Ghana Industries and Association of Small Scale Industries. A number of privately run business consulting services also support the industry and the private sector in Ghana. Incubators such as the Climate Innovation Centre Ghana, innovation hubs and venture capital firms support the entrepreneurial space. A governmental organisation called GRATIS Foundation which is under the Ministry of Trade and Industry also assist the industry through technology transfer, training provision and manufacturing of tools and equipment.

Non-Governmental Organizations

Ghana has several NGOs that work in the space of STI and development. These mostly include learned societies and professional institutions such as Ghana Academy of Arts and Sciences, Ghana Medical Association and Ghana Institution of

⁶⁸<https://www.tipconsortium.net/resource/mapping-of-science-technology-and-innovation-policy-development-in-ghana-using-the-transformative-change-lens/>

Engineers. More closely related to the advancement of STI is the Ghana Science Association which promotes and disseminates scientific information and technology transfer for national development. The Institute of Economic Affairs is a public policy institute promoting good governance, democracy and a fair market economy. Ghana also has an independent non-profit organisation, Research and Grant Institute of Ghana, dedicated to the promotion, generation, dissemination, and utilization of research. A chapter of the “Organization for Women in Science for the Developing World” also exists in Ghana.

2.3 Involvement in regional and international organisations

Ghana is a member of UN, AU, and Economic Community of West African States (ECOWAS). It is involved ASTII and NEPAD. Within the UN system, it participates in UNCTAD, UNIDO and UNESCO. Ghana also has bilateral cooperation with a number of countries including Canada, the UK and Netherlands.

2.4 Financing of Innovation

Funding of the STI system by the Government is channelled through the Ministry of Finance from the Consolidated Fund.⁶⁹ The Science, Technology and Research Fund is set up to promote R&D in the national innovation system and there are grant schemes for R&D institutions. The private sector is encouraged to contribute to financing of STI application and development through PPPs, while Ghana Venture Capital Trust Fund provides financing to SMEs. A percentage of the Ghana Education Trust Fund is recommended to contribute to STI programmes particularly in the area of high level scientific human resource development. Although the National STI Policy recommends the establishment of the Science, Technology and Innovation Fund, such a fund doesn't yet exist. There is also an ongoing process to establish the National Research Fund. International organisations and donors such as the WB, USAID and Danish International Development Agency (DANIDA) provide funding for STI activities through various projects and programmes as well.

Ecosystem map examples can be seen in Appendix 2.

Nigeria

National Innovation System and Ecosystems Overview

1. Overview

Nigeria ranks 117th among the 131 economies in the GII 2020, behind other African countries such as Botswana (89), Kenya (86), Ghana (108) and the United Republic of Tanzania (88). In addition, the GII 2020 ranks Nigeria 25th out of 29 lower-middle income economies and 15th out of 26 SSA economies. For the five pillars of innovation input sub-index, Nigeria ranks as follows: institutions (110th), human capital & research (121st), infrastructure (124th), market sophistication (102nd), and

⁶⁹ <https://www.tipconsortium.net/resource/mapping-of-science-technology-and-innovation-policy-development-in-ghana-using-the-transformative-change-lens/>

business sophistication (75th). For the two pillars of innovation output sub-index, Nigeria was ranked 120th in knowledge and technology output, and 110th in creative output.

In relation to its GDP, Nigeria's performance is below expectations regarding its level of development. Some improvements have been made in its innovation inputs, which rank 115th, a higher level than in 2019 and 2018. However, in terms of innovation output, Nigeria ranks 121st, below its level in 2019 and 2018, with innovation output below its level of innovation investments.

2. Governance, policy and institutional capabilities

2.1 Policy structure landscape

Policy frameworks and plans

(Driving long-term development vision, main innovation policies and instruments)

Nigeria relies on varied policy frameworks and plans to drive its long-term development vision. The National Digital Economy Policy and Strategy (2020-2030) has been developed to reposition Nigeria to take advantage of the many opportunities that digital technology offers. This is in line with President Muhammadu Buhari's vision, to diversify Nigeria's economy away from dependence on oil and gas sector. The growth of the digital technology sector in recent years has been a good indicator that this sector can serve as a catalyst for the rapid development of the economy.

The National Science, Technology Innovation Roadmap 2030 Highlights the importance of research funding and building research capacity in agriculture and encourages research and development (R&D) in manufacturing and trade. The National Science, Technology Innovation Roadmap 2030 is a high-level document that sets out the long-term framework for science and technology. The document sets specific goals for a number of knowledge sectors and focuses on linking research to all areas of national development.

Nigeria's Vision 2020 highlighted the importance of research for agriculture, manufacturing and trade, and recommended a reform of technical and vocational education and training (TVET) in order to provide skilled workforces in applied science and engineering. The National Science, Technology and Innovation Policy, 2011 sets out ambitious strategies for STI promotion, capacity building, sectoral R&D (for agriculture, water, biotechnology, health, energy, environment, ICT, raw materials and mineral resources, ICT, defence, transport, tourism, housing and forests) intellectual property, technology transfer, information management systems and female participation in research.

The Framework for the Nigerian National System of Innovation articulates the relationship between the federal, sectoral, regional, state and local innovation councils. The National Education Policy (2013) mentions R&D as one of the goals of tertiary education. The policy also requires universities to have sizeable proportion of expenditure to science and technology research and at least 80% of places to technology and agriculture. The national ICT policy (2012) notes its vision as being

the transformation of Nigeria into a knowledge based and globally competitive society by integrating Information and Communication Technologies into the country's socio-economic development.

Nigeria's Cloud Computing Policy contributes to the Nigerian Government's goals to foster the growth of the local ICT industry, significantly improve business continuity and quality of service in the public sector. The policy contributes to this goal by enabling the Nigerian government and public sector to access cloud computing and other technologies enabled by the cloud, such as artificial intelligence, machine learning or the internet of things amongst other.

2.2 Stakeholder landscape

Governance structure

(Key structures and organs)

Key actors include the Computer Professionals Registration Council of Nigeria (CPN). The CPN aims to determine the standards of knowledge and skills required of individuals wishing to become members of the computer science profession and to improve these standards from time to time as circumstances dictate. The National Council on Science, Technology and Innovation is in charge of accelerating the growth of innovation-based entrepreneurship in the country and creating the conditions for the commercialisation of current and future research findings in Nigerian universities and research institutes.

The Nigerian Investment Promotion Commission (NIPC) was established to encourage, promote and coordinate investments in Nigeria. The Federal Ministry of Science and Technology has the mandate to drive the promotion of Science, Technology, Innovation Research and Development for Socio -Economic Development.

The Federal Ministry of Communications and Digital Economy has the task of leveraging Digital Technology for National Economic Development while the National Information Technology Development Agency (NITDA) is the ICT policy implementing arm of the Federal Ministry of Communication of the Federal Republic of Nigeria.

The Nigerian Communications Commissions (NCC) remains the independent regulatory authority for the telecommunications industry in Nigeria. The National Office for Technology Acquisition & Promotion (NOTAP) oversees the Evaluation/Registration of Technology Transfer Agreements; Promotion of Intellectual Property; Technology Advisory and Support Services; Commercialization of R& D Results; Research Industry Linkage; Maintenance of a Compendium on R&D activities in the country; Production and Publication of Industrial Project Profiles on SMEs, etc.

Academia / Research

Stakeholders in academia include, but are not limited to the University of Ibadan, Covent University and University of Lagos. The University of Ibadan is a public

research university in with their domain of activity ranging from Agriculture, public health to technology research. Covenant University as a private university works and concentrates on developing the next generation of leaders. The University of Lagos, popularly known as UNILAG is one of the five first generation universities in Nigeria. It is public university with research as one of their core activities.

Industry / Private

The UK-Nigeria Tech Hub, an initiative by the UK government's Department for Digital, Culture, Media, and Sports (DCMS) aims to support the growth of the Technology ecosystem in Nigeria. The UK-Nigeria Tech Hub works to stimulate local digital economies, support inclusive and sustainable economic growth and jobs, build high-end digital skills, and forge innovation partnerships between Nigerian tech sectors and international businesses which will inadvertently lead to more trade and investment in the longer term, thereby driving increased productivity and growth. Alongside Nigeria, Hubs have been announced in South Africa, Kenya, India, Indonesia and Brazil to date as part of the International Tech Hub Network. The UK-Nigeria Tech Hub forms a pillar of a broader UK Digital Access Programme which aims to catalyse digital inclusion across Africa.

Co-Creation hub is a "shared working space for technologists, entrepreneurs, government, tech companies, impact investors and hackers to co-create new solutions to the many social problems in Nigeria.

Young Innovators of Nigeria Social Organization (YIN) is a social impact organization focused on IT innovations and research, mobile technology businesses, innovation trends, in particular, indigenous technology to foster national development. YIN's mission is to bridge the skills and entrepreneurial gap among Nigeria youths in the area of information and communication technology (ICT) and relevant crafts towards enterprise development. A critical part of their objective is to drive and develop the capacity of Tech start-ups and create an ecosystem for technology entrepreneurship.

Wenovation Hub is Nigeria's first start up Accelerator founded in August 2010, began operations in February 2011. Wenovation Hub seeks to build Nigeria's high-impact innovators through a dedicated program custom built to help turn their ideas into bankable businesses. Wenovation Hub provides access to technical and business mentors, business consultants, finance and go-to-market strategy among other services to early-stage innovators.

Non-governmental organisations

There are a number of NGOs and international agencies working in the Nigeria innovation ecosystem such as ARIPO, UNESCO, EU, the World Health Organisation (WHO) and others. ARIPO Works to promote the development of the region's IP ecosystem and support national efforts to harness the value of local innovative and creative resources, while the World Health oversees matters related to international public health. Furthermore, The EU has a delegation in Nigeria and their domain of activities focuses on trade, development and political co-operation with Botswana, Ghana and the SADC region.

2.3. Involvement in regional and international organisations

Nigeria is a member of many international organisations such as the UN, Commonwealth of Nations, AU, UNICEF, and UNESCO. Regionally, Nigeria is an active member of Economic Community of West African States (ECOWAS).

2.4. Financing innovation

Nigeria's innovation ecosystem exhibits a mixture of government led funding and private led funding. However, its innovation ecosystem appears to be primarily private sector driven, with some federal and government state support. Currently, Nigeria has several STI policies that posit economy diversification as central to reducing its dependency on the oil and gas sector. However, it appears that the innovation ecosystems noted above, have been largely driven by both industry and foreign investors & donors.

Ecosystem map examples can be seen in Appendix 2.

Acknowledgements

The AIESyS study team would like to acknowledge the UK Government's Foreign, Commonwealth and Development Office for initiating and supporting this work on a 'Scoping Study and Mapping of Innovation Ecosystem Development and Support Initiatives in Southern and West Africa. Special gratitude to Kristin Klose, Jaco Louw and Sue Kinn from the FCDO's Science, Innovation and Technology, Southern Africa Science, Research and Innovation Hub, for timeous feedback and support throughout the study. We are grateful too to the 80 respondents who set aside time to complete the survey, and our 15 interviewees, in addition to numerous other stakeholders who shared thoughts on the study in one way or another. We also acknowledge the input of our advisory panel, Dr Eugene Mutimura, Prof Joanna Chataway and Prof Yacob Mulugetta.



References

- AU, 2019. African Innovation Outlook III | African Union.
- Audretsch, D.B., Cunningham, J.A., Kuratko, D.F., Lehmann, E.E., Menter, M., 2019. Entrepreneurial ecosystems: economic, technological, and societal impacts. *J Technol Transf* 44, 313–325. <https://doi.org/10.1007/s10961-018-9690-4>
- Banwell, C., Dixon, J., Bambrick, H., Edwards, F., Kjellström, T., 2012. Socio-cultural reflections on heat in Australia with implications for health and climate change adaptation. *Global Health Action* 5, 19277. <https://doi.org/10.3402/gha.v5i0.19277>
- BriterBridges, 2019. 618 Tech Hubs: A mapping in collaboration with the GSMA Ecosystem Accelerator programme [WWW Document]. URL https://images.squarespace-cdn.com/content/v1/5ab2a4d655b02c29746fc58c/1562760438125-GHKT6QG598FYKEEQCAO8/ke17ZwdGBToddI8pDm48kBXyodhp7Xnp2ku-gdbQBpx7gQa3H78H3Y0txjaiv_0fDoOvxcdMmMKkDsyUqMSsMWxHk725yiiHCClfrh8O1z5QPOohDIaleIjMHgDF5CVIOqpeNLcJ80NK65_fV7S1Uf-6hwgRqSt09yaNe_ljafJ12XwPsasQQ8cSU-mH_PnAG6v6ULRah83RgHXAWD5lbQ/Tech+Hubs+in+Africa+in+2019?format=1500w (accessed 3.18.21).
- BriterBridges and AfriLabs, 2019. State of Africa's Startup Support Ecosystem Report.
- Chataway, J., Hanlin, R., Kaplinsky, R., 2014. Inclusive innovation: an architecture for policy development. *Innovation and Development* 4, 33–54.
- Daniels, C., Dosso, M., Amadi-Echendu, J. (Eds.), 2021. Entrepreneurship, Technology Commercialisation, and Innovation Policy in Africa. Springer International Publishing. <https://doi.org/10.1007/978-3-030-58240-1>
- Daniels, C.U., Ustyuzhantseva, O., Yao, W., 2017. Innovation for inclusive development, public policy support and triple helix: perspectives from BRICS. *African Journal of Science, Technology, Innovation and Development* 9, 513–527. <https://doi.org/10.1080/20421338.2017.1327923>
- De Beer, J., Millar, P., Mwangi, J., Nzomo, V., Rutenberg, I., 2017. A Framework for Assessing Technology Hubs in Africa. *NYU Journal of Intellectual Property and Entertainment Law* 6, 237.
- Dosso, M., Braoulé Méité, F., Ametepe, G., Gbogou, C., Guiella, G., Oulaï, D., 2021. New Entrepreneurial Narratives in Urban West Africa: Case Studies of Five Innovation Hubs and Communities, in: Daniels, C., Dosso, M., Amadi-Echendu, J. (Eds.), Entrepreneurship, Technology Commercialisation, and Innovation Policy in Africa. Springer International Publishing, Cham, pp. 169–193. https://doi.org/10.1007/978-3-030-58240-1_8
- EC, 2007. Towards a green infrastructure for Europe: Developing new concepts for integration of Natura 2000 network into a broader countryside.
- Edquist, C., 1997. Systems of Innovation: Technologies, Institutions and Organizations.
- Gawer, A., 2014. Bridging differing perspectives on technological platforms: Toward an integrative framework. *Research Policy* 43, 1239–1249. <https://doi.org/10.1016/j.respol.2014.03.006>
- Gawer, A., Cusumano, M.A., 2014. Industry Platforms and Ecosystem Innovation. *Journal of Product Innovation Management* 31, 417–433. <https://doi.org/10.1111/jpim.12105>

- Giuliani, E., 2005. Cluster Absorptive Capacity: Why do Some Clusters Forge Ahead and Others Lag Behind? *European Urban and Regional Studies* 12, 269–288. <https://doi.org/10.1177/0969776405056593>
- GoSA, 2019. White Paper on Science, Technology and Innovation | South African Government [WWW Document]. URL <https://www.gov.za/documents/white-paper-science-technology-and-innovation-1-mar-2019-0000> (accessed 4.17.20).
- GoSA, 2012. National Development Plan 2030: Our future - make it work. Sherino Printers.
- Granstrand, O., Holgersson, M., 2020. Innovation ecosystems: A conceptual review and a new definition. *Technovation* 90–91, 102098. <https://doi.org/10.1016/j.technovation.2019.102098>
- Herselman, M., Botha, A., Toivanen, H., Myllyoja, J., Fogwill, T., Alberts, R., 2016. A Digital Health Innovation Ecosystem for South Africa, in: 2016 IST-Africa Week Conference. Presented at the 2016 IST-Africa Week Conference, pp. 1–11. <https://doi.org/10.1109/ISTAFRICA.2016.7530615>
- Lai, E.R., 2011. Collaboration: A Literature Review, Research Report.
- Lundvall, B.-Å., 2010. National Systems of Innovation Toward a Theory of Innovation and Interactive Learning, Anthem Other Canon Economics. Anthem Press, London.
- Lundvall, B.-Å., 1992. National systems of innovation : towards a theory of innovation and interactive learning.
- Malerba, F., 2005. Sectoral systems of innovation: a framework for linking innovation to the knowledge base, structure and dynamics of sectors. *Economics of Innovation and New Technology* 14, 63–82. <https://doi.org/10.1080/1043859042000228688>
- Mugwagwa, J.T., Banda, G., Ozor, N., Bolo, M., Oriama, R., 2019. New approaches for funding research and innovation in Africa, Research paper. African Technology Policy Studies Network, Nairobi, Kenya.
- Nelson, R.R., 1993. National Innovation Systems: A Comparative Analysis. Social Science Research Network, Rochester, NY.
- Nyamaka, A.T., Botha, A., Biljon, J.V., Marais, M.A., 2020. The components of an innovation ecosystem framework for Botswana's mobile applications. *The Electronic Journal of Information Systems in Developing Countries* 86, e12137. <https://doi.org/10.1002/isd2.12137>
- Otsuka, K., Sonobe, T., 2018. The Role of Human Capital in Cluster-Based Industrial Development. *The Developing Economies* 56, 104–116. <https://doi.org/10.1111/deve.12166>
- Peltoniemi, M., 2006. Preliminary theoretical framework for the study of business ecosystems. *EMERGENCE-MAHWAH-LAWRENCE ERLBAUM-* 8, 10.
- Peltoniemi, M., 2005. Business ecosystem: A conceptual model of an organisation population from the perspectives of complexity and evolution.
- Pilinkienė, V., Mačiulis, P., 2014. Comparison of Different Ecosystem Analogies: The Main Economic Determinants and Levels of Impact. *Procedia - Social and Behavioral Sciences*, 19th International Scientific Conference “Economics and Management 2014 (ICEM-2014)” 156, 365–370. <https://doi.org/10.1016/j.sbspro.2014.11.204>
- Porter, M.E., 1998. Clusters and the New Economics of Competition. *Harvard Business Review*.

- Russell, M.G., Huhtamäki, J., Still, K., Rubens, N., Basole, R.C., 2015. Relational capital for shared vision in innovation ecosystems. *Triple Helix* 2, 1–36. <https://doi.org/10.1186/s40604-015-0017-2>
- Smorodinskaya, N, Russell, M., Katukov, D., Still, K., 2017. Innovation Ecosystems vs. Innovation Systems in Terms of Collaboration and Co-creation of Value, in: *Proceedings of the 50th Hawaii International Conference on System Sciences*.
- Smorodinskaya, Nataliya, Russell, M., Katukov, D., Still, K., 2017. Innovation Ecosystems vs. Innovation Systems in Terms of Collaboration and Co-creation of Value. <https://doi.org/10.24251/HICSS.2017.636>
- Suominen, A., Seppänen, M., Dedehayir, O., 2019. A bibliometric review on innovation systems and ecosystems: a research agenda. *European Journal of Innovation Management* 22, 335–360. <https://doi.org/10.1108/EJIM-12-2017-0188>
- Tong, Y.D., Huynh, T.D.X., Khong, T.D., 2021. Understanding the role of informal sector for sustainable development of municipal solid waste management system: A case study in Vietnam. *Waste Management* 124, 118–127. <https://doi.org/10.1016/j.wasman.2021.01.033>
- Twiringiyimana, R., Daniels, C., Chataway, J., Forthcoming. STI Policy and Governance in Sub-Saharan Africa: fostering actors' interactions in research and innovation.
- Valkokari, K., 2015. Business, innovation, and knowledge ecosystems: How they differ and how to survive and thrive within them. *Technology Innovation Management Review* 5.
- Watkins, A., Papaioannou, T., Mugwagwa, J., Kale, D., 2015. National innovation systems and the intermediary role of industry associations in building institutional capacities for innovation in developing countries: A critical review of the literature. *Research Policy* 44, 1407–1418. <https://doi.org/10.1016/j.respol.2015.05.004>
- Wdowiarz-Bilska, M., 2019. Technopolis – Beyond Technology Park. *IOP Conf. Ser.: Mater. Sci. Eng.* 471, 112028. <https://doi.org/10.1088/1757-899X/471/11/112028>
- WEF, 2015. *Global Competitiveness Report 2015*.
- Wessner, C.W., 2005. Entrepreneurship and the Innovation Ecosystem Policy Lessons from the United States. *Local Heroes in the Global Village* 67–89. https://doi.org/10.1007/0-387-23475-6_5
- WIPO, 2020. *Global Innovation Index 2020: Who Will Finance Innovation?*



Appendix 1: Global Innovation Index Full Example

Detailed illustrative example based on World Intellectual Property Organisations (WIPO)'s recent report on countries' performance in innovation, the Global Innovation Index (GII 2020)

South Africa

Five pillars of innovation inputs:

a) Institutions (political environment, regulatory environment, business environment)

South Africa ranks 55th worldwide in institutions, making second best performing country in SSA in the indicator. South Africa's regulatory environment performing better than political and business environments, which partly implies existing capabilities potential of policy instruments in support to innovation ecosystem.

b) Human capital & research (education, tertiary education, R&D)

South Africa ranks 35th globally according to the quality of universities metric, with the University of Cape Town placing among the top 200 highest ranking universities in the world. South Africa allocates a larger share of its GDP to the public funding of primary, secondary and post-school education and training than many comparative countries. However, while the literacy rate has risen and a much larger number of youths are gaining access to secondary education, very few attain tertiary education. GERD of 0.8% remains the government target of 1.5%.

From 2017-2019 NRF Grants were on the decline: from R1.72 billion in 2017 to R1.61 billion in 2018 and R1.52 billion in 2019. From 2008, with the abolition of the three-level Senior Certificate (higher, standard and lower grade), mathematical literacy or mathematics were made compulsory subjects in the National Senior Certificate (NSC). (The 1994, ANC Policy for Education and Training did in fact call for both mathematics and a science subject to be compulsory through-out the years of schooling. Thus far it is only the mathematics requirement that has become national policy). Most of the doctoral degrees produced in South Africa are in the field of natural and agricultural sciences, with 1 051 doctorates produced during 2018. Doctoral degrees in social sciences and humanities follow with 913 and 759 doctoral degrees, respectively. Engineering fared the lowest, with 229 doctorates during 2018.

c) Infrastructure (ICTs, general infrastructure, ecological sustainability)

The ICT Research, Development and Innovation (RDI) Implementation Roadmap (2012) is a plan to guide the implementation of national ICT research, development and innovation strategy. The Roadmap is driven by the potential to deliver socio-economic impact and presents a sound case for increased public and private investment in ICT RDI. The National Integrated ICT Policy states that in order to have a vibrant and inclusive knowledge economy, there is a need to: provide affordable access to communication (equity); increase accessibility of services,

devices, infrastructure and content to all citizens (accessibility); improve the quality of life (social development); and ensure proper data governance (user protections) – all preconditions of an equitable digital economy and society.

The Universal Service and Access Fund (USAF) was established under the Electronic Communications Act (ECA) to fund projects and programmes that strive to achieve universal service and access to ICTs by all South African citizens. However, Universal access and service funds have been largely unsuccessful in enhancing universal access. The levy is an added input cost to the total cost of services (carried by the user), which is already unaffordable in many jurisdictions.

The Council for Scientific and Industrial Research (CSIR) was commissioned to map connectivity in the country, a useful exercise critical to any government planning. They had mapped networks in 2013 for South Africa Connect on the basis of confidential data from operators, which had found that 90% of people were geographically located within 10 km from a point of presence (POP). Updating the fibre and mobile networks could potentially fill an important information gap in trying to identify evidence-based policy intervention on infrastructure needs.

d) Market sophistication (credit, investment, trade, competition and market scale);

South Africa has the most sophisticated financial market on the continent. South African start-ups benefit from the relatively mature status of the local ecosystem, which has active investors at most stages of the start-up lifecycle. Early-stage is well covered by an active angel investment scene incorporating a relatively high number of groups and individuals, as well as early-stage funds like E4E Africa. The “middle”, meanwhile, is accommodated by scale-up funds like Knife Capital, Kalon Venture Partners and CRE Venture Capital.

e) Business sophistication (knowledge workers, innovation linkages, knowledge absorption)

Service sectors are more likely to get the information that they require to innovate from education and research institutions than is the case with industrial sectors: Between 2014 and 2016, 11.9% of service-sector enterprises derive the information that they require to innovate from public research institutions; 11.1% from government. By contrast, only 1.2% of industrial-sector enterprises derive the information that they require from public research institutions and 1.5% from the government.

Business expenditure on R&D, as a percentage of GERD, has been declining since 2008. The BERD, as a share of GDP, has also shown a tendency to decline. However, real expenditures on R&D on the part of the business sector has increased, albeit at a slow rate, since 2010.

2 pillars of innovation outputs:

South Africa produces less innovation outputs relative to its level of innovation investments.

a) Knowledge & technology outputs (*knowledge creation, knowledge impact, knowledge diffusion*)

South Africa is currently leading the continent in agricultural biotech, with more than 80 percent of its maize and soya genetically modified. The number of scientific publications per million population was 360 in 2018 and 371 in 2017. The average of upper middle-income countries was 327 in 2018. In 2017, the majority of patents were granted to non-residents (595 v. 4940).

b) Creative outputs (*intangible assets, creative goods and services, online creativity*).

South Africa ranks 70 worldwide in Creative output, indicating that South Africa needs to engage in a more active use of ICTs and organizational model creation, for better economic performance in this domain.

Appendix 2: Ecosystem Maps

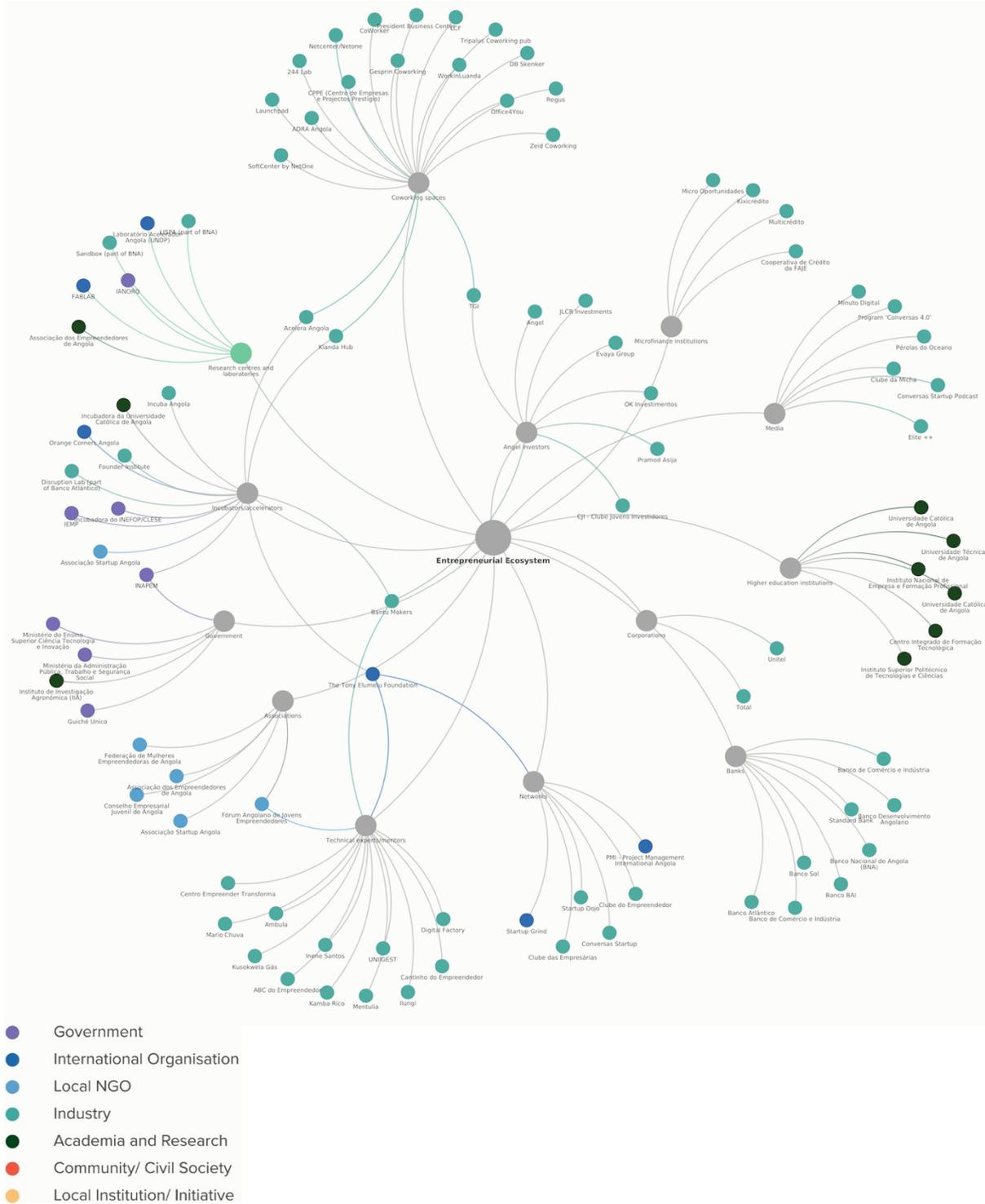
Summary details of innovation ecosystem maps presented in this appendix

| | Innovation Ecosystem | Typology and number of Stakeholders | | | | | | |
|------------------------|--|-------------------------------------|---------------------------|-----------|----------------------------|---------------------|---------------------------|--------------------------------|
| | | Government | Industry / Private Sector | Local NGO | International Organisation | Academia / Research | Community / Civil society | Local Institution / Initiative |
| Southern Africa | | | | | | | | |
| Angola | Entrepreneurial ecosystem | 7 | 68 | 6 | 6 | 9 | 0 | 0 |
| | Tech ecosystem | 1 | 11 | 1 | 6 | 0 | 0 | 0 |
| Botswana | Botswana Innovation Ecosystem | 13 | 11 | 1 | 9 | 12 | 0 | 0 |
| Malawi | DeSIRA Initiative | 6 | 0 | 0 | 10 | 2 | 2 | 0 |
| | mHealth4Afrika | 4 | 2 | 0 | 1 | 5 | 0 | 0 |
| Namibia | Namibia University of Science and Technology | 2 | 12 | 2 | 17 | 0 | 0 | 0 |
| | Southern Africa Innovation Support | 1 | 3 | 4 | 25 | 2 | 0 | 0 |
| South Africa | Western Cape Innovation Ecosystem | 8 | 6 | 20 | 11 | 6 | 1 | 0 |
| Zambia | BongoHive, Zambia | 2 | 10 | 2 | 7 | 2 | 0 | 0 |
| Zimbabwe | ZAGP Zimbabwe | 9 | 13 | 12 | 13 | 2 | 3 | 21 |
| Western Africa | | | | | | | | |
| Cameroon | Buea Cameroon Silicon Mountain | 0 | 2 | 2 | 10 | 0 | 2 | 0 |
| Ghana | Impact Hub Accra | 0 | 1 | 0 | 19 | 0 | 0 | 0 |
| | Kumasi Hive | 2 | 4 | 5 | 15 | 2 | 0 | 0 |
| | Water Innovation Ecosystem | 2 | 7 | 3 | 19 | 4 | 0 | 0 |
| Nigeria | Young Innovators Nigeria (YIN) | 10 | 14 | 2 | 1 | 2 | 0 | 0 |

Southern Africa

Angola

Country-Level Entrepreneurial ecosystem



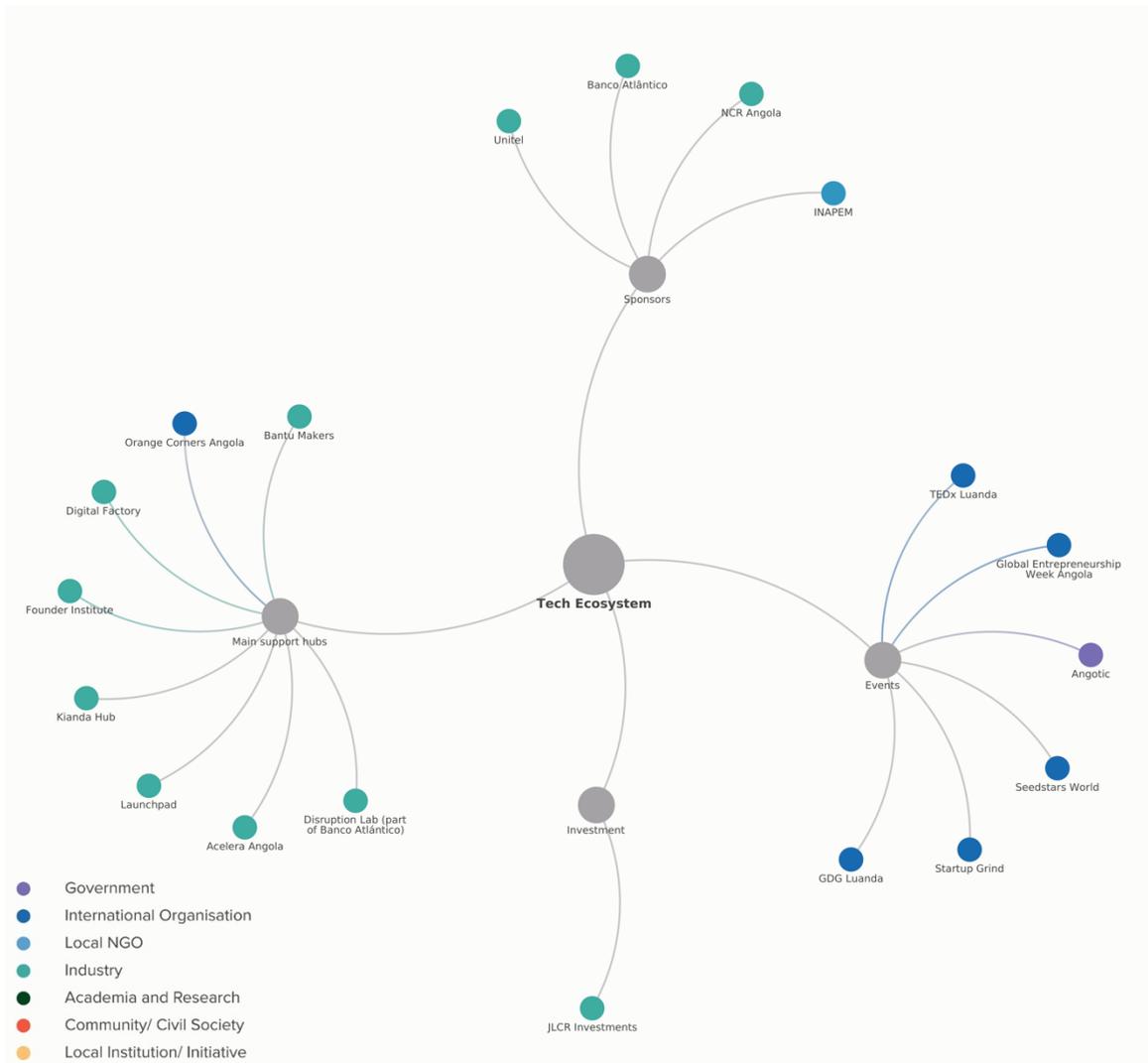
NOTES:

This ecosystem isn't very closely linked to Angola's national innovation system (NIS) as the ecosystem largely exists within the private sector, and the linkages with the governmental organisations are weak.

- **Government:** National Institute to Support Small Medium Enterprises is the main linkage between the ecosystem and the NIS. Its role is to monitor and supervise the actors in the private business sector and promote the adaptation of procedures, values and regulatory frameworks. In turn, the institute helps the Government in designing financial plans and programmes that meet the need of private companies. This is likely to feed into the types of services financial institutions can offer to small businesses. Institute for Agricultural Research is also an actor in the NIS promoting innovation within the agriculture sector and contributes to this ecosystem through knowledge exchange and support of innovative solutions. Overall, Angola's private sector is underdeveloped, and this ecosystem supports the development of a newly emerging private sector, which will ultimately improve the innovative activities undertaken by the industry.
- **Academia:** This ecosystem isn't linked to academia in terms of research and development. Higher education institutions contribute to this ecosystem through training skilful individuals with potentially sectoral knowledge who can undertake entrepreneurial activities.
- **Industry:** The linkages between the industry and this ecosystem isn't very strong either. Corporations such as Total and Unitel provide a path for small enterprises to access the market and contribute to their development and future ability in becoming potential suppliers/service providers. However, these types of initiatives and programmes are rare.

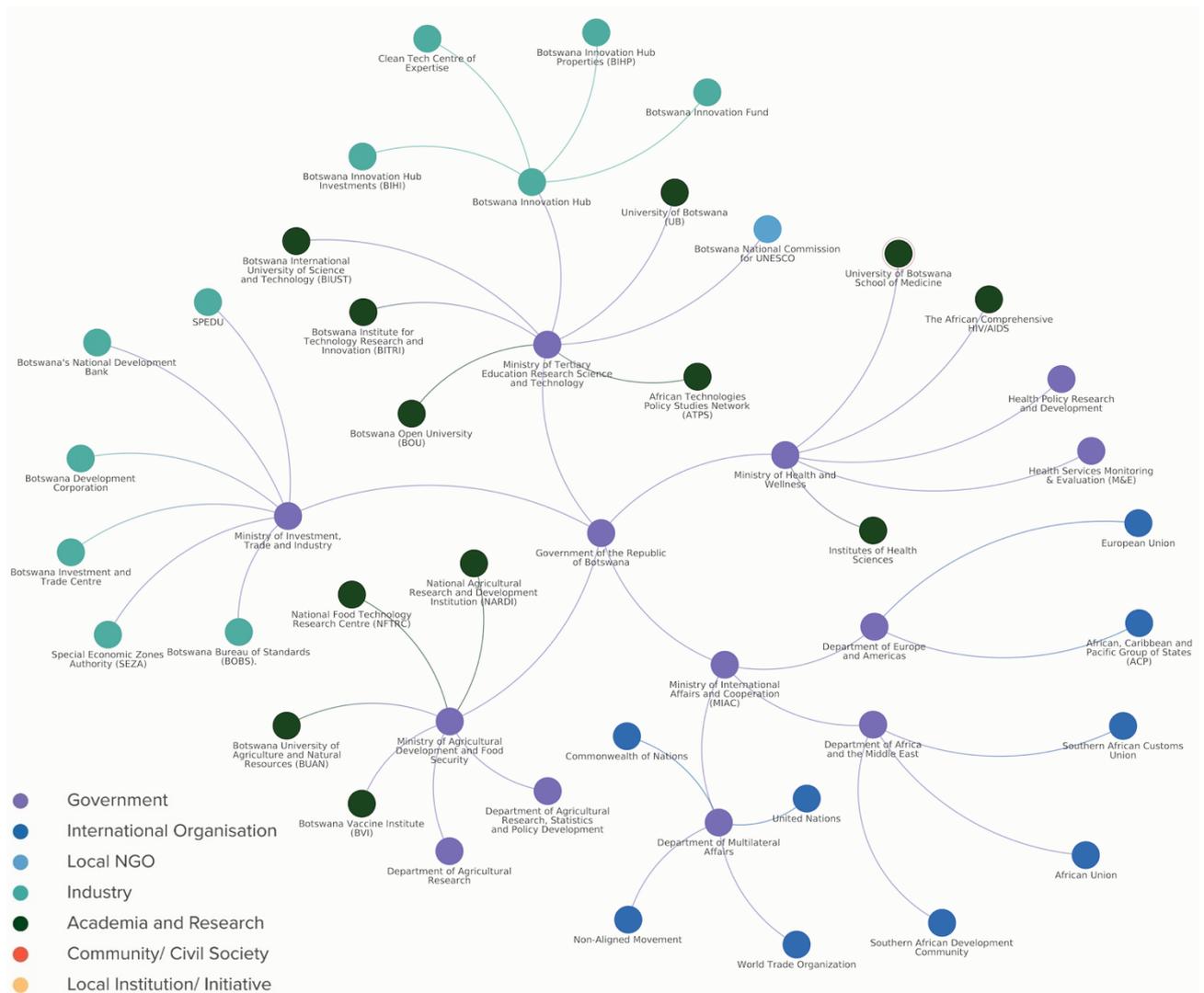
Angola

Country-Level Tech ecosystem



Botswana

Country-Level Innovation Ecosystem

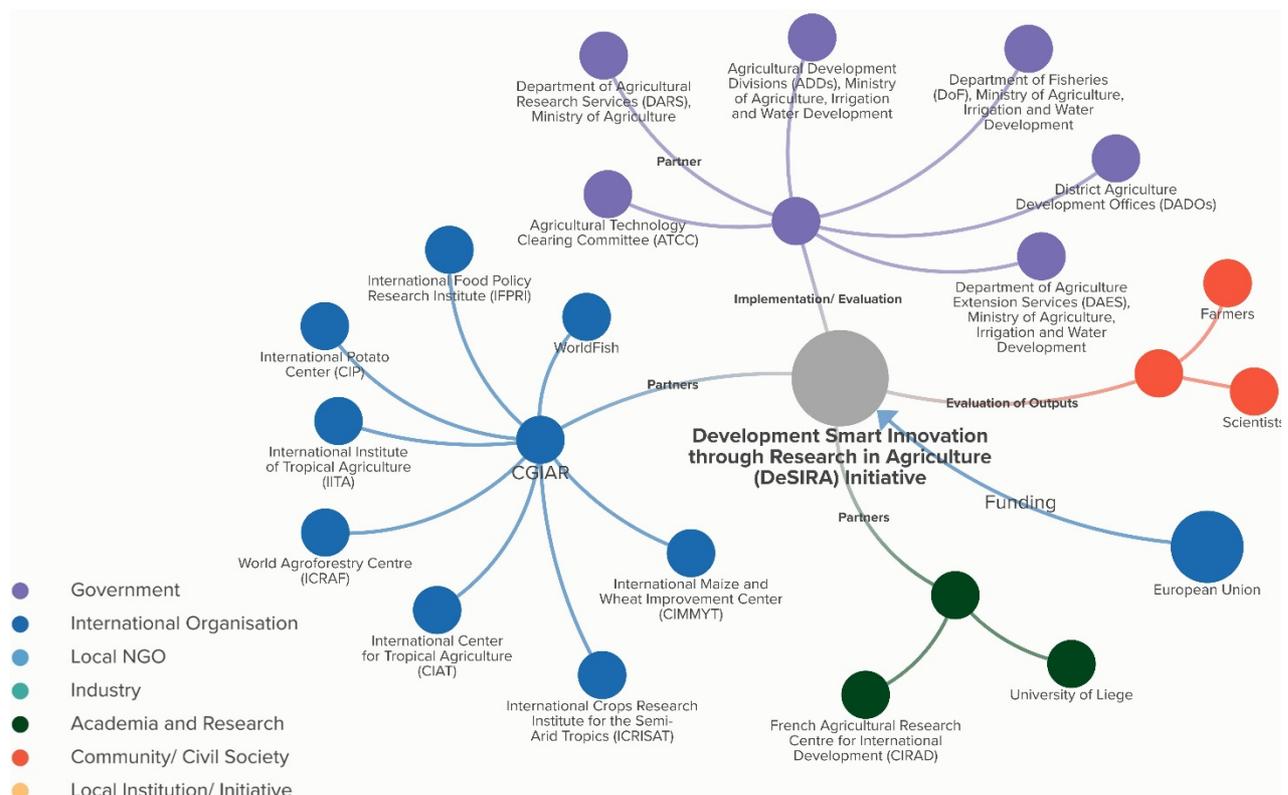


NOTES:

In Botswana, the government plays an important role in the development of its national innovation ecosystem. Thus, in an effort to reduce dependence on the mining sector, the Tenth National Development Plan (2009-2016) identified economic diversification as one of Botswana's main strategic priorities. To deliver on this priority, the government concluded that the most effective way to stimulate economic growth is to strengthen the role of research and development in fueling entrepreneurship and private sector growth.

Malawi

Development Smart Innovation through Research in Agriculture (DeSIRA) Initiative



NOTES:

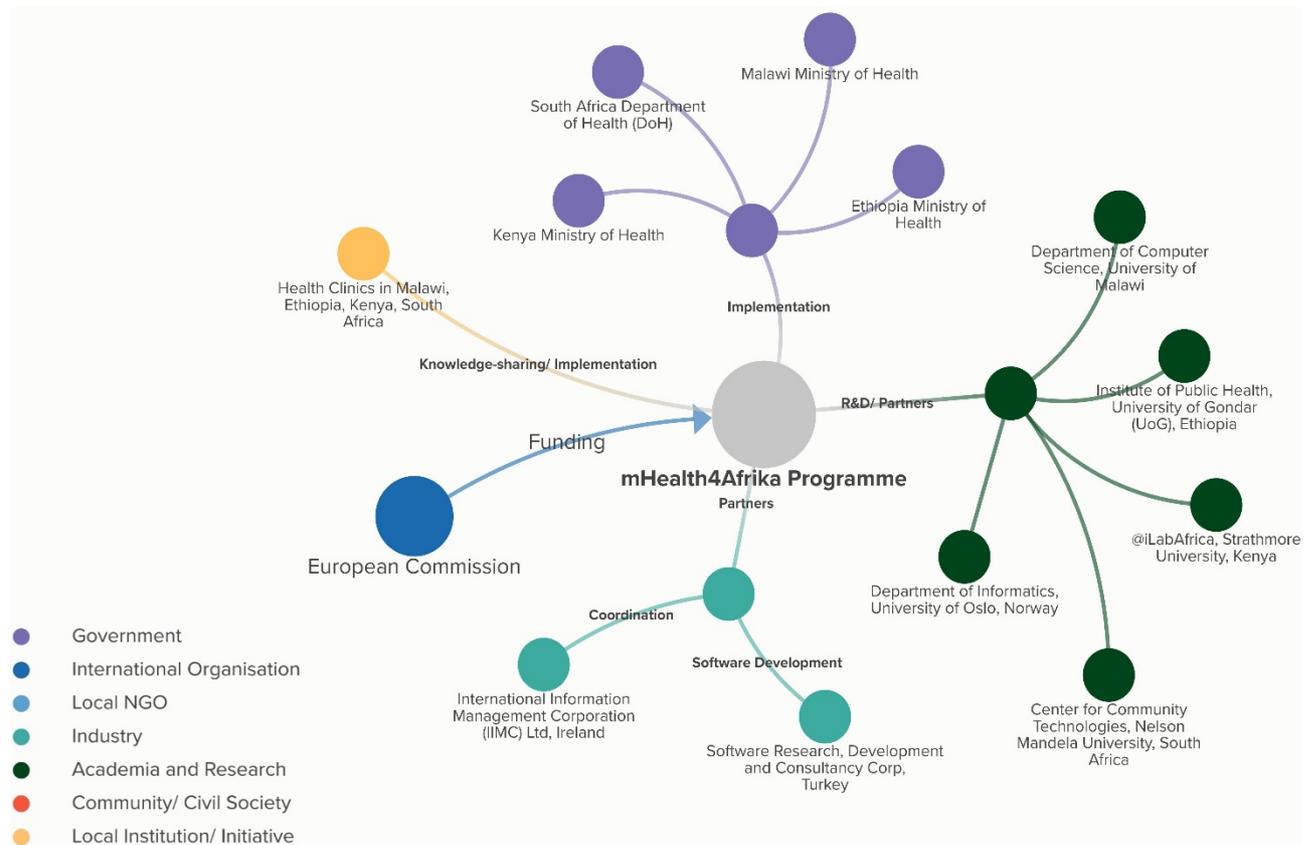
Established in July 2020 by the Department of Agricultural Research Services (DARS), the European Union, the French Agricultural Research Centre for International Development (CIRAD), University of Liege, and eight members of the CGIAR (Consultative Group on International Agricultural Research).

Through this 5-year initiative, partners are developing and disseminating “multi-disciplinary and integrated technologies, appropriate for agri-food systems in Malawi.”¹

¹ https://massp.ifpri.info/2020/09/04/desira-initiative-to-improve-smallholder-farming-systems-in-malawi/#_ftn2

Malawi

mHealth4Afrika



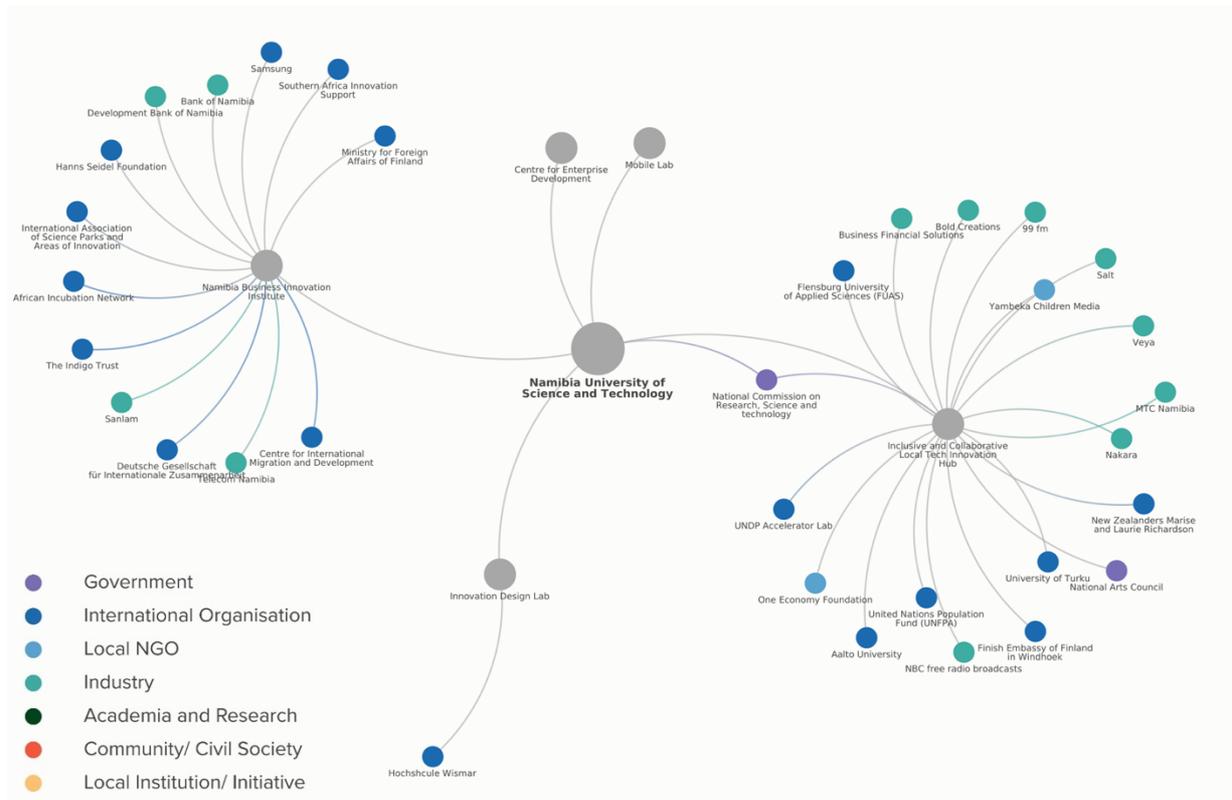
NOTES:

mHealth4Afrika is a collaborative research and innovation programme, bringing together a range of stakeholders to co-design and validate “a comprehensive, patient-centric health platform that is adaptable and extensible, modular and multilingual.”² The programme has a regional focus, operating in Malawi, Ethiopia, Kenya and South Africa.

² <http://www.mhealth4afrika.eu/page/about/>

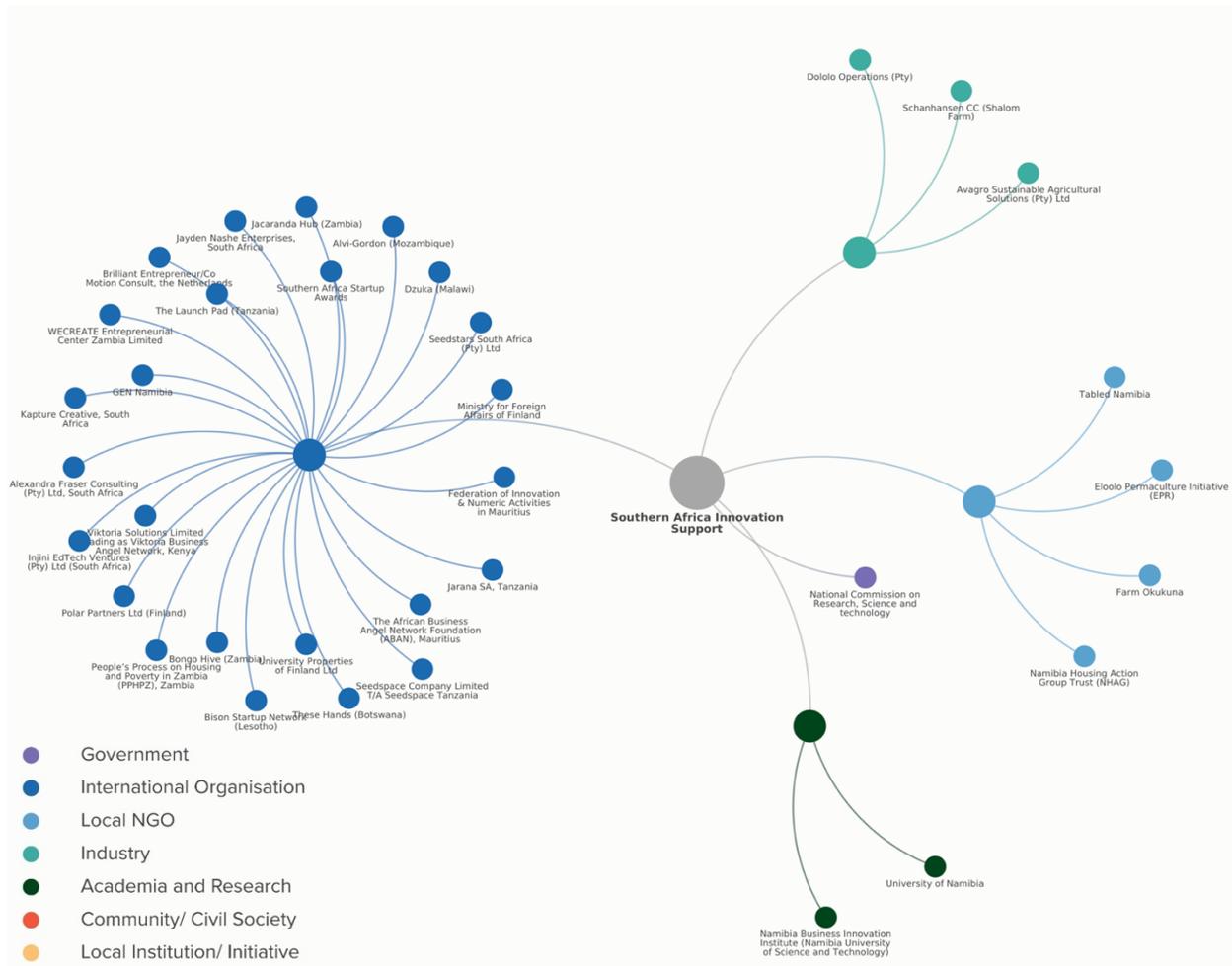
Namibia

Namibia University of Science and Technology



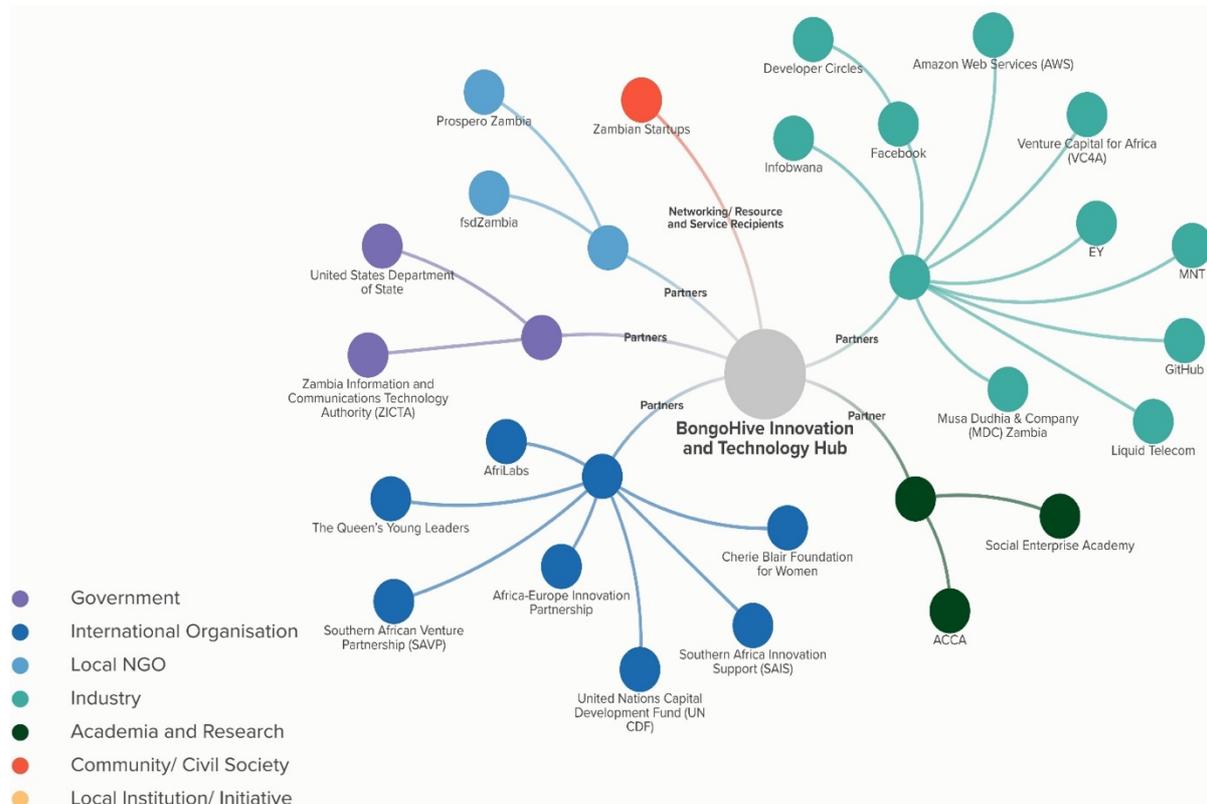
Namibia

Southern Africa Innovation Support



Zambia

BongoHive, Zambia



NOTES:

“BongoHive is Zambia’s first technology and innovation hub. Established in May 2011 and based in Lusaka, the co-founders, all enthusiastic programmers, sought to address the gaps they experienced working within the local technology industry leading to a lack of coordination, skills exposure and productivity.”³

³ <https://bongohive.co.zm/about/>

NOTES:

This programme, set to run for the period 2018-2024, is a joint initiative between the Government of Zimbabwe and the EU, with the overarching aim to “contribute to the development of a diversified agriculture sector that promotes inclusive green economic growth.” The programme launched 6 projects that are addressing gaps and weaknesses in livestock value chains, involving multisectoral collaborations between government, civil society, INGOs, local NGOs, academia and the private sector.

6 ZAGP Projects:

1. *The Beef Enterprise Strengthening and Transformation (BEST) project*
Aim: to establish “a robust, competitive beef value chain that promotes enhanced trade, employment creation, food security, and inclusive green economic growth by 2023”⁴ for 25,000 small, medium and commercial cattle farmers.
2. *The Transforming Zimbabwe’s Dairy Value Chain for the Future (TranZDVC) project*
Aim: to strengthen linkages between production, processing and financing to address under-performance in Zimbabwe’s Dairy Value Chain (DVC).⁵
3. *The Inclusive Poultry Value Chain (IPVC) project*
Aim: to develop “an efficient poultry value chain which contributes to inclusive green economic growth in Zimbabwe.”⁶
4. *The Value Chain Alliance for Livestock Upgrading and Empowerment (VALUE) project*
Aim: to transform and promote Zimbabwe’s goat and pork value chains.⁷
5. *The transforming Zimbabwe’s Animal Health and Food Safety Systems for the Future (SAFE) project*
Aim: to “transform Zimbabwe’s animal health, sanitary and phytosanitary/food safety systems for improved livestock productivity, food safety and consumer safety to enhance market access.”⁸
6. *The Zimbabwe Agriculture Knowledge and Innovation Services (ZAKIS) project*
Aim: to “link agricultural research, education and extension” in order to improve the lives of farmers and value chain actors, and contribute to agricultural growth and rural green-economic development.⁹

⁴ <http://zagp.org.zw/projects/view/beef>

⁵ <http://zagp.org.zw/projects/view/dairy>

⁶ <http://zagp.org.zw/projects/view/poultry>

⁷ <http://zagp.org.zw/projects/view/goats-and-pigs>

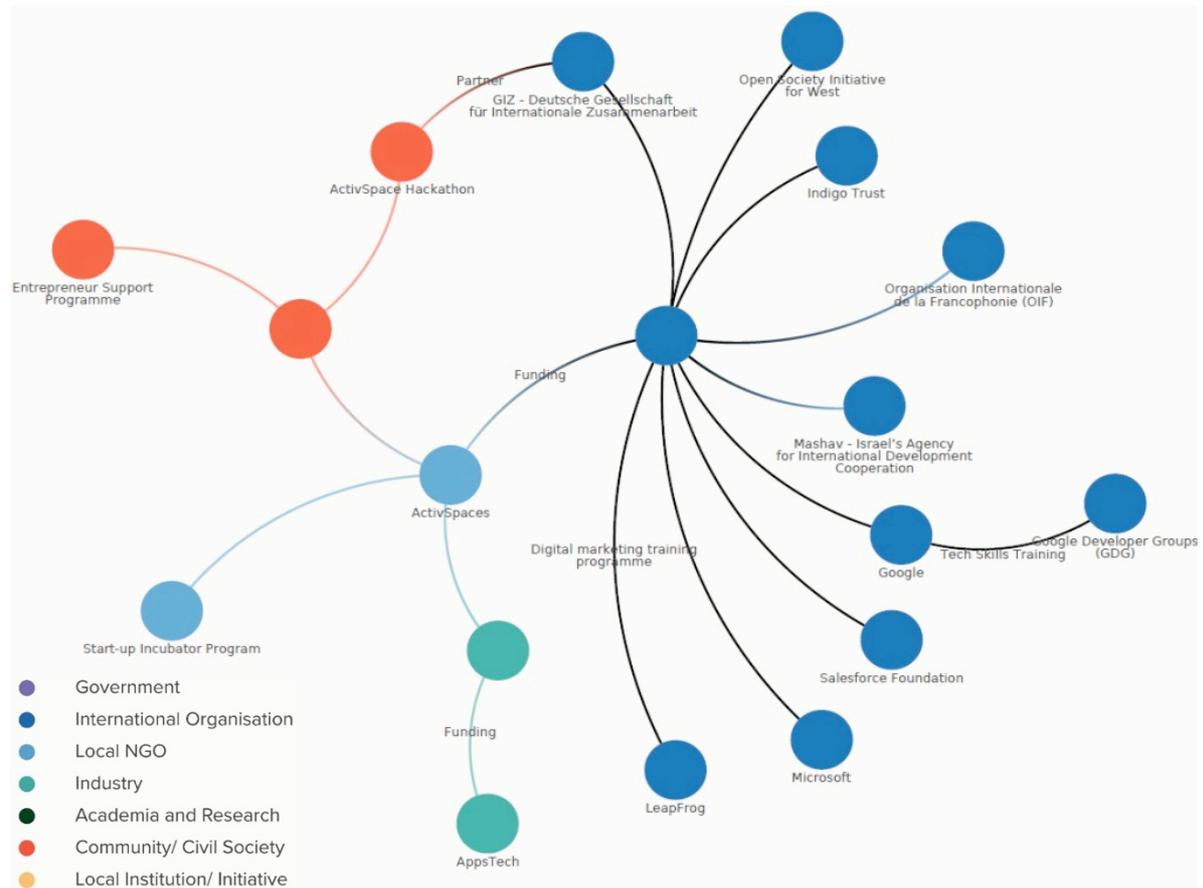
⁸ <http://zagp.org.zw/projects/view/safe>

⁹ <http://zagp.org.zw/projects/view/zakis>

Western Africa

Cameroon

Buea Cameroon Silicon Mountain

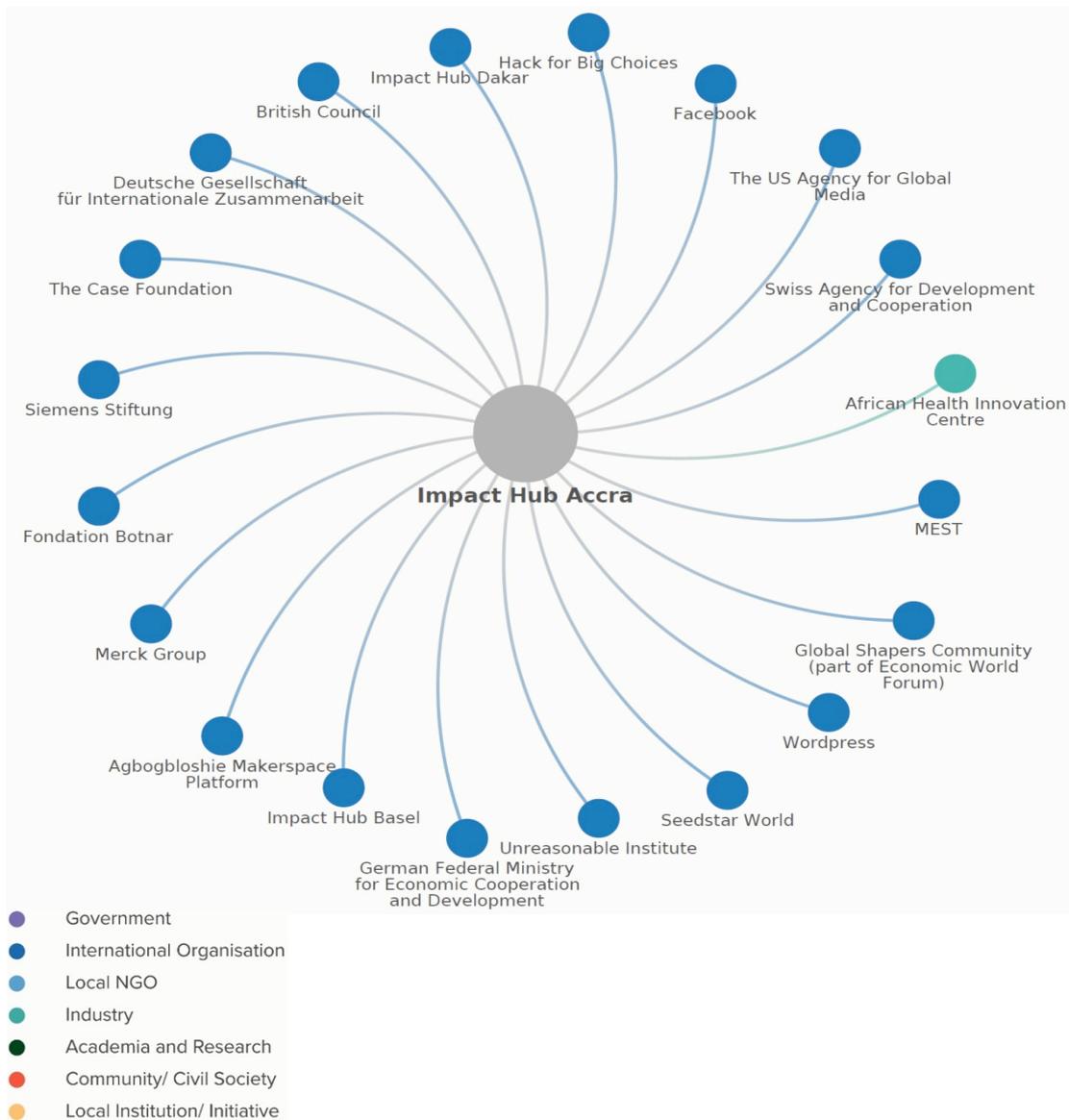


NOTES:

Buea, located in the South West Region is home to the first anglophone university in Cameroon, the University of Buea. The university is a central element in the town's journey to becoming Cameroon's most prominent technology hub. Silicon Mountain's Cameroon's first and largest community of technovators and techpreneurs. Pioneers/founders of the Silicon Mountain community, which include tech players like Churchill Nanje, Valery Colong, Tse Fua, Otto Akama, Ayuk Eta, Fritz Ekwoke, Ebot Tabi, Isaac Kamga, Nyah Check, Daisy Nkweteyim; were at the forefront of the Silicon Mountain revolution.

Ghana

Impact Hub Accra



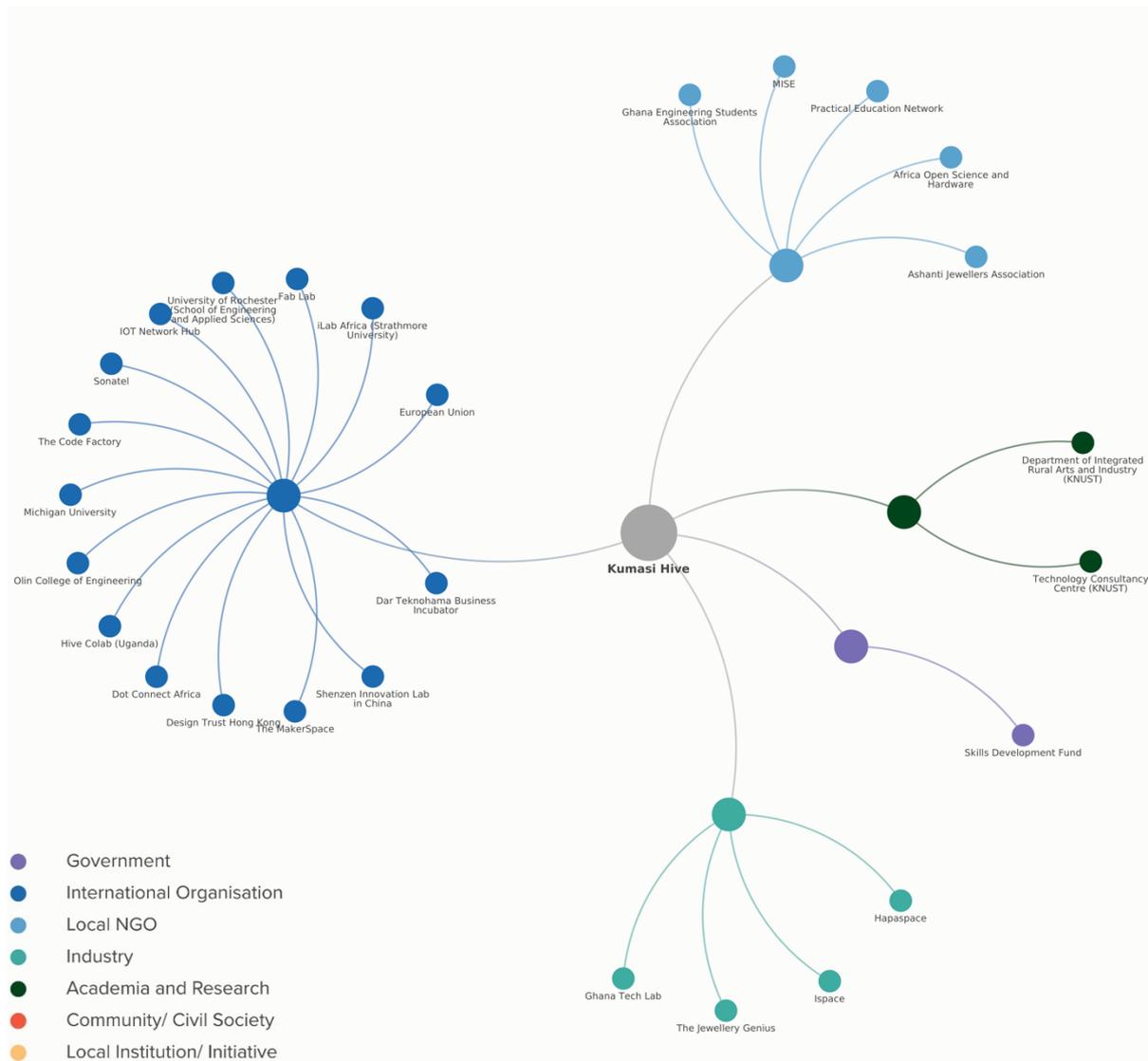
NOTES:

Impact Hub Accra is a co-working space that seeks to provide: “A locally rooted, globally connected and inclusive home for innovators. Our inspirational plug and play spaces are a hive for co-working, private office space, conference room rental, vibrant networking events, incubation and acceleration programs.”¹⁰

¹⁰ <https://accra.impacthub.net>

Ghana

Kumasi Hive

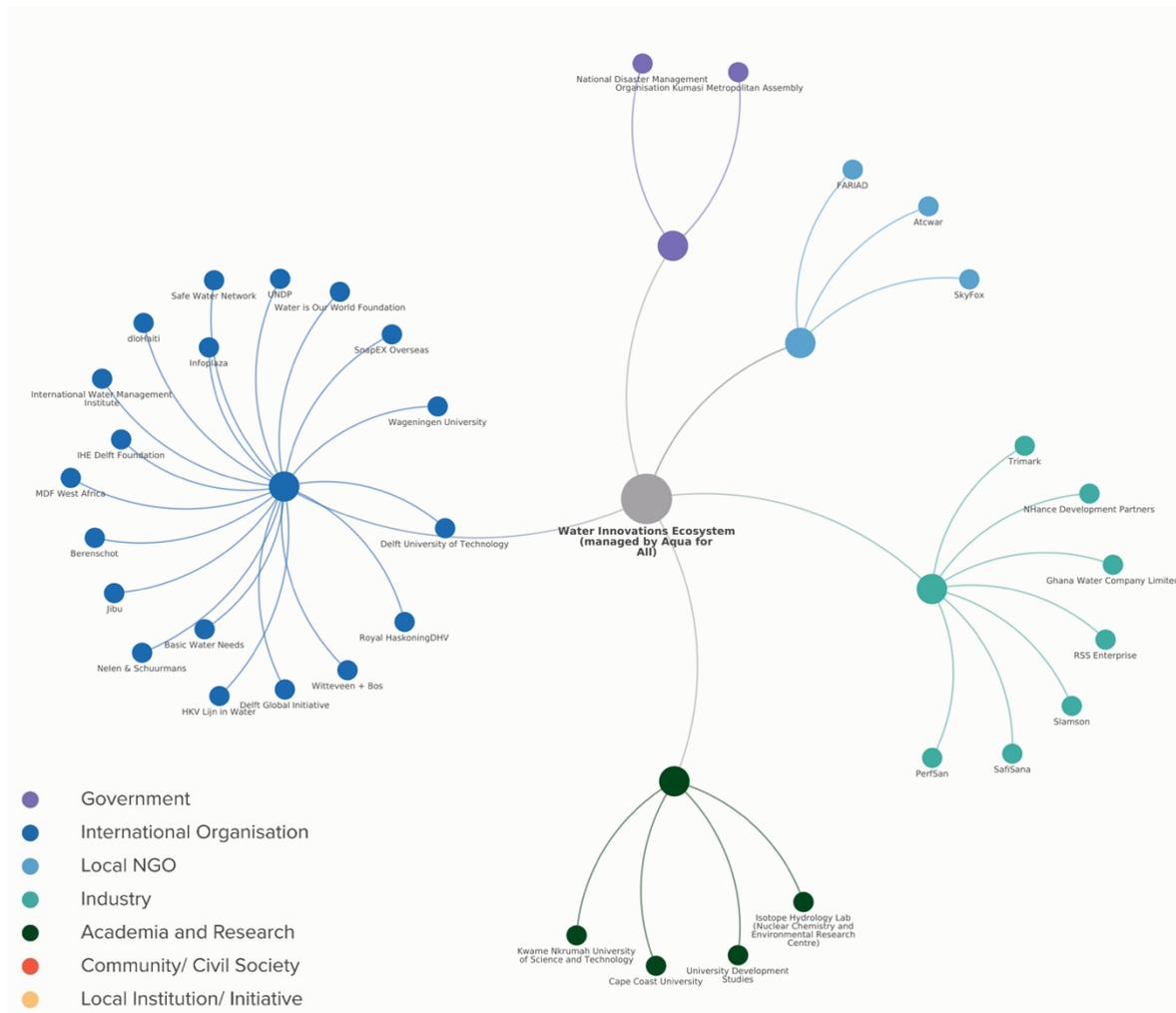


NOTES:

Kumasi Hive is a multi-space Innovation Hub. It provides: “a platform for rapid Prototyping of ideas, supporting local Innovations & impact start-up and promoting entrepreneurship... [and] promotes Sustainable Industrialization by lowering the barriers to creating local small-scale manufacturing businesses for products needed in the immediate community.”

Ghana

Water Innovation Ecosystem



NOTES:

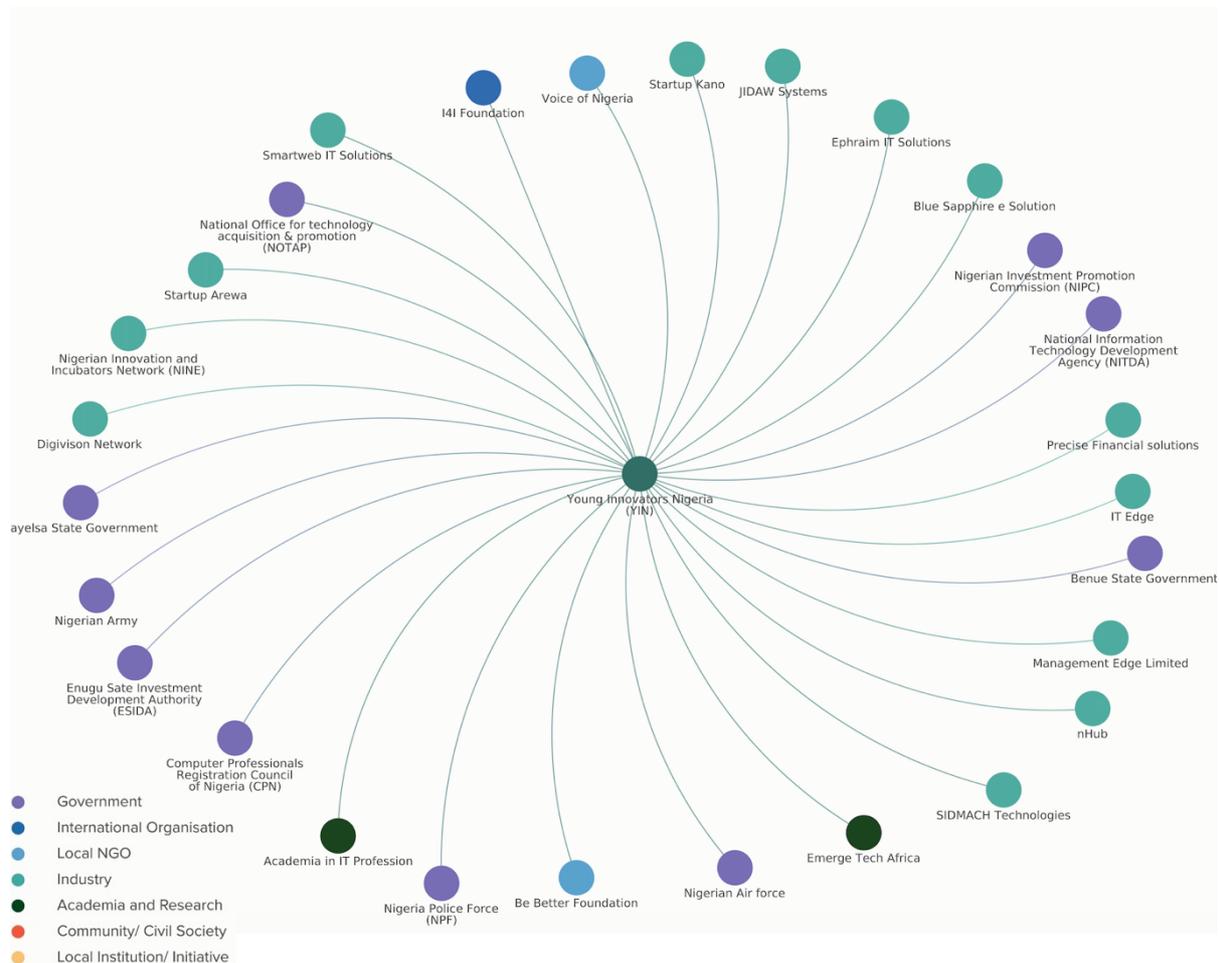
A large majority of the actors in this ecosystem are foreign. The actors that are from Ghana can be found below:

- NGOs from Ghana: SkyFox, FARIAD
- State-own companies: Ghana Water Company Limited
- Private companies: Slamson, RSS enterprise, Trimark, NHance Development Partners
- Public universities: KNUST (Kwame Nkrumah University of Science and Technology), UDS (University for Development Studies)
- R&D institutes: Isotope Hydrology Lab – National Lab (Nuclear Chemistry and Environmental Research Centre, Ghana Atomic Energy Commission)
- Government agency: MADMO (National Disaster Management Organisation)

This ecosystem is linked to the national innovation system of Ghana through the involvement of academia and industry. There aren't clear links to the government departments which are involved in STI activities. The funding of projects is dominantly undertaken by foreign actors, while two public universities, an R&D institute and four private companies from Ghana are involved in water innovation activities. Certain Ghanaian private companies and the Ghana Atomic Energy Commission also fund some of the projects. Public universities are generally involved in the implementation of the projects.

Nigeria

Young Innovators Nigeria (YIN)



NOTES:

Young Innovators of Nigeria Social Organization (YIN)¹¹ is a social impact organization focused on IT innovations and research, mobile technology businesses, innovation trends, in particular, indigenous technology to foster national development. YIN's mission is to bridge the skills and entrepreneurial gap among Nigeria youths in the area of information and communication technology (ICT) and relevant crafts towards enterprise development. A critical part of their objective is to drive and develop the capacity of Tech start-ups and create an ecosystem for technology entrepreneurship.

¹¹ <https://www.yinigeria.com.ng/about.html>