Understanding and Accelerating Innovation Driven Ecosystems in Sub-Saharan Africa – Towards a Research and Technology Organization for North-South Cooperation

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Abstract

According to the African Union's strategy, Science, Technology, and Innovation (STI) are to play a central role in accelerating Africa's transition to an innovation-led, knowledge-based economy. Member countries are to build and upgrade research infrastructures, enhance professional and technical competencies, promote entrepreneurship and innovation, and generally provide an enabling environment for STI. Over the last ten years, innovation-driven ecosystems have emerged in numerous African cities, often developing around tech hubs and incubators. Using an analytical framework developed at MIT, this thesis assesses the innovation-driven ecosystems of Accra, Ghana; Nairobi, Kenya; and Freetown, Sierra Leone. It then explores if Research and Technology Organizations (RTOs) could be introduced as innovation intermediaries in the context of nascent African innovation ecosystems. RTOs are a category of organizations present in many high- and middle-income countries whose mission is to harness science and technology in the service of innovation. It concludes by suggesting a new model of RTO for North-South Cooperation, linking emerging ecosystems in the Global South, such as those found in Accra, Nairobi, and Freetown, with established ones in the Global North.

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In memory of Calestous Juma
Champion of science, technology and innovation in sub-Saharan Africa

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Chapter 1 – Introduction

According to a 2017 United Nations population report, by 2050 the world's population will grow by around 2.2 billion people. The African continent is estimated to account for approximately 1.3 billion additional people, totaling more than half of the projected growth. Africa's current population of approximately 1.25 billion is set to double to 2.5 billion in the next three decades, and current projections predict a population of 4.5 billion by the end of the century. Africa is home to a rapidly growing and largely young population, striving for opportunities to secure a dignified life. This poses an enormous challenge for African countries, who will have to create additional employment opportunities for their citizens at scale.

Historically, industrialization has played a central role in the transformation of low-income countries who have attained middle- and high-income status. In sub-Saharan Africa (SSA), with few exceptions, countries have yet to industrialize. "Traditionally industrialization in its broad sense includes manufacturing, mining, construction and utilities such as electricity, water and gas among others. But further, the definition of industrialization during the latter years of the 20th century expanded to refer to a process of development that is balanced and sustained as far as the economic as well as socio-political realms of any society are concerned" (Nzau, 2010). The continent remains in large part dependent on imports. Since the 1980s sub-Saharan Africa's manufacturing value added as a percent of GDP declined from 17 percent to approximately 10 percent in 2016. According to Rodrik (2015) low-income countries are experiencing premature deindustrialization. "Countries are running out of industrialization opportunities sooner and at much lower levels of income compared to the experience of early industrializers." The window for industrial development is growing increasingly narrower for industrial latecomers and less developed countries. At the same time, renewed calls for industrialization across the continent have gained momentum in the last decade. In the words of UN Undersecretary General Lopes, "industrialization is an imperative for Africa, and it has to count on a regional African market before it extends to global supply chains. And it ought to have a special emphasis on agro-processed products and value addition to commodities. For example, transforming the continent's mineral export volume in this way by just 5% before export can create 5 million jobs a year" (Lopes, 2016). Among the numerous pathways the continent can take to pursue transforming the lives of its citizens, science, technology and innovation (STI) are poised to play a central role.

In 2014 the African Union (AU) produced "On the Wings of Innovation," a ten-year Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024) to "accelerate Africa's transition to an innovation-led, knowledge-based economy." The report outlines its priorities as:

- Building and/or upgrading research infrastructures
- Enhancing professional and technical competencies
- Promoting entrepreneurship and innovation

- Providing an enabling environment for STI on the African continent

In STISA-2024, the African Union developed a vision and a strategy that sees STI at the center of the continent's transformation, aiming to leverage the emergence of innovation-driven ecosystems across the continent, which are introducing innovative products and services that are new to the continent or new to the world.

Innovation-driven ecosystems, defined as "place-based communities of interacting actors engaged in producing innovation and supporting processes of innovation, along with the infrastructure and enabling environment which allows them to create, adopt, and spread solutions to local challenges" (Hoffecker, 2018), have the potential to become engines of transformation across the continent. There are now at least 442 active tech hubs across the continent, consisting of "physical spaces designed to foster and support tech start-ups" (GSMA, 2018), driven by rapidly rising mobile and internet adoption and lower access costs. In turn, risk capital is increasing with $725.6 million raised by African startups across 458 deals in 2018, up from $560 million in 2017 (WeeTracker, 2018).

In parallel, tech giants like Google, Microsoft, IBM, and others are establishing and growing their presence on the continent, investing in human capital and betting on technology-enabled business opportunities. Google opened its first artificial intelligence (AI) Research Lab in Accra, Ghana in 2019 "to develop a coordinated plan to encourage AI education across the continent, incentivize entrepreneurship in the AI sector, and facilitate collaboration between AI researchers and experts in health care, agriculture and other sciences" (Cisse, 2019), while Microsoft launched a $100 million Africa Development Centre in Kenya and Nigeria in 2019 to "engage further with partners, academia, governments and developers – driving impact in sectors important to the continent, such as FinTech, AgriTech and OffGrid energy" (Spencer, 2019). While these global tech companies bring new technologies to the continent, innovation in the African context also takes place in the form of innovating business processes where context specific knowledge of African markets and consumers are combined with borrowed technologies that have been developed elsewhere (as in the case of mobile money). Incremental innovation, "taking equipment, systems and processes that already work and adapting them to become better or to better fit the African environment" (Alli, 2018) has enormous potential.

Although universities and tertiary educational institutions are very important stakeholders in innovation ecosystems, they are generally not known for their ability to innovate and substantially contribute to the continent's research and development (R&D) landscape, leading to weaker linkages with other stakeholder groups in innovation-driven ecosystems across the continent than observed in more mature ecosystems. Strengthening universities and research institutions is central to STISA-2024, and the creation of innovation universities in fields such as agriculture, industry, health, services, and the environment has long been championed, both by upgrading existing universities as well

as by setting up “new innovation universities in line ministries, public corporations, private enterprises, and development agencies” (Juma, 2016).

Lastly, institutions, such as the enforcement of property rights legal systems, levels of corruption, forms of governance, constraints on politicians and political elites, and electoral rules play a critical role in the development trajectory of nations, as well as in the establishment of innovation ecosystems, where “economic institutions encouraging economic growth emerge when political institutions allocate power to groups with interests in broad-based property rights enforcement, when they create effective constraints on power-holders, and when there are relatively few rents to be captured by power-holders” (Acemoglu, Johnson, and Robinson, 2004). Institutions have historically benefitted from industrial development, as industrialization led to some byproducts at the basis of strong democracies, such as organized labor disciplined political parties, and a right-left political competition (Rodrik, 2015). With premature deindustrialization and generally low industrial development these institutional benefits are harder to reap.

Developing innovation-driven ecosystems is closely linked to an enabling environment with active stakeholders and favorable institutional arrangements. This thesis sets out to investigate and understand innovation-driven ecosystems in sub-Saharan Africa, and how their development could be accelerated by radically reinventing Research and Technology Organizations (RTOs), an established category of organizations acting as innovation intermediaries present in many industrialized middle- and high-income countries, by exploring the following three questions:

1. What does the innovation-driven ecosystem currently look like in Accra, Ghana; Nairobi, Kenya; and Freetown, Sierra Leone?
2. Could there be a Research and Technology Organization for North-South Cooperation operating as an innovation intermediary?
3. What might an RTO for North-South Cooperation look like in Accra, Nairobi, and Freetown?

Chapter two will provide an overview of the analytical framework used to assess the innovation-driven ecosystems of the cases in this thesis. Chapters three, four, and five will investigate the innovation-driven ecosystems of Accra, Nairobi, and Freetown, respectively. Chapter six will introduce Research and Technology Organizations and explore the creation of an RTO for North-South Cooperation to accelerate the development of innovation-driven ecosystems and industrial capabilities, and chapter seven will offer a closing reflection.

Chapter 2 – Analytical Framework

Innovation and entrepreneurship pursuits by young technologically savvy citizens are ubiquitous nowadays. Cities, regions, and countries across the world are increasingly committed to supporting innovation-driven entrepreneurship to spur or sustain growth, to develop their capabilities, to attract talent, and to compete in the regional, national, and international arena. This has given rise to increased attention and study of innovation-driven "ecosystems," defined as geographically bounded places where innovation-driven enterprises (IDEs) flourish (Murray et al., 2019). As a result of this, researchers and analysts started developing analytical frameworks and lenses through which to understand, evaluate, and grow these ecosystems. Current frameworks to understand innovation ecosystems are an evolution from the concept of national innovation systems which became prominent starting in the 1980s (Lundvall et al., 2002) and regional innovation systems, which built on research on general systems theory (1960s), regional innovation policy and practice (1980s), and on ideas related to "network regions" and industrial district theory (Cooke, 2002).

The MIT Innovation Initiative[1] developed "A systematic MIT approach for assessing 'innovation-driven entrepreneurship' in ecosystems" (Murray et al, 2019) to better understand the formation, evolution, and growth of innovation ecosystems (iEcosystems). With the creation of numerous new innovation and entrepreneurship rankings, metrics, and indices for cities, regions, and nations there are increasingly more data points available for researchers and policy makers, going beyond traditional metrics that have been associated with iEcosystems such as research and development (R&D) investment or the number of startup companies launched in a given time in a geographically bounded place. Unfortunately, while data points are indeed increasing, coverage is mostly concentrated on high income countries, with an abundance of information available for OECD countries in particular, but limited or no information for many developing countries, making assessments of iEcosystems in the developing world more difficult.

This chapter will present an in-depth look at the MIT iEcosystems analytical framework, at the innovation ecosystem stakeholder model, and explore various metrics and indices that are relevant to the understanding of iEcosystems. The following chapters will explore the iEcosystems in three case studies, Accra (Ghana), Nairobi (Kenya), and Freetown (Sierra Leone). Even in the context of cities and regions for which there is not much information available, such as in the case of the three aforementioned case studies, the analytical framework works well in providing an overall understanding of an innovation ecosystem.

2.1 MIT iEcosystems Framework

A good analytical framework for iEcosystems is one that provides a comprehensive understanding of the system and that also works in different contexts for which

[1] https://innovation.mit.edu/

information availability may vary significantly. MIT's iEcosystems Framework breaks the system into four core elements (Figure 1): Foundational Institutions; Innovation Capacity (I-Cap) and Entrepreneurship Capacity (E-Cap); Comparative Advantage; and Impact.

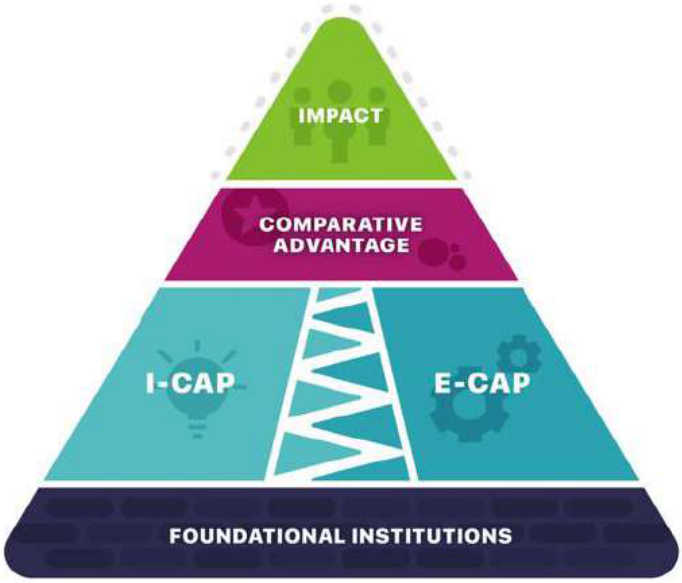


Figure 1: MIT iEcosystems Framework
Source: Murray et al., 2018

What follows is a look at each these categories and at the relevant metrics and indices that are helpful in getting a more grounded understanding of where an innovation-driven ecosystem is at.

2.1.1 Foundational Institutions

Foundational institutions "are those institutions, rules, practices and norms that are often taken for granted, but ensure that investments in a wide variety of capacities and assets can be effectively protected and leveraged to the benefit of the economy" (Murray et al, 2019). According to the iEcosystems framework, foundational institutions include the rule of law and lack of corruption, the presence of financial institutions, property rights and their protection (particularly including provisions to protect intellectual property), the ease of doing business, and the freedom to pursue new ideas (particularly in relation to scientific openness). Additional elements of importance in relation to foundational institutions, particularly in the context of developing countries, are related to political stability and security. Countries that experience significant political turmoil or that face security issues in the form of terror attacks or civil unrest are less likely to have solid foundational institutions, with repercussions on the strength of the entire ecosystem.

The metrics identified by MIT's analytical framework to capture foundational institutions focus around the rule of law, property rights, ease of doing business, and levels of corruption. Table 1 outlines the metrics and institutions that produce them:

Indicator	Description
Ease of doing business (World Bank)	Composite country ranking from the World Bank across 10 topics relevant to ease of operating private-sector firms.
Starting a business (WB)	Ranking of the simplicity of starting a new business for entrepreneurs incorporating and registering a new firm.
Paying taxes (WB)	Ranking level of tax rates and administrative burden in tax payment for typical medium-size firms.
Resolving Insolvency (WB)	Ranking level of weaknesses in insolvency law and main bottlenecks in the process.
Enforcing Contracts (WB)	Ranking level of time/cost for resolving a commercial dispute including degree of good practices in the court system.
Property Rights (Index of Economic Freedom)	Score across the strength of laws allowing individuals to accumulate five types of property rights (including intellectual property rights).
Government Integrity (IEF)	Score capturing levels of trust, transparency and absence of corruption.
Labor Freedom (IEF)	Score capturing flexibility and efficiency of a country's labor market including hindrance to hiring.
Trade Freedom (IEF)	Score capturing tariff and non-tariff barriers to imports and exports.
Corruption Perception Index (Transparency International)	Overall ranking of countries in their composite level of perceived corruption (high ranking = high corruption).

Table 1: Metrics of Foundational Institutions – MIT iEcosystems Framework
Source: Murray et al., 2018

2.1.2 I-Cap & E-Cap

Innovation Capacity (I-Cap) and Entrepreneurship Capacity (E-Cap) are considered the "twin engines of the system, resting on the foundational institutions and combining distinctive 'inputs' to ultimately drive impact, often in the form of innovation-driven enterprises (IDEs), rather than standard small/medium sized enterprises (SMEs)" (Ibid). The difference between SME entrepreneurship and IDE entrepreneurship is outlined in the work of Aulet and Murray (2013) and shown in Table 2 below:

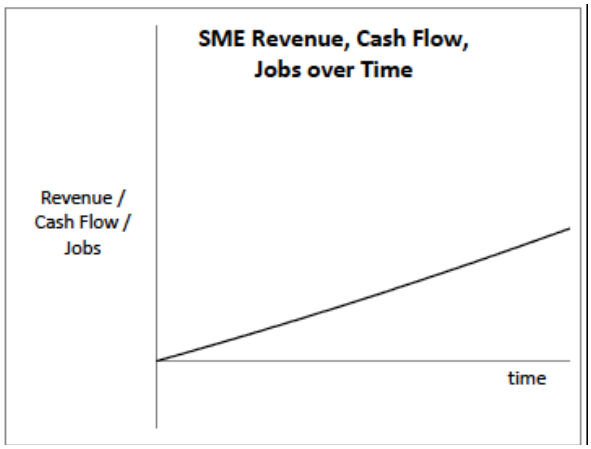
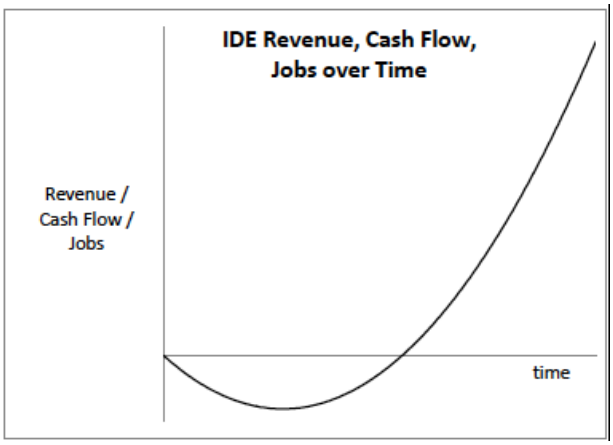
SME Entrepreneurship	IDE Entrepreneurship
Focus on addressing local and regional markets only.	Focus on global markets.
Innovation is not necessary to SME establishment and growth, nor is competitive advantage.	The company is based on some sort of innovation (tech, process, business model) and potential competitive advantage.
"Non-tradable jobs" – jobs generally performed locally, e.g. restaurants, dry cleaners, service industry.	"Tradable jobs" – jobs that do not have to be performed locally.
Most often family businesses or businesses with very little external capital.	More diverse ownership base including wide array of external capital providers.
The company typically grows at a linear rate. When you put money into the company, the system (revenue, cash flow, jobs, etc.) will respond quickly in a positive manner.	The company starts by losing money, but if successful will have exponential growth. Requires investment. When you put money into the company, the revenue / cash flow / jobs numbers do not respond quickly.
	

Table 2: SME Entrepreneurship vs. IDE Entrepreneurship
Source: Aulet and Murray, 2013

The SME-IDE distinction is of particular importance in the realm of government policy, as the program and policy interventions (PPIs) that support SMEs and IDEs are different, and governments often don't employ people with entrepreneurial experience and tend to produce policies that treat SMEs and IDEs alike, as outlined by Aulet & Murray (2013). In the context of iEcosystems the focus is concentrated more on IDEs, which the authors argue have greater potential at creating jobs and driving exports than SMEs.

I-Cap is defined as “the capacity of a place – a city, a region or a nation – to develop ‘new-to-the-world’ ideas and to take them from inception to impact (whether this be to economic, social and/or environmental impact)” (Murray et al, 2019). This means that I-Cap is not just about the development of innovations, but also about their translation into solutions to problems. The presence of research institutions such as universities or research centers (public or private) plays an important role in the strength of a region’s I-Cap, and it is complemented by a strong educational system which provides the foundations on which to build the talent pipeline.

E-Cap on the other hand is defined by the authors as the entrepreneurial capability and conditions for forming, growing, and scaling enterprises that are new to the world, from inception all the way to maturity. Aspects of E-Cap are of particular importance in relation to growing and supporting IDEs in an iEcosystem, and similarly to I-Cap its strength is tied to a strong educational system; particularly with regards to business education and entrepreneurial capability.

MIT’s iEcosystem researchers identified five critical inputs for I-Cap and E-Cap (Figure 2):

1. Human Capital – the availability of talent with relevant training, education, and experience for innovation and entrepreneurship;
2. Funding – the availability of capital from various sources, both private and public, that support innovation and entrepreneurship at its various stages;
3. Infrastructure – the availability of physical infrastructure to support both innovation and entrepreneurship (space, equipment, supply chains);
4. Demand – having specialized demand for the outputs of innovators and entrepreneurs; and
5. Culture & Incentives – the presence of role models and social norms that are supportive of innovation and entrepreneurship efforts.

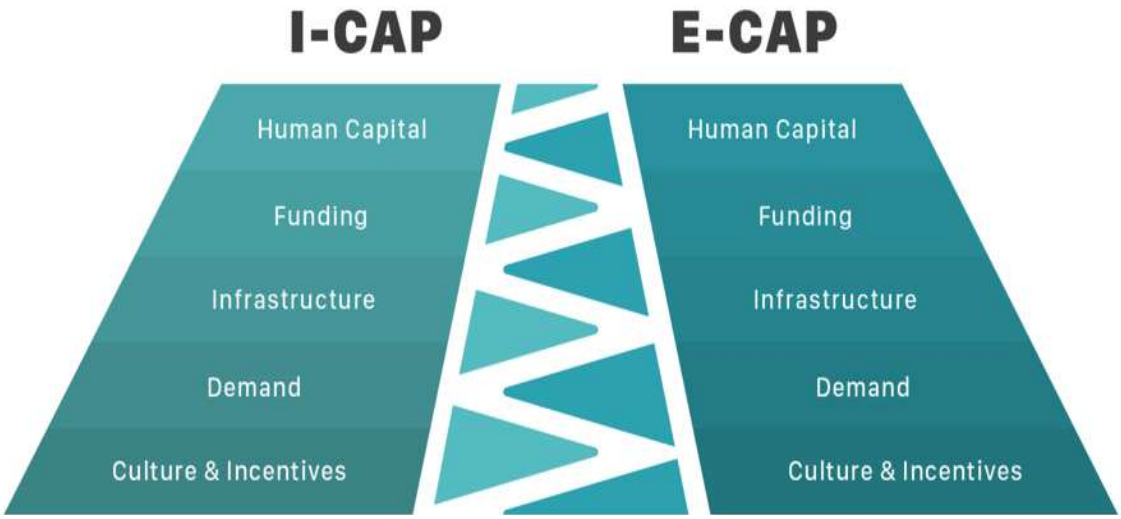


Figure 2: MIT I-Cap and E-Cap framework
Source: Murray et al., 2018

Each of these inputs has specific measures associated with them, outlined in Table 3 for I-Cap and Table 4 for E-Cap. These measures are drawn from: The Global Competitiveness Index[2], OECD[3], European Innovation Scorecard[4], Global Innovation Index[5], UNESCO[6], Global Entrepreneurship Monitor[7], United Nations[8], World Bank[9].

I-Cap Inputs	Measures
Human Capital	• Quality of STEM education • STEM graduates per capita • New PhD graduates per capita • Availability of scientists & engineers • People engaged in R&D per million
Funding	• R&D expenditure as % of GDP • R&D expenditure in '000 current PPP$ • Public R&D expenditure as % of total R&D expenditure • Business R&D expenditure as % of total R&D expenditure
Infrastructure	• ICT access • Internet bandwidth • Production process sophistication • Availability of latest technologies
Demand	• Government procurement of advanced tech • University-industry research collaborations • Trade, competition & market scale
Culture & Incentives	• Quality of scientific research institutions • Graduates in science & engineering (%)

Table 3: I-Cap Inputs and Measures – MIT iEcosystems
Source: Murray et al., 2018

[2] http://reports.weforum.org/global-competitiveness-report-2018/competitiveness-rankings/
[3] https://data.oecd.org/
[4] https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en
[5] https://www.globalinnovationindex.org/Home
[6] http://uis.unesco.org/
[7] https://www.gemconsortium.org/
[8] http://data.un.org/Default.aspx
[9] https://data.worldbank.org/

E-Cap Inputs	Measures
Human Capital	• % school grads in tertiary education • Entrepreneurship perceived capabilities
Funding	• Easy access to loans • Ease of credit • Venture capital availability, investment, and deals
Infrastructure	• Electricity & telephony infrastructure • Number of internet users • Logistics performers
Demand	• Buyer sophistication • Domestic market scale
Culture & Incentives	• Entrepreneurial intention • Attitudes towards entrepreneurial risk • Fear of failure • Entrepreneurship as a good career choice • High status to successful entrepreneurs • Business freedom

Table 4: E-Cap Inputs and Measures – MIT iEcosystems
Source: Murray et al., 2018

Data coverage across the globe varies for each of these indicators and tends to be higher in OECD countries, while for developing countries there is significantly less data available, making assessments more reliant on qualitative data. The same can be said for I-Cap and E-Cap outputs, which can be measured by the following metrics: I-Cap can be measured in terms of the number of research publications or the number of patent applications filed and granted, and E-Cap can be measured by the number of new start-up companies created. These measurements are helpful indicators, but assessments solely based on these indicators fail to capture only a part of an iEcosystem.

Together, I-Cap and E-Cap play a significant role in a city, region, or nation's impact, but they are also key to understanding its comparative advantage, which revolves around areas of specialization and domain expertise.

2.1.3 Comparative Advantage

A region's comparative advantage, a concept put forth by David Ricardo in 1817, rests on areas of specialization and domain expertise. These areas of specialization tend to be a differentiating factor for iEcosystems, both at a regional level and increasingly at a global

level. Michael Porter's "Competitive Advantage of Nations" (1990), which advanced Ricardo's concept toward "competitive advantage," put forth what is now known around the world as cluster theory, highlighting the geographic concentration of businesses and their intricate relations, resulting in higher productivity and more competitive regional economies. The concept of competitive advantage is important because it emphasizes what can be created by regions beyond what they are naturally endowed with. Silicon Valley represents perhaps the world's most well-known cluster, with its concentration on computer technology, both in the hardware and software sectors. In the context of the developing world, regional comparative advantage is often less well defined as in the case of advanced regions such as the Silicon Valley, the Boston Area, Singapore, or Shenzhen to name a few. In some cases, regions may be endowed with natural resources which present potential sources of comparative advantage around which to develop an iEcosystem. In other cases, it may be less clear what a region's comparative advantage is or could be, and the formation of an iEcosystem may result from other factors, such as deliberate actions and investments by stakeholders.

Comparative advantage can be measured across scales – some iEcosystems are renowned on a global scale for their clusters around specific domain expertise, because their comparative advantage puts them at the forefront globally. Others are better known at a regional or national scale, meaning their comparative advantage is stronger in regional or national terms, but they are not as performant as globally leading regions. Accra, Nairobi, and Freetown, for example, are cities with certain comparative advantage at a national level, and at a regional level as well for Accra and Nairobi in the context of West Africa and East Africa respectively. Assessing the economic clusters of a region can be very important in understanding where its comparative advantage may lie or where it may be developed and compete within global value chains (Gereffi, Humphrey, and Sturgeon, 2005).

2.1.4 Impact

Lastly, an iEcosystem's impact is the result of combining its I-Cap and E-Cap around a potential or manifest comparative advantage to create a concentration of successful innovation-driven enterprises (IDEs) supported by strong stakeholders that create an enabling environment. This often happens in a deliberate way through program and policy interventions (PPIs) which aim to drive quantifiable changes in impact in an iEcosystem over the long run. According to Murray et al, "at the highest level, impact can be captured in the form of economic or social progress indicators" such as GDP per capita, the Social progress Index (SPI), or possibly also by looking at progress towards attaining the United Nations Sustainable Development Goals (SDGs). Impact can also be defined as "qualitative changes in local attitudes", for example towards entrepreneurship or risk aversion, or other aspects of relevance. Finally, at "a more granular level, impact can be captured in terms of the types of start-ups that are being created and grow within an ecosystem" (Murray et al, 2019). Impact is often measured on specific PPIs, which are

an important part of an iEcosystem's strategy, but before looking at strategy it's worth looking at the key stakeholders that make up an iEcosytstem.

2.2 iEcosystems Stakeholders

In assessing an innovation-driven ecosystem understanding the strength and weaknesses of its stakeholders is key. Mapping stakeholders and grouping them in categories and creating a shared taxonomy is a useful way to create a common language and providing a solid foundation for collective engagement. MIT's analytical framework places particular importance on the following five stakeholder groups (Figure 3): entrepreneurs; universities; government; corporates; and risk capital.

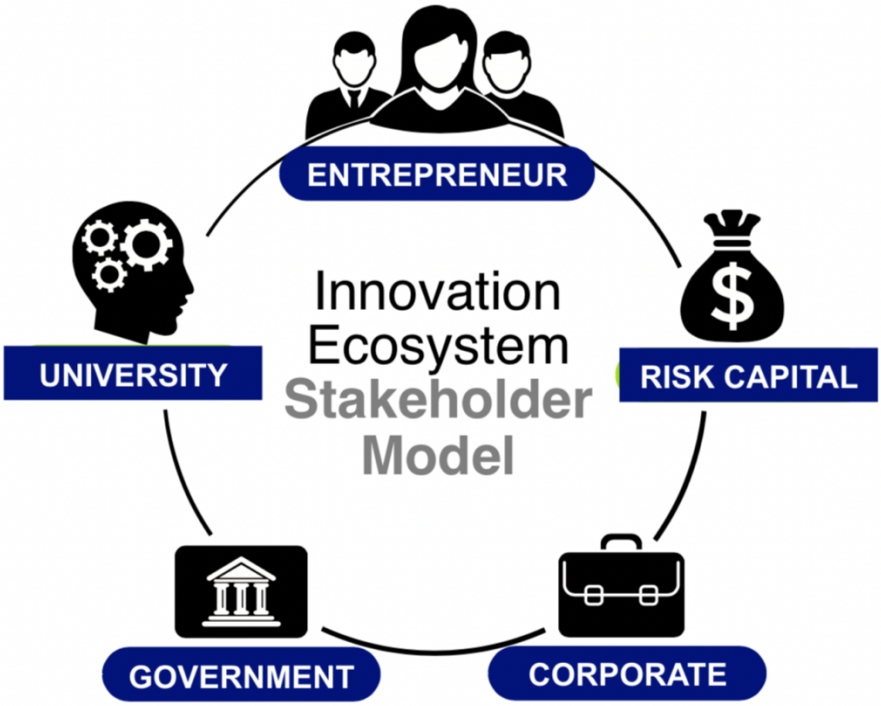


Figure 3: MIT Innovation Ecosystem Stakeholder Model
Source: Source: Murray et al., 2018

The presence and sophistication of each of these stakeholder groups plays a critical role in the strength of an iEcosystem. The analytical framework does not present a systematic way to assess and possibly even rank stakeholders; for example, the number of universities present in an ecosystem is not a sufficient measure to assess their contribution to its strength, and particularly in the context of developing countries where data and indicators are scarce, assessments rely heavily on qualitative and anecdotal information. Below is a summary of some of the questions asked in assessing ecosystem stakeholders.

- Entrepreneurs – Who are the entrepreneurs in an innovation-driven ecosystem and what kind of companies are they creating? Where are they concentrated and what is their background? Are they locally trained? Are there accelerators, incubators, or other programs that support entrepreneurs?
- Risk Capital – Is there risk capital in the form of angel investors, venture capitalists, impact investment funds, or other forms of investment available for entrepreneurs? Where do entrepreneurs turn to get funding at various stages of growth?
- Corporate – What does the corporate sector look like? Are there multinational corporations in an ecosystem and how are they engaging with it? Are there indigenous corporations? Who are or were the first corporate movers in an ecosystem?
- Government – How does government (local, regional, and national) see its role in supporting or enabling an innovation-driven ecosystem? What are the policies and programs in place that support the ecosystem?
- Universities – Are there universities in the ecosystem and what are the areas they are most successful in? Are they heavily investing in research or focusing mostly on teaching? Are they training both technical talent as well as managerial talent? Are they producing innovations and generating new ideas and products? How are their graduates perceived by other stakeholders?

Lastly, it is important to understand the interactions and linkages between these stakeholder groups, as the potential for collective action depends heavily on stakeholders that are both well connected and share mutual trust. With more stakeholder engagement and communication comes a better understanding of roles and responsibilities, which makes setting a common agenda more likely to lead to collective action, and the development of a strategy that leads to impact.

2.3 iEcosystems Strategy

Successful ecosystems more and more rely on strategies for collective action that drive toward desired outcomes. They accelerate their innovation-driven ecosystem because stakeholders understand their regional comparative advantage or simply pursue their aspirations and the leverage that for growth through program and policy interventions (PPIs), such as establishing and supporting accelerators and incubators, organizing prizes and competitions, cultivating international networks (particularly with the diaspora in the context of developing countries), and supporting talent development programs, or providing early-stage capital. PPIs such as those mentioned above may be present in an ecosystem, but they often are not the result of collective action among the stakeholders, thus reducing the impact that can otherwise be achieved with collective action and strategic foresight. Governments play a particularly important role when it comes to strategy aimed at establishing and strengthening cluster formation and organization, particularly in the light of global competition, suggesting that governments should create industry clusters programs “that stimulate the collaborative interactions of firms and

supporting organizations in regional economies to produce more commercial innovation and higher wage employment" (Mills, Reamer, and Reynolds, 2008).

2.4 Conclusions

The MIT analytical framework to assess innovation-driven ecosystems, which itself is still a work in progress and subject to revisions and amendments on a regular basis, provides a solid lens through which to assess the iEcosystems of Accra, Ghana; Nairobi, Kenya; and Freetown, Sierra Leone. The following chapters will dive into each city/region trying to capture the current standing of their iEcosystems, how they got to where they are, and where they may be headed. While this chapter outlined numerous useful metrics to assess an innovation-driven ecosystem, data is often not available for these case studies, so the assessment will be strongly supported by qualitative evidence gathered in interviews with various stakeholders from the summer of 2018 to now.

Lastly, MIT's analytical framework is by no means the only one to assess iEcosystems; Cukier and Kon for example developed a maturity model for software startup ecosystems (2018) that assesses an innovation-driven ecosystem's integration in the twenty-first century's digital economy. While the assessments in the following chapters adhere more to MIT's framework, they are also informed by elements of other approaches.

Chapter 3 – Accra, Ghana's iEcosystem Assessment

Following the introduction of the analytical framework in the previous chapter, this chapter will assess Accra's innovation-driven ecosystem. It will do so first by providing an overview of Ghana as a country, highlighting some general information about its economy and politics in particular, before diving into the iEcosystem analysis, which will explore the country's foundational institutions, Accra's innovation capacity (I-Cap) and entrepreneurship capacity (E-Cap), its comparative advantage, and an overview of Accra's innovation ecosystem stakeholders, which together will provide an overall assessment of Accra's iEcosystem.

3.1 Introduction to Ghana

Ghana is a West African country of roughly 29 million people. Located along the Gulf of Guinea, Ghana shares a border with the Ivory Coast to the west, Burkina Faso to the north, Togo to the east, and the Gulf of Guinea and the Atlantic Ocean to the south. Its population is ethnically diverse and roughly 70 percent of its citizens are Christian, 20 percent Muslim, with the remaining population either practicing traditional faiths or no faiths. A former British colony known as the British Gold Coast, Ghana gained its independence from the United Kingdom in 1957 and is governed as a constitutional democracy led by President Nana Akufo-Addo.

Over time, Ghana has been recognized as one of Africa's success stories, enjoying consistent economic growth (its annual GDP growth rate has been positive every year since 1984). Ghana has been able to rapidly reduce poverty and after some politically tumultuous years resulting from a series of military coups in the 1960s and 1970s its democracy was fully restored in 1996 when it held its first elections deemed free and fair. Since then Ghana has been able to significantly strengthen its democratic credentials and emerged as a leading nation in West Africa.

In the last decade however, Ghana has shown signs of strain and a macroeconomic crisis caused some cracks in its otherwise solid political and institutional context. The government's effectiveness deteriorated and the population has grown more disillusioned with Ghana's political institutions. Strengthening the country's institutions and addressing institutional challenges will be key in consolidating Ghana's position as a middle-income country and beacon of stability and prosperity in an otherwise often volatile region.

On the economic front, Ghana has been a strong performer in the region. During the years of the commodity boom, roughly from 2002 to 2011, the country averaged an annual GDP growth of 6.8 percent (World Bank data). In the following years, Ghana's growth rate slowed down to an average of 3.5 percent, its lowest growth rate in decades, due to fiscal imbalances and sinking commodity prices (gold and cocoa in particular). Figures 3.1 and 3.2 below show a snapshot of Ghana's exports in 2017 and in 2000 respectively (Observatory of Economic Complexity OEC), highlighting the importance of commodities

such as gold, oil, and cocoa, and painting a picture of a country whose income depends heavily on unprocessed natural resources, and showing enormous potential for economic growth by adding value to its natural resources through processing and refining some of its natural riches, and by manufacturing increasingly complex goods. In 2017 the OEC index ranked Ghana the 111th most complex economy out of 126. The country's solid foundations suggest that with the right interventions in the public and private sector, it could leverage assets such as good governance and a strong educational system to take off and climb the ladder of economic complexity.

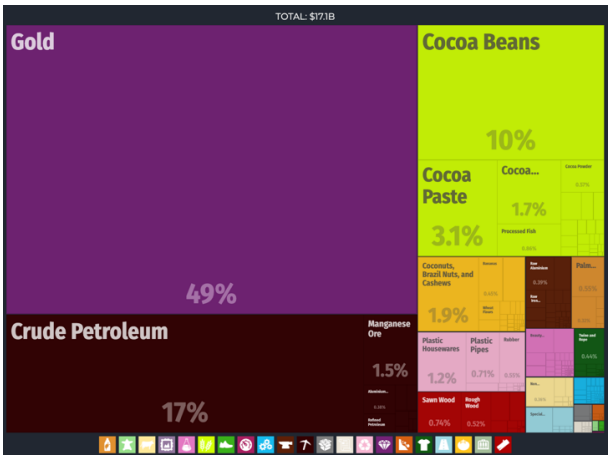


Figure 3.1 Ghana's Exports in 2017

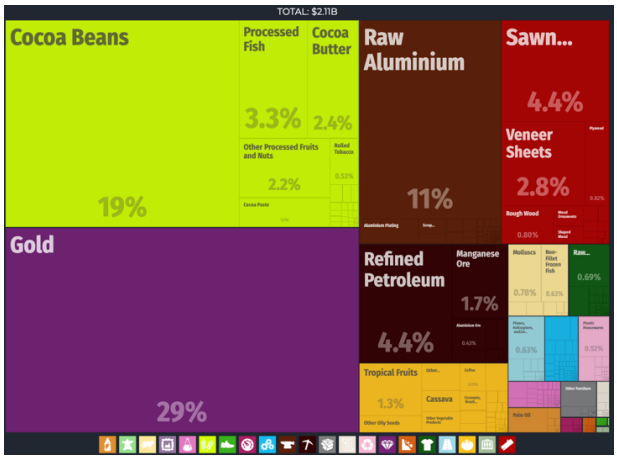


Figure 3.2 Ghana's Exports in 2000

Source: MIT Observatory of Economic Complexity

Ghana's GDP per capita rose from $183 in 1960 to $2,046 in 2017, positioning the country at the lower end of middle-income countries presently. Through sustained economic growth Ghana was able to lift millions of its citizens out of poverty. At the same time the country's population also grew significantly, from 6.6 million in 1960 to nearly 30 million at present. Throughout this time Ghana has been a substantial recipient of official development assistance (ODA) and official aid, depending substantially on donor countries to grow its economy. Table 3.1 below captures some of these statistics from 1960 until 2017, painting the picture of a country with a rapidly growing population and economy over the last six decades.

Ghana	1960	1990	2000	2010	2017
GDP per capita (current US$)	$183	$402	$263	$1312	$2,046
GDP per capita (PPP $)	NA	$1,240	$1,790	$2,997	$4,502
GDP growth (annual %)	3.4	3.3	3.7	7.9	8.1
Population	6,652,287	14,628,260	18,938,762	24,512,104	28,833,629
Net ODA + aid received (current US$)	$3M	$560M	$600M	$1.7B	$1.25B

Table 3.1: GDP per capita, GDP annual growth, population, official development aid and official aid received. Source: World Bank Data, 2017.

Table 3.2 captures some of Ghana's economic, social, and infrastructure transformation over the last 15 years. The country's rapidly growing economy meant that net official development assistance (ODA) went from nearly 11 percent of gross national income in 2005 to just above 3 percent in 2018 (Ghana also received less ODA over the same timeframe, but the decrease was not as substantial). The country transitioned from a majority rural population in 2005 to a majority urban population, with 56 percent of citizens living in urban areas. This also had implications on the economy's three sectors: the primary sector, agriculture, saw its contribution to the country's gross value added (GVA) shrink from nearly 32 percent in 2005 to 19 percent in 2018. Meanwhile the secondary sector, industry, saw an increase from 20 percent of GVA to 24 percent, and the tertiary sector, services, grew from 48 percent in 2005 to 57 percent. Similarly, employment decreased in agriculture, which employed nearly half of Ghana's population in 2005, and now employs roughly 40 percent. Industry experienced growth in productivity but not in employment, where it slightly declined, while services went from employing 35 percent of the population in 2005 to 46 percent in 2018. In the last 15 years Ghana's exports rose from $3 billion in 2005 to nearly $8 billion in 2018, and its internet users went from 1.8 per 100 inhabitants to nearly 35 per 100 inhabitants, thus bringing millions of citizens into the digital age. Ghana's mobile penetration was estimated at 128 percent in 2016.

Ghana	2005	2010	2018
Net Official Development Assist. received (% of GNI)	10.87	5.36	3.19
Economy: Agriculture (% of Gross Value Added)	31.8	29.8	18.9
Economy: Industry (% of Gross Value Added)	20.3	19.1	24.2
Economy: Services and other activity (% of GVA)	47.9	51.1	56.9
Employment in agriculture (% of employed)	49	42	39.7
Employment in industry (% of employed)	15.8	15.2	14.4
Employment in services (% of employed)	35.2	42.8	46
Unemployment rate (% of labor force)	4.7	5.3	2.4
International trade: exports (million current US$)	$3060	$5233	$7982
Education: Government expenditure (% of GDP)	7.4	5.5	6.2
Urban population (% of total population)	47.3	50.7	56.1
Individuals using the Internet (per 100 inhabitants)	1.8	7.8	34.7

Table 3.2: Economic, Social, and Infrastructure Indicators for Ghana. Source: United Nations Data, 2018.

Ghana's transformation has been substantial and will likely continue for decades to come. The role of science and technology in catalyzing this process of transformation is yet to be seen. What is clear is that Ghana, like the majority of sub-Saharan African (SSA) countries, does not want to be left out of the digital world of the twenty-first century, and that science and technology are to play an important role in shaping a better future for its citizens. What follows in this chapter is an in-depth look at Ghana's foundational institutions and at Accra's iEcosystem in particular. Accra is home to 2.5 million people, while over 4 million people live in the greater metropolitan area. It is the country's largest city and its main economic hub. The analysis will apply the analytical framework developed by the MIT Innovation Initiative presented in chapter two. It will combine quantitative information drawn from several of the indicators discussed earlier, and it will be complemented by qualitative information gathered through fieldwork in the form of interviews with Accra's innovation ecosystem stakeholders.

3.2 Ghana and Accra's iEcosystem

Ghana's innovation driven ecosystem is rapidly evolving and growing, particularly in the capital Accra. The country's solid educational system, increased access to information communication technology (ICT), a stable economy (particularly in comparison to neighboring countries), and political stability coupled with a safe environment have all contributed to making Ghana and Accra an attractive place in which an innovation driven ecosystem has been growing over the last decade. What follows is a look at Ghana's iEcosystem and Accra's in particular.

3.2.1 Foundational Institutions

Ghana's foundational institutions are solid in comparison to neighboring countries as well as in the general context of sub-Saharan Africa, however they are lagging behind at the global level. What this means is that Ghana is far from having the strong foundational institutions found in many OECD countries, but at the same time it is poised for improving them at a faster pace than many other countries in sub-Saharan Africa.

The Heritage Foundation's Economic Freedom Score, an indicator that captures numerous data points of relevance in relation to foundational institutions, places Ghana in 109th position (out of 180 ranked countries) in 2019, with a score of 57.7, which places it slightly below the world average of 60.8 and slightly above sub-Saharan Africa's average of 54.2 (Ghana ranks 13th among the 47 countries in SSA). According to the rule of law assessment, Ghana struggles with processes related to property rights, and scarce resources compromise and delay its judicial effectiveness and government integrity, making them both prone to corruption. Ghana's regulatory efficiency is in slightly better shape, but its business freedom is still burdened by bureaucratic procedures which make "the overall process for establishing and running a private enterprise cumbersome" according to the Heritage Foundation's index. Similarly, labor regulations "remain restrictive and outmoded." Ghana's relative strengths are related to its government spending and tax burden, while areas of concerns are its fiscal health and government integrity (Heritage Foundation, Economic Freedom Index, 2019).

On the 2018 Corruption Perception Index produced by Transparency International Ghana scored 41/100 (where 0 is highly corrupt and 100 very clean) ranking it 78th out of 180 countries and placing it among the highest ranked countries on the entire African continent. In terms of business regulations, data from the World Bank Doing Business ranks Ghana in 114th place globally with a score of 59.22/100. Figure 3.3 below shows a detailed composition of Ghana's rankings and score on doing business topics. What this shows is that there is significant room for improvement in Ghana's business environment across many dimensions, from infrastructure ones such as getting electricity to bureaucratic ones such as resolving insolvency, trading across borders, dealing with construction permits, registering property, and paying taxes.

Figure 3.3: Ease of Doing Business Indicators for Ghana, 2019.
Source: World Bank (2019a).

While the indicators listed above paint a complicated picture when it comes to Ghana's foundational institutions, the country's political stability and secure environment certainly play in its favor as it works towards strengthening the rule of law, reducing burdens to doing business, providing enabling infrastructure, and tackling corruption.

3.2.2 I-Cap and E-Cap

While Ghana and Accra are not yet known for their Innovation Capacity (I-Cap) and Entrepreneurship Capacity (E-Cap) at a global scale, regionally Accra enjoys somewhat of a hub status, particularly due to the strength of the country's educational system. Ghana's educational system was ranked 48th globally in 2017 by the World Economic Forum's education quality index, and the country's tertiary education is rapidly expanding, particularly through the establishment of private universities. Education continues to be a

priority also for the current administration, which is particularly interested in exploring the potential "for technical and vocational education to support and drive innovation in the economy" (Fry et al, 2018). To go along with this, the government is also pursuing a "One District, One Factory"[10] to boost manufacturing linked to a practical education.

What follows is a brief overview of the inputs for I-Cap and E-Cap in relation to human capital, funding, infrastructure, demand, and culture & incentives. While the analytical framework presented in chapter two outlined numerous indicators, unfortunately data is not readily available for most indicators.

Ghana was ranked 106th out of 140 in 2018 on the World Economic Forum's Global Competitiveness Index. Figure 3.4 below places Ghana in the index's 12 pillars, showing how Ghana averages above sub-Saharan Africa in all of them except in macroeconomic stability.

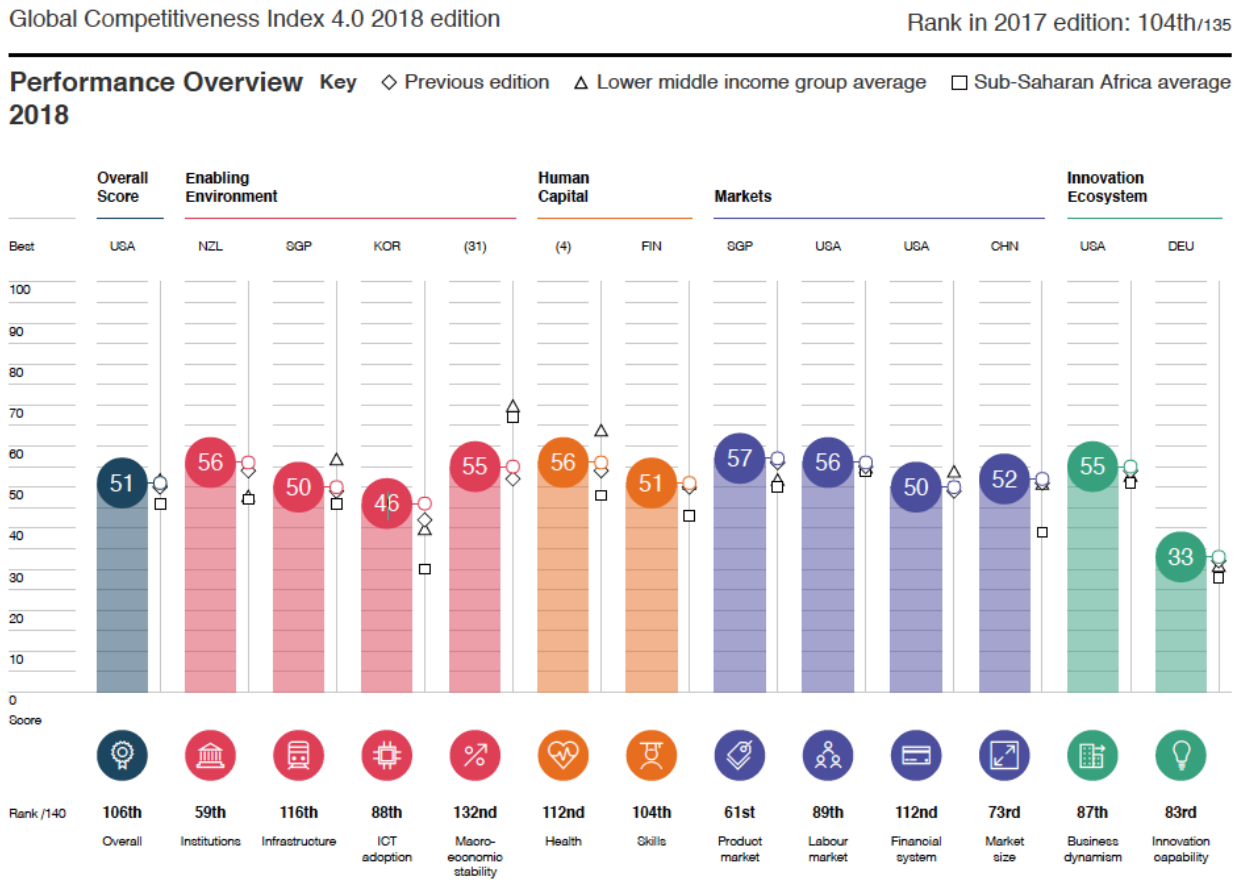


Figure 3.4: Ghana's Global Competitiveness Index in 2018. Source: World Economic Forum, 2018.

[10] http://1d1f.gov.gh/

In terms of **human capital** inputs Ghana is ranked 104th for skills overall, but in some areas such as ease of finding skilled employees, extent of staff training, quality of vocational training, and skillset of graduates it is ranked among the world's top 70. Ghana currently spends approximately 6.2 percent of its GDP on education, ranking 18th globally; it has a tertiary education enrollment of 16.1 percent, of which only 12.2 percent graduate in science and engineering.

In terms of **funding** inputs, Ghana invested 0.4 percent of its GDP in research and development as of 2018 (Global Innovation Index), up from 0.23 percent in 2007, but access to credit is a big issue, with domestic credit to the private sector at 20 percent of GDP, ranking Ghana 122/140 (Global Competitiveness Index GCI, 2018). Risk capital is also available in the form of venture capital, private equity, donor funding, and personal loans, although data on the extent of risk capital invested is not available.

In terms of **infrastructure** inputs, Ghana was ranked 98th for ICT access and 86th for ICT use in 2018 (GII), and approximately 35 percent of the population are internet users (GCI), with a broadband of 9.9 kB/s per user (GCI). The country's general infrastructure is a weakness, its electricity output ranks it 106th globally at 419.2 kWh per capita, and its logistics performance ranks Ghana 87th out of 160 countries (Logistics Performance Index).

In terms of **demand** inputs Ghana appears to have strengths according to the following indicators: it is ranked 37th in innovation linkages, 62nd in university/industry research collaboration (GCI), 35th in government procurement of advanced technology (GCI), while in trade, competition, and market scale Ghana ranks in 105th position (GII). While there are no strong clusters, agricultural technology and health related services may emerge as clusters as Ghana, and Accra in particular build on their existing competences and early stage initiatives begin show impact.

Lastly, in terms of **culture and incentives**, the quality of scientific research institutions in Ghana is ranked 74th globally (GCI), with only 12.2 percent of students graduating in science and engineering, and a very small researcher population, counting 38 researchers per million citizens (GII). A closer look at universities in particular will follow in the stakeholder analysis.

Overall, Ghana, like many other developing countries, has more E-Cap than I-Cap. Entrepreneurship is much more prevalent in developing countries with large informal sectors, where citizens often have to cultivate an entrepreneurial mindset to survive. I-Cap on the other hand is harder to come by because it depends on so many elements that are harder to attain: an advanced education, reliable infrastructure, strong research institutions and the availability of funding. This is not to say that Ghana has no I-Cap and that its E-Cap is observed only or mainly in the informal sector; on the contrary there is ample evidence of promising activity in Accra and in Ghana which will be explored in section 3.3 analyzing Accra's iEcosystem Stakeholders.

3.2.3 Comparative Advantage

At present, Ghana's comparative advantage is dictated more by its natural riches rather than by its domain expertise. It has a comparative advantage in mining gold and other minerals, in cocoa production, and in oil due to its natural endowment. Little value added is captured locally on these value chains, with Ghana acting mainly as an exporter of raw materials and commodities, and processing and value addition happening elsewhere in more knowledge intensive locations with more advanced infrastructure. Developing innovation driven strategies around some of these areas could unlock a new phase of growth for Ghana, based on more knowledge intensive capabilities in fields such as agribusiness and mining, but also others such as health and energy.

Ghana also has a comparative advantage in democratic governance in comparison to its neighboring countries, as well as in education, making it an attractive country for talent from the region to train and relocate to. Anecdotal evidence gathered through interviews in Accra also seems to suggest that Ghana may also have a regional comparative advantage in healthcare provision, with many middle-income citizens from West African countries (Nigeria in particular) seeking healthcare in Ghana. Developing strategies for collective action around these areas could propel Accra and Ghana's iEcosystem forward, attracting more talent and investors while creating more and better opportunities for Ghana's citizens.

3.2.4 Strategy & Impact

Ghana's innovation driven ecosystem appears to be in an upward trajectory. Infrastructure is improving (Accra recently opened a brand-new terminal in its international airport and connectivity within the city is being improved, reducing the time spent on the road to get to meetings), access to ICT and connectivity are growing, new tertiary educational institutions are being created and existing ones are improving. Accra also has numerous hubs supporting innovation driven entrepreneurs providing them with an enabling environment, and corporations are slowly taking a more proactive approach to engaging with universities and entrepreneurs. The government is thinking about the role of innovation driven entrepreneurship too, particularly at the level of the Ministry of Environment, Science, Technology and Innovation (MESTI). Yet, as the following section will explore, Accra's iEcosystem stakeholders still have significant ground to cover to work together on aligning intent and strategy towards collective action that leads to impact at scale.

3.3 Accra's iEcosystem Stakeholders

Accra is home to a growing innovation driven ecosystem. Entrepreneur support organizations (ESOs) (Wangari and Crawford, 2019), such as tech-hubs, incubators, and co-working spaces, have emerged and aspiring entrepreneurs as well as established ones crowd the city's incubators and accelerators. Greater Accra is home to over 30

universities and colleges, and many of them increasingly offer an entrepreneurial curriculum to their students and regularly run hackathons and competitions in partnership with corporations, NGOs, and incubators and accelerators. During a two week visit in July 2018, this author was exposed to a broad offering of events, conferences, and networking opportunities bringing together Accra's iEcosystem stakeholders; from a conference and workshop to reduce graduate unemployment organized by the German Academic Exchange (DAAD) in partnership with Ghana's Technical Universities, to the first Ghana Tech Summit[11], to a startup pitching contest organized by Seedstars World Competition[12]. What follows is a closer look at these stakeholders.

3.3.1 Entrepreneurs and Enablers

Accra is home to numerous incubators and accelerators that support entrepreneurs. A few among them stand out. The Meltwater Entrepreneurial School of Technology (MEST)[13] was founded in Accra in 2007 by the Norwegian Meltwater Group as a training program and a pan-African incubator network focused on building capacity for entrepreneurs in software development, business, and communications. Entrepreneurs are recruited across the continent and admitted through a selective process and provided a fully funded one-year training to develop a venture, and at the end of the year they pitch for a chance to receive seed funding and enter the MEST incubator, which is another yearlong program where the entrepreneurs incubate and accelerate their ventures before becoming fully independent. MEST receives 8000 applications for each cohort and selects 50 candidates to participate in the first-year program. MEST started in Accra and is now present also in Lagos, Nigeria, Cape Town, South Africa, and will soon also be in Nairobi, Kenya and Abidjan, Ivory Coast. To date, MEST incubator invested in 50 companies (with 36 in the Accra incubators as of July 2018), 4 had successful exists, and two became market leaders (Ravichandran, 2018). Ghana was selected as the host country for its stability, its more advanced value chain in agriculture (in comparison to neighboring countries), and because it's an anglophone country. Over time, MEST has been able to build capacity not only through training its entrepreneurs, but also by collaborating with other local institutions and training them in their efforts. The program enjoys a very high reputation well beyond the borders of Ghana and it is building a successful track record and expertise in agritech in particular, where Accra has produced some promising startups such as AgroCenta[14] and CowTribe[15].

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[11] http://ghanatechsummit.com/ Ghana Tech Summit brings together hundreds of entrepreneurs, investors, digital marketers and creatives under one roof together to address humanity's grandest challenges via technology and entrepreneurship. 2018 marked the first edition of the summit, which is scheduled to run yearly until 2030.

[12] https://www.seedstarsworld.com/event/seedstars-accra-2018

[13] https://meltwater.org/

[14] https://agrocenta.com/ A digital food distribution platform creating shared value for businesses and smallholder farmers, which won the Seedstars World competition in 2017.

[15] https://www.cowtribe.com/ Africa's first last mile animal vaccine delivery platform, winner of Seedstars Accra 2018.

Another important player in Ghana's iEcosystem is the Impact Hub Accra[16], which is part of the global network of Impact Hubs and offers coworking space along with mentorship, training, and access to seed capital, and is often where entrepreneurial expatriates from the United States and Europe can be found. Other similar players are the Climate Innovation Centre Ghana[17], a business incubator founded in 2016 by Ashesi University in partnership with the World Bank with a focus on developing SME ventures and entrepreneurs in Ghana's green economy.

These programs and others listed below make up Ghana's complex entrepreneurship landscape, however the growth in new startups and expected employment boost has yet to happen. Most entrepreneurs are still found in incubators and hubs, and "not yet scaling and running full-steam" (Fry et al., 2018).

3.3.2 Risk Capital

While there has been a surge of private equity (PE) and venture capital (VC) in Ghana (and across the continent) from investors seeking new growth markets with high yields, many hurdles remain in place, both in terms of regulation as well as in terms of risk capital available to high growth innovation driven enterprises. According to a recent study on Ghana's PE and VC scene, "the planning, development, and support of a private equity and venture capital ecosystem represents a collaboration between public and private sector actors that must closely align with market realities and limitations. As the experience of Ghana attests, flaws in program design or a lack of alignment of actors and incentives, when coupled with macroeconomic or environmental challenges, can be greatly compounded. Thus, launching a PE and VC industry absent a supportive industry context almost assures that significant headwinds will prevail" (Divakaran et al, 2018).

With a nascent ecosystem of incubators and accelerators, Ghana also launched the Ghana Angel Investor Network (GAIN) in 2011 on a mission to establish an active angel investor network in the country, with currently 20 Ghanaian business angels who are slowly establishing links to the local incubators and accelerators (Divakaran et al, 2018).

Senyo (2018), who runs Accra's Impact Hub, reports that "capital still sits with a generation that does not understand [IDEs], which means that the rate at which you can grow as a tech business in our ecosystem is limited by the access to capital, which means that most people are having to grow on revenue," forcing them to follow a growth path more similar to that of SMEs rather than IDEs. While entrepreneurs often mention the lack of funding as a key challenge they face, other stakeholders believe that there are investors but entrepreneurs often don't know where to look for them or don't know how to approach them. There are indications, however, that this is slowly changing (Ravichandran, 2018).

[16] http://accra.impacthub.net/
[17] http://www.ghanacic.org/

3.3.3 Corporate

Corporations are slowly beginning to play a bigger part in Accra's iEcosystem. Banks and telecommunications companies invested in open innovation and competitions, often in collaboration with educational institutions and with a strong capacity building angle. MEST is supporting the setup of Standard Bank and MTN's incubators, and Ravichandran (2018) reports that "corporates are getting very interested in open innovation, but unfortunately large amounts of them are still service providers" who are not yet prepared to address big challenges that they cannot solve alone through open innovation and collaboration with Accra's incubators and accelerators and universities. From Ecobank's Fintech Challenge to MTN's App Challenge[18] to others launched by Vodafone, TigoAirtel and Fidelity Bank, there are more and more opportunities linked to finance and ICT in particular. In the energy sector Kosmos Energy launched the Kosmos Innovation Center[19] serving as a "nexus between information and communications technology (ICT) and agriculture, with the goal of inspiring entrepreneurs to transform Ghana's agriculture sector." A particularly encouraging new entrant was Google, which opened an Artificial Intelligence (AI) Laboratory in Accra in April 2019 and aims to build products that can solve problems faced on the continent today. The robust network of tertiary institutions in Accra, as well as the city's solid infrastructure in terms of internet access and electricity, motivated Google to set up in Ghana, and it is likely that other international technology companies may follow, as has been the case in other African cities such as Nairobi.

3.3.4 Government

With priorities in education, particularly technical and vocational education, to go along with the One District, One Factory program, the Ghanaian government faces significant challenges, particularly in connecting and aligning stakeholders of the innovation ecosystem which are operating independently of each other in a fragmented way. Ghana's Ministry of the Environment, Science, Technology, and Innovation (MESTI) is spearheading efforts with its 2017-2020 policy whose goals are to "facilitate mastering of scientific and technological capabilities; providing a framework for collaborations in science, technology and innovation (STI); creating the conditions for the improvement of scientific and technological infrastructure for R&D and innovation; and promoting an STI culture across Ghana" (MESTI, 2017). According to a recent paper, "Ghana's policies and institutions for science, technology and innovation have not been modernized and aligned to economic growth and human development goals. A key feature of Ghana's institutional landscape is the weak links and poor positive feedback between and among institutions including the higher education and research institutes and the private sector. More importantly, there are no incentives to work together and few mechanisms to encourage communication and collaboration" (Divakaran et al, 2018).

[18] https://appschallenge.mtn.com.gh/
[19] https://www.kosmosinnovationcenter.com/

What emerged in conversations with other stakeholders of Accra's ecosystem is a desire for the government to play more of a facilitator and enabler role. Ravichandran (2018) describes the government as a "very traditional West African bureaucracy; they are very slow and everyone complains about the Ghanaian government not being like the Rwandan government, but at least they are thinking" about their role, and slowly implementing policies that are favorable to new businesses. While in the past many stakeholders did not have an open channel with the government, many are currently part of informal knowledge network exchange groups, often organized via WhatsApp, that include key people in MESTI with whom they have regular in-person and remote exchanges on policies, programs, and initiatives.

3.3.5 Universities

Universities are both a strength and a weakness in Accra's iEcosystem. According to a recent World Bank study, "Ghana has in place many of the individual components necessary for an efficient and effective technology development system. […] However, the capacity of the overall system is limited in comparison to those of middle-income countries such as India or South Africa" (Divakaran et al, 2018). With 16 research and development institutes, 7 public universities and approximately 40 private ones, 10 public polytechnics, and numerous technical institutes (many of which are concentrated around Greater Accra), Ghana is growing its competitive advantage in tertiary education, attracting students from numerous neighboring countries. The quality of graduates of Ghanaian universities is generally considered high by other stakeholders, although the educational system is not yet optimized to work with industry and SMEs in particular. A senior administrator at a public Ghanaian university reported in a conversation that a culture of mistrust makes collaboration with industry very difficult, stating that "[companies] first think of all the negative things before they see the positive in working with students and researchers," mentioning that the first thought goes to questions such as "are they sent by the competition to spy on us?" and concluding that "industry doesn't think academia has anything to offer, and academia thinks too highly of itself."

In 2016 Ghana began a process of converting its Polytechnics to Technical Universities (TUs) through the Technical Universities Act (Act 922), whose aim is "to provide higher education in engineering, science and technology based disciplines, technical and vocational education and training, applied arts and related disciplines as the Council of the Technical University may, in consultation with the National Council for Tertiary Education determine in accordance with the following principles". This conversion has taken place in collaboration with the German Academic Exchange Services (DAAD) and German universities of applied sciences in an effort to reform TUs to reduce graduate unemployment and more closely align TUs with industry. While there are not yet any studies on the curriculum side of this conversion, on the administrative side "after the conversion to TUs, there was a remarkable improvement on policies and procedures used in the creation and storage of administrative records in manual format and organizational

file plan that compile primary types by functional Units in order to locate information" (Frimpong et al, 2018).

In addition to the public universities, Ghana is also home to numerous private universities. Among these, Ashesi University[20] stands out as a virtuous example. Founded in 2002, Ashesi has a strong focus on entrepreneurship and ethical leadership, cultivating an "entrepreneurial mindset and the ability to solve complex problems". Ashesi has established significant links with the private sector on IT, as well as collaborations with international corporations like General Electric and McKinsey (Divakaran et al, 2018). Academic City College[21], Ghana's newest private university launched in late 2018 by an MIT alumnus, has innovation and entrepreneurship at its core.

3.4 Conclusions

The picture that emerges from this chapter is one of a country that still faces numerous and significant challenges, but that at the same time enjoys solid foundations on which to build its economic transformation. Innovation driven entrepreneurship is poised to play an important part in Ghana and Accra's transformation. Addressing critical challenges such as energy provision, tackling corruption, strengthening infrastructure, and reforming public universities from the old model of training public servants to preparing young graduates for careers in the private sector will likely define Ghana's future success. What is clear is that the innovation ecosystem is rapidly evolving, attracting talent, and generating new companies and ideas. Because the relatively early stage of Accra's iEcosystem, establishing informal knowledge exchange networks should be a priority, with the objective of bringing together an otherwise fragmented group of stakeholders. Bridging gaps and bringing stakeholders together to shape a common vision and strategy will be key to accelerating Ghana's transformation. In the words of one of its stakeholders, "the ecosystem is one hour behind East Africa and catching up."

[20] https://www.ashesi.edu.gh/about.html
[21] https://acity.edu.gh

Chapter 4 – Nairobi, Kenya's iEcosystem Assessment

4.1 Introduction to Kenya

Kenya is an East African country with approximately 50 million inhabitants. Located on the Indian Ocean, Kenya shares a border with Somalia to the north east, Ethiopia to the north, South Sudan to the north west, Uganda to the west, Tanzania to the south, and the Indian Ocean to the east. Home to a diverse ethnic population, Kenya is a majority Christian country, with 83 percent of the population practicing Christianity; 15 percent of the population are Muslims, and the remaining population split between Hindus and other traditional faiths or no faiths. Kenya was also a former British colony and it gained independence from the United Kingdom in 1963. Now a presidential representative democratic republic, Kenya is led by President Uhuru Kenyatta, the son of Jomo Kenyatta who served as Kenya's first President.

Kenya has grown its economy substantially over the last decades, with positive GDP growth every year since 1992, resulting in substantial poverty reduction. The country's woes in the last decades are more tied to its poor political stability and security issues. Kenyan elections are often fraught and contested and violence has erupted in several of the last elections. At the same time Kenya is embedded in a volatile region and susceptible to a large influx of migrants due to conflicts in neighboring countries and natural disasters such as droughts, and it is frequently subject to terrorist attacks from the Al-Shabaab terrorist group based in Somalia.

In the last few years Kenya's political stability has improved and the government is prioritizing the alleviation of structural obstacles that hinder economic growth. According to a 2019 report on the country's economic freedom by the Heritage Foundation, "the country has a growing entrepreneurial middle class and has enjoyed steady growth, but its economic and development trajectory is impaired by weak governance, ineffective rule of law, and corruption." At the same time, Kenya maintains strong relations with numerous OECD countries and China, and has been successful at attracting foreign direct investment to finance infrastructure projects. Kenya is also pursuing a path of sustained regional integration with the East African Community (EAC) for greater regional trade liberalization and infrastructure integration, both in terms of roads and rail, as well as in terms of digital infrastructure related to connectivity.

Over the past decade Kenya has averaged GDP growth of 5 percent (World Bank data). Figures 4.1 and 4.2 below show a snapshot of Kenya's exports in 2017 and 2010 respectively (Observatory of Economic Complexity OEC), highlighting how the country's exports structure did not change substantially. Kenya's economy depends in large part on the primary sector, with the exports of vegetable products such as tea, flowers, coffee and others making up nearly 50 percent of the country's exports. At the same time Kenya has some industrial strength, with exports industries such as textiles, chemical products, processed foodstuffs, and machines. The OEC index ranked Kenya as the worlds 89th

most complex economy in 2017 out of 126. With a growing entrepreneurial middle class and a relatively diverse set of production capabilities Kenya's foundations to climb the ladder of economic complexity are particularly strong.

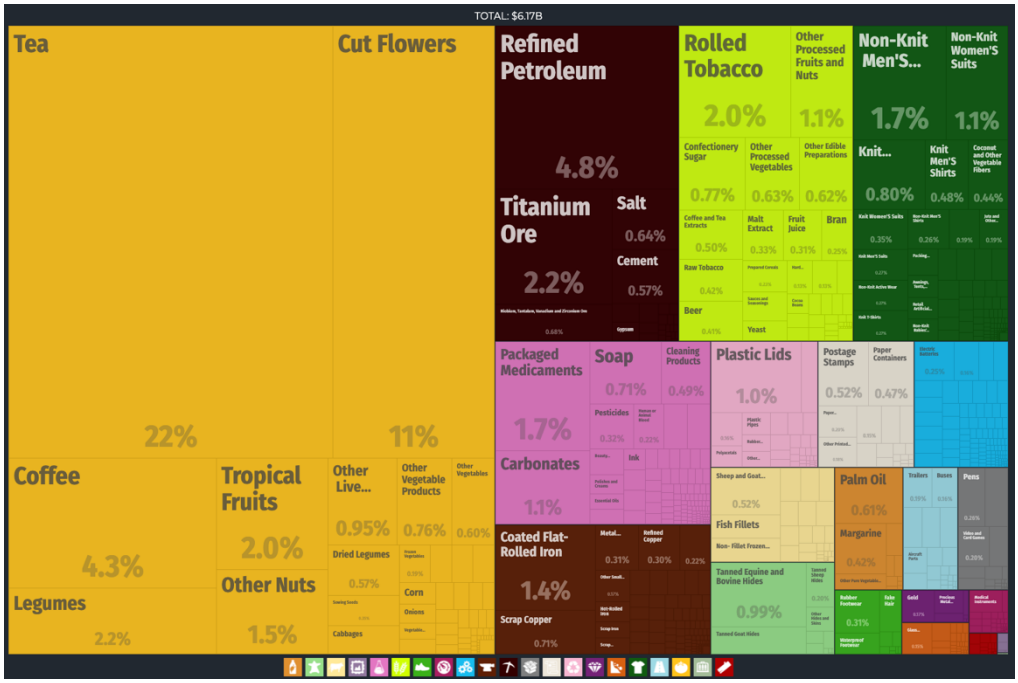

Figure 4.1: Kenya's Exports in 2017. Source: MIT Observatory of Economic Complexity

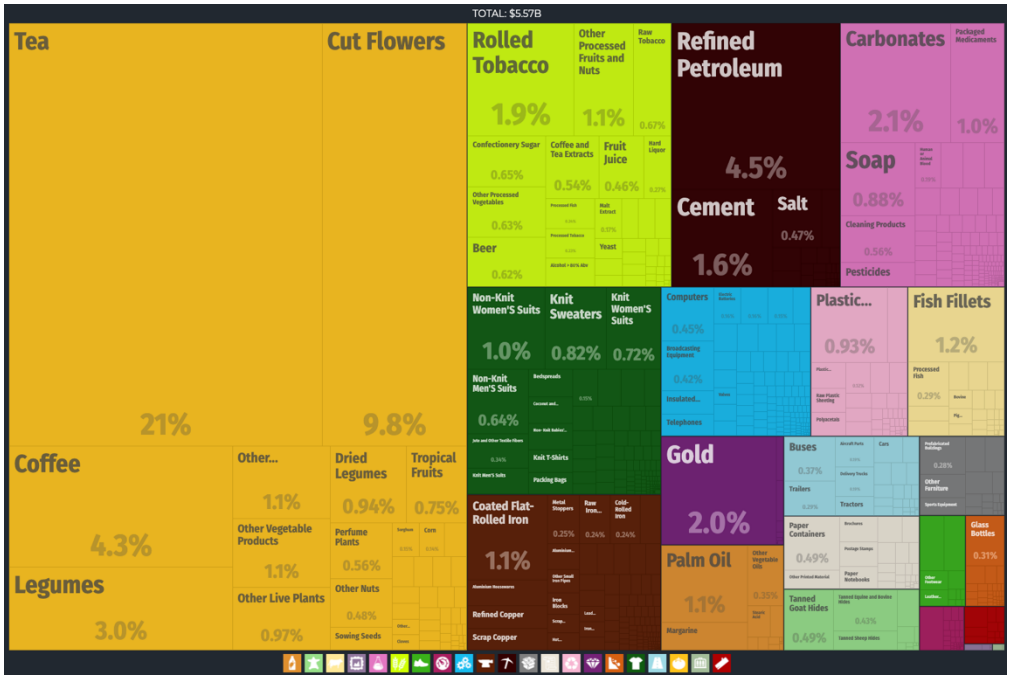

Figure 4.2: Kenya's Exports in 2010. Source: MIT Observatory of Economic Complexity

Kenya's GDP per capita rose from $98 in 1960 to $1,595 in 2017, propelling Kenya to join others like Ghana in the club of lower-middle income countries. In the same timeframe, Kenya's population grew from approximately 8 million to 50 million. Kenya's strong relations with OECD countries, as well as its significant refugee population, made it a strong recipient of official development assistance (ODA) and official aid. Table 4.1 below highlights these figures from 1960 to 2017.

Kenya	1960	1990	2000	2010	2017
GDP per capita (current US$)	$98	$366	$404	$967	$1,595
GDP per capita (PPP $)	NA	$1,538	$1,690	$2,425	$3,292
GDP growth (annual %)	-7.8	4.2	0.6	8.4	4.9
Population	8,105,440	23,402,507	31,450,483	41,350,152	49,699,862
Net ODA + aid received (current US$)	$21M	$1.2B	$514M	$1.6B	$2.47B

Table 4.1: GDP per capita, GDP annual growth, population, official development aid and official aid received. Source: World Bank Data, 2017.

Table 4.2 below captures some of Kenya's economic, social, and infrastructure transformation over the last 15 years. Kenya's dependence on ODA didn't exceed 4 percent of gross national income in the last 15 years, and it amounted for 3.13 percent of GNI in 2018. While the African continent is experiencing a major shift towards urbanization this trend has not been as strong in Kenya, where the country's urban population went from nearly 22 percent in 2005 to 27 percent in 2018, leaving the country far from being a majority urban country as is the case of many others, like Ghana. Kenya's economy has seen some interesting shifts over the last 15 years: the share of agriculture's gross value added (GVA) went from 23.2 percent in 2005 to 34.5 percent in 2018, denoting significant investments and growth in productivity in the agriculture sector, as employment in agriculture went from 41.4 percent of employed in 2005 to 37.2 percent in 2018. Industry saw its share of GVA decrease from 22.3 percent to 18.5 percent, while employment in industry remained relatively constant at 14 percent. Lastly, the services sector saw its share of GVA shrink from 54.5 percent to 47 percent, while its employment share rose from 44 percent to 48.5 percent. The inverse shift for agriculture (share of GVA up and employment down) and services (share of GVA down and employment up) is likely due to more productivity growth in agriculture rather than in services. Kenya's exports in this timeframe grew from $3.4 billion in 2005 to $5.8 billion in 2018, and the

country's internet users went from 3 users per 100 inhabitants in 2005 to 26 in 2018. Kenya's mobile penetration in 2018 is estimated at 91 percent.

Kenya	2005	2010	2018
Net Official Development Assist. received (% of GNI)	4.04	4.09	3.13
Economy: Agriculture (% of Gross Value Added)	23.2	27.1	34.5
Economy: Industry (% of Gross Value Added)	22.3	20.3	18.5
Economy: Services and other activity (% of GVA)	54.5	52.6	47
Employment in agriculture (% of employed)	41.4	39.1	37.2
Employment in industry (% of employed)	14.6	15.3	14.3
Employment in services (% of employed)	44	45.6	48.5
Unemployment rate (% of labor force)	10.5	12.1	11.4
International trade: exports (million current US$)	$3420	$5169	$5805
Education: Government expenditure (% of GDP)	7.3	5.5	5.3
Urban population (% of total population)	21.7	23.6	27
Individuals using the Internet (per 100 inhabitants)	3.1	7.2	26

Table 4.2: Economic, Social, and Infrastructure Indicators for Ghana. Source: United Nations Data, 2018.

Kenya has changed quite dramatically over the last few decades, and science, technology and innovation have played quite an important part in the Kenyan narrative over the last two decades. Kenya is known around the world for being home to the mobile revolution, which has transformed the lives of Kenyans by providing access to communications and financial inclusion through the introduction of mobile money, pioneered in the country in 2007 by M-PESA, allowing citizens to transfer and store money on their cell phones. What follows is a look at Kenya's innovation driven ecosystem (iEcosystem) and that of Nairobi, the country's capital, in particular. Nairobi has a population of 4 million people, with over 6.5 million inhabitants in the greater metropolitan area. It is the country's largest city and its main economy hub, often also referred to as the Silicon Savannah. As in the case of Accra, Ghana, the analysis will apply the MIT Innovation Initiative analytical framework and combine quantitative data with qualitative information.

4.2 Nairobi and Kenya's iEcosystem

Kenya, and Nairobi in particular, is home to an innovation driven ecosystem that already enjoys significant global renown, making it one of the more mature and dense iEcosystems found on the continent today. Despite the country's political turmoil, particularly around elections, and a concerning security situation due to repeated terrorist attacks, Nairobi continues to be an attractive city for innovation driven entrepreneurs. What follows is an in depth look at Kenya and Nairobi's iEcosystem specifically.

4.2.1 Foundational Institutions

Kenya's foundational institutions are mixed; in some respects, the country performs comparatively well and is ranked above its neighbors and most countries on the continent, in other respects the country is among the poorest performers.

The Heritage Foundation's Economic Freedom score ranks Kenya in 130th position globally (out of 180) in 2019, placing it in the 22nd among 47 countries in sub-Saharan Africa, with a score of 55.1. In terms of the rule of law, the country struggles with government integrity due to corruption; its property rights are on par with the rest of the world, but generally weak, as is the country's judicial effectiveness. Kenya's regulatory efficiency is improving, according to the indicator the "entrepreneurial environment has become more streamlined, and no minimum capital is required for launching a business." Kenya's tax burden and government spending are considered strong areas, while its fiscal health is considered a weakness due to high debt and government integrity due to corruption.

On the 2018 Corruption Perception Index Kenya scored 27/100, ranking it 144th out of 180 countries, placing Kenya among the world's most corrupt countries. In terms of business regulations, the World Bank's Doing Business ranking places Kenya in 61st position globally with a score of 70.31/100. Figure 4.3 below shows a details composition of Kenya's ranking and score. Kenya performs particularly well in access to credit and protecting minority investors, while starting a business, getting construction permits, registering property and trading across borders remain particular pain points.

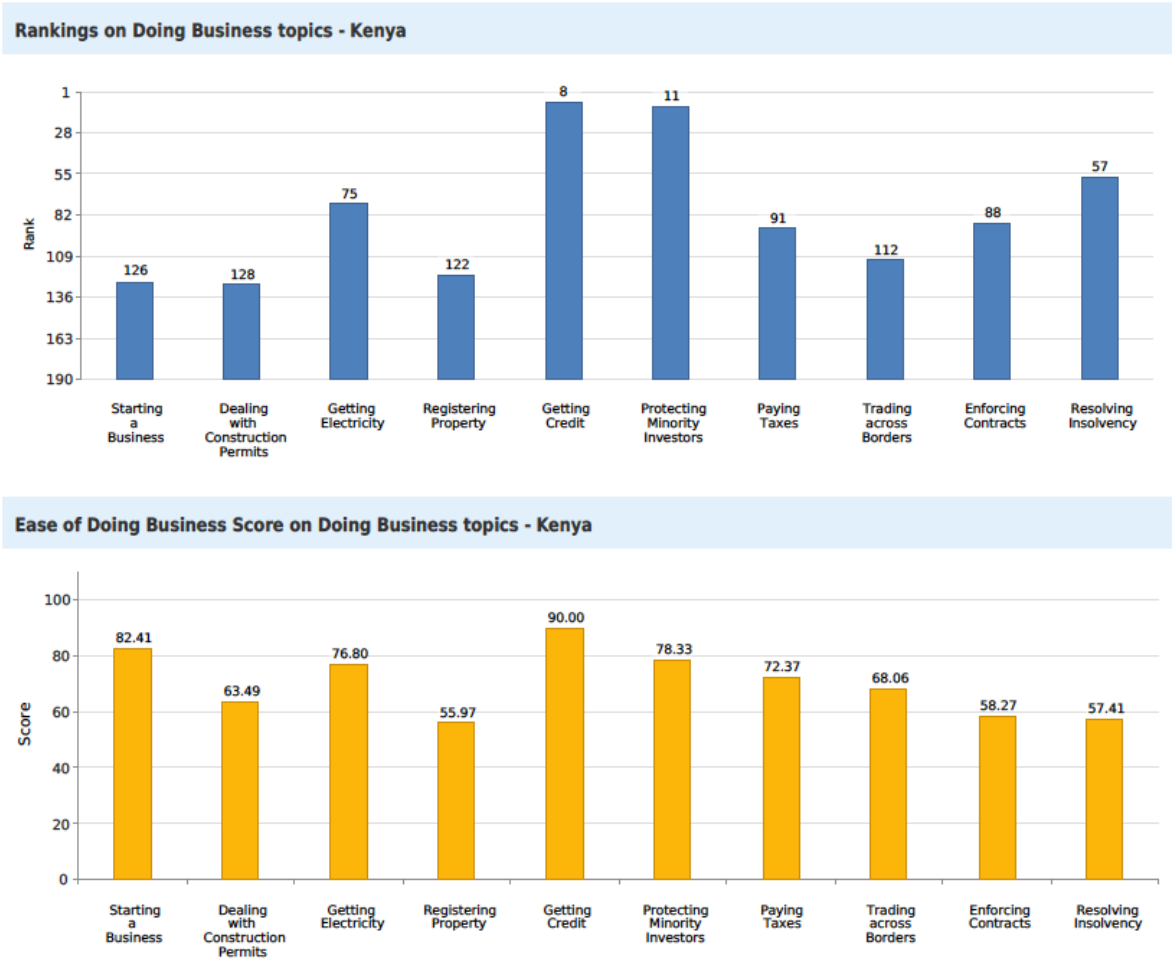

Figure 4.3: Ease of Doing Business Indicators for Kenya, 2019. Source: World Bank (2019b).

Kenya's foundational institutions paint a mixed picture. In certain respects, the country does well, while in others it faces significant challenges and much of its future evolution will depend on the government's ability to tackle corruption and improve its bureaucratic apparatus.

4.2.2 I-Cap and E-Cap

Kenya, and Nairobi in particular, enjoy a stronger reputation in the global arena when it comes to innovation driven ecosystems. Digital entrepreneurship around mobile technologies has grown dramatically in Kenya over the last decade, leading many to believe that Nairobi in particular is poised to become a major digital entrepreneurship hub with global renown. To better understand Nairobi and Kenya's potential, this section will look at current I-Cap and E-Cap in relation to human capital, funding, infrastructure, demand, and culture & incentives.

Kenya was ranked 93rd out of 140 in the 2018 Global Competitiveness Index (GCI) produced by the World Economic Forum (WEF). Figure 4.4 below summarizes Kenya's score in the index's 12 pillars, which was mostly above the average for sub-Saharan Africa, with the innovation ecosystem measured in terms of business dynamism and innovation capability emerging as the country's stronger areas, along with its labor market. Of note, despite ranking 113th in ICT adoption, Kenya enjoys a very strong reputation in the ICT domain for its strength in developing and deploying mobile technologies.

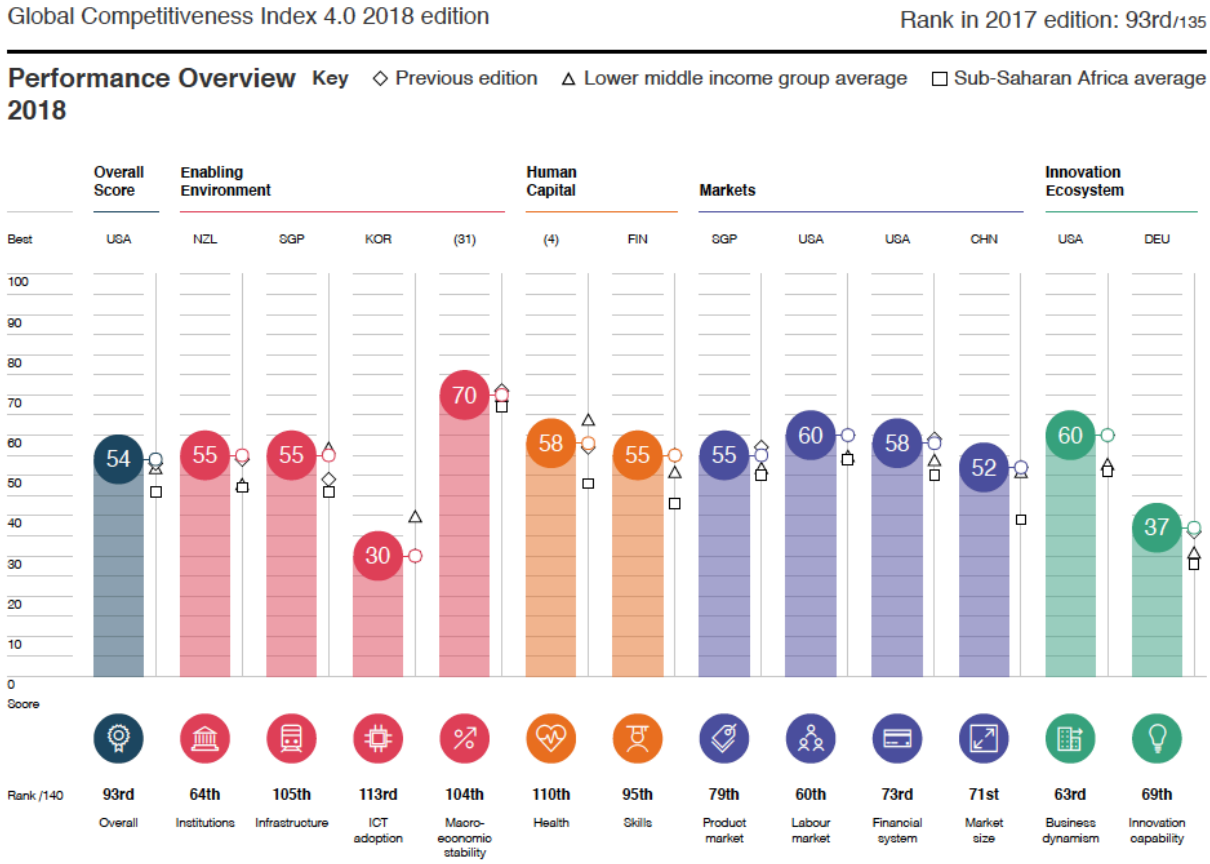

Figure 4.4: Kenya's Global Competitiveness Index in 2018.
Source: World Economic Forum, 2018.

In terms of **human capacity** inputs Kenya is ranked 95th for skills overall, but it ranks particularly high in ease of finding skilled employees (21st), digital skills among the population (43rd), and quality of vocational training (57th). Kenya's educational system is ranked 28th globally, and its spending on education is approximately 5.3 percent of its GDP, ranking it 39th globally. The country's tertiary enrollment is very low at 4 percent and the proportion of graduates in science and engineering is not known.

In terms of **funding** inputs, Kenya invested 0.8 percent of its GDP in research and development in 2018 (Global Innovation Index GII), more than doubling its investment from 2007 when it was 0.23 percent. Access to credit is particularly strong in Kenya,

where the country is ranked 22nd, and domestic credit to the private sector is 32.9 percent of GDP (GII, 2018).

In terms of **infrastructure** inputs, Kenya was ranked 103rd for ICT access and 107th for ICT use (GII), and only 16.6 percent of the population are internet users (GCI), with a broadband of 69 kB/s per user, ranking Kenya 58th globally (GCI). Kenya's general infrastructure ranks 74th, with a very weak electricity output per capita of 209.6 kWh per capita, ranking it 112th, but a strong logistics performance placing Kenya in 41st position (Logistics Performance Index).

In terms of **demand** inputs, Kenya ranks very strongly in innovation linkages in 9th place, 31st in university/industry research collaboration (GII), 19th in government procurement of advanced technology products (GCI), while in trade, competition and market scale Kenya is ranked 94th globally (GII)

Finally, in terms of Kenya's **culture and incentives**, the quality of scientific research institutions is ranked 66th globally (GCI), 52nd in scientific publications, and 225 researchers per million citizens (GII). The number of science and engineering graduates in Kenya is not known.

On its I-Cap and E-Cap indicators, Kenya appears to be ahead of many other African countries, including Ghana. During the Cold War, Kenya was one of the few countries in the region to maintain strong ties to the West, thus the country favored a market economy and free enterprise, developing an institutional arrangement likely more conducive to build I-Cap and E-Cap.

4.2.3 Comparative Advantage

Kenya has East Africa's most dynamic economy and while it is not as urbanized as many others African countries it does have a better educated population than many of its neighbors, with more technically trained talent than others. Its geographic location, acting as a gateway to the Indian Ocean trading routes for many of its landlocked neighbors gives Kenya a comparative advantage based on geography, and as the region pursues greater economic integration the market for Kenyan goods is poised to grow significantly. With its primacy already established in mobile financial services, Kenya does already enjoy a regional comparative advantage in the digital economy. While issues related to governance, security, political stability, and corruption may dampen the pace of Kenya's transformation, it is likely that Kenya and Nairobi in particular will continue to grow as a regional knowledge-based hub.

4.2.4 Strategy & Impact

While Kenya and Nairobi's innovation driven ecosystem enjoy a particular position of regional strength, it has yet to develop a clear strategy among its many stakeholders to achieve sustainability. Nairobi's iEcosystem still relies heavily on donor funding, supporting projects and initiatives that often prioritize social impact over business sustainability. The government is not yet acting as a coordinating entity among the iEcosystem's stakeholders and universities are highly politicized and are struggling to meet private-sector expectations. Yet Nairobi's ecosystem has been able to achieve a remarkable impact, particularly through the introduction of mobile financial services in 2007, propelling Kenya as a global leader in this sector. What follows is a closer look at Nairobi's iEcosystem stakeholders.

4.3 Nairobi's iEcosystem Stakeholders

Nairobi is arguably home to sub-Saharan Africa's most well-known innovation driven ecosystem with a rich offering of support programs for aspiring innovators and entrepreneurs and established hubs and co-working spaces throughout the city catering to different focus areas, from software to hardware. Cafes in neighborhoods like Kilimani and Kileleshwa are packed with young Kenyan and expatriate entrepreneurs working on their startups and negotiating deals. Opportunities to network and explore Nairobi's innovation ecosystem abound, with public events at many of the startup hubs, universities, and companies throughout the city.

4.3.1 Entrepreneurs and Enablers

Nairobi has a strong network of startup enablers. The city's most renowned hub is iHub[22], Nairobi's first innovation hub founded in 2010 as a space to provide an enabling environment for technologists, investors, entrepreneurs, designers, researchers and programmers. Today iHub has partnerships with major corporations like Facebook, Google, Microsoft, Oracle, and Safaricom (one of East Africa's most profitable companies). Other hubs are NaiLab[23] and Metta[24] which also focus on providing an enabling environment for digital innovators, as well as Gearbox[25] which focuses on supporting hardware entrepreneurs with a state-of-the-art makerspace. In addition to these hubs there are also numerous other centers and initiatives aimed at supporting innovators, including numerous FabLabs[26] and non-profits that run innovation competitions for young entrepreneurs like Global Minimum[27].

[22] https://ihub.co.ke/
[23] http://nailab.co.ke/
[24] https://www.metta.co/#home
[25] http://www.gearbox.co.ke/
[26] https://www.fablabs.io/labs/fablabnairobi
[27] http://gmin.org/

Ushahidi[28] is one of the most renowned organizations born out of Nairobi's innovation ecosystem. Founded in 2008, Ushahidi is a social enterprise that was "developed to map reports of violence in Kenya after the post-election violence and help marginalized people raise their voice and those who serve them to listen and respond better" and has since grown to over 120,000 deployments in over 160 countries. Many of Ushahidi's founders also played an important role in rise of Nairobi's ecosystem. BRCK[29] is one of Ushahidis's spin offs, now a successful technology company producing both hardware and software products for connectivity. Other notable success stories include "Wananchi Online[30], a leading Kenyan Internet service provider has become East Africa's leading cable, broadband and IP (Internet-based) phone company, and is currently valued at over $100 million; additionally, Craft Silicon[31], a Kenyan software firm that provides core banking, microfinance, mobile, switch solutions software and electronic payments services for over 200 institutional clients in 40 countries has a $50 million market value" (Digital Entrepreneurship in Kenya 2014 Report), and Sanergy[32], a Nairobi based company which builds and scales viable sanitation infrastructure in informal settlements and converts human waste into biogas. Today, Nairobi is home to over 200 startups mostly concentrated around digital and mobile technologies and while some have successfully managed to raise multiple rounds of capital both locally as well as internationally (for example, Pesapal[33], Ongair[34], and Africa's Talking[35]), many still struggle to do so, and numerous aspiring entrepreneurs survive by participating in startup competitions and seeking small grants and subsidies.

4.3.2 Risk Capital

Nairobi's risk capital resources have grown in parallel with the supply of high-quality entrepreneurship. As Nairobi's startup scene grew, the demand for investors grew with it making Nairobi the region's most advanced in terms of funding availability. However, numerous issues still remain to be addressed. For example, there are few investors working at very early stages, with most capital spread across later stages for ventures that have been able to build a track record (Digital Entrepreneurship in Kenya, 2014). A large presence of NGOs disbursing donor funds contribute to the availability of capital largely in the form of grants and loans, but they favor investments towards social innovation projects which often develop innovations that perform well in terms of addressing social challenges, but struggle to become financially sustainable and thus remain dependent on donor funding. From the perspective of investors, business plans are often perceived as poorly developed and entrepreneurs need considerable business support after a deal is struck, leading to heavy post-investment involvement from fund

[28] https://www.ushahidi.com/
[29] https://www.brck.com/
[30] http://wananchi.com/
[31] https://www.craftsilicon.com/
[32] http://www.sanergy.com/
[33] https://www.pesapal.com/
[34] https://ongair.im/
[35] https://africastalking.com/

managers, leading them to play roles that go beyond what they might typically do in more mature ecosystems (Gugu and Mworia, 2017). A PE fund manager reports that his portfolio managers "have to talk to at least 100 to 200 companies in this market at this stage to be able to end up investing in maybe three to four," while also noting that "there are a lot of people who want to invest and we just got money from pension schemes in Kenya for the first time, showing a growing interest in PE and VC" (Makatiani, 2018). Nairobi's investors tend to favor companies with foreign co-founders, an issue that emerged in numerous conversations and confirmed by a VC manager (Crawford, 2018), who stated "we did a study that found 90 percent of VC backed companies in SSA have at least one foreign co-founder", an issue that her fund is addressing proactively, with a portfolio of investments featuring 40 percent of businesses founded by women and 40 percent either by members of the diaspora or founders with African origins. Foreign co-founders are perceived to have better entrepreneurial capacity.

According to a VC4Africa report in 2015, "total invested capital in tech start-up across Africa more than doubled in 2015 to $26.9 million from $12 million in 2014. The average capital secured per venture increased from $129,348 to $205,374 over the same period. The source of risk capital in Kenya is in large part international, while local capital is not yet investing significantly in Nairobi's tech scene. Local corporations, particularly in ICT, are thought to have great potential to enter the funding scene as suppliers of funds or by setting up in-house investment arms.

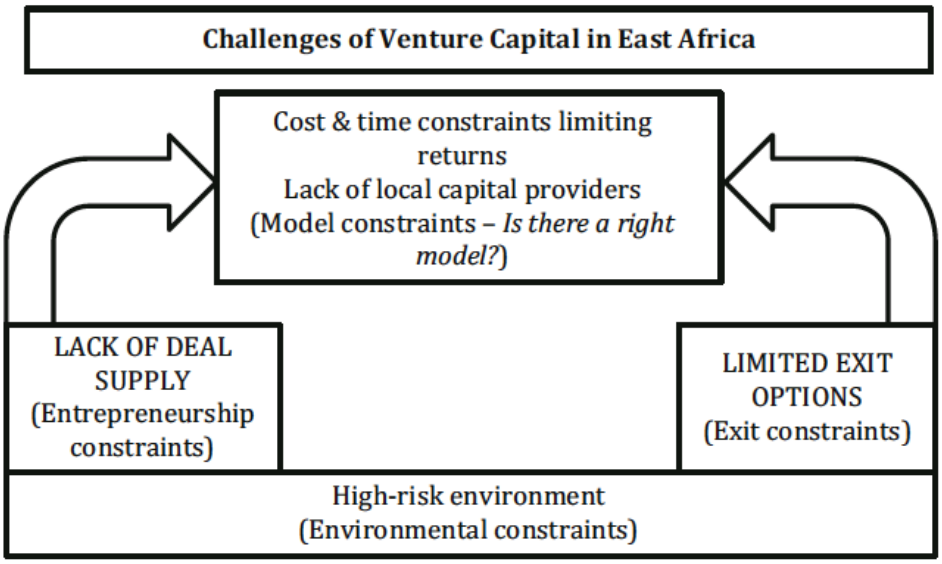

Figure 4.5: Challenges of Venture Capital in East Africa.
Source: Gugu and Mwoira, 2017

Figure 4.5 above summarizes the current VC dilemma in East Africa: "on the one hand, there is a limited supply of high value deals and, on the other hand, a challenging exit environment. Compounding this dilemma are the issues of time, cost, and lack of local capital providers for VC investing" (Gugu and Mwoira, 2017). Lastly, a challenge that

emerged in numerous conversations with Kenyan entrepreneurs revolves around investor's tendency to favor ventures with expatriates among their founders who often have experience from more mature iEcosystems and are better prepared to woo investors. This suggest that building further capabilities in E-Cap to better prepare and train entrepreneurs on the business side is needed.

4.3.3 Corporate

Nairobi's corporate sector plays a key role in its iEcosystem. Corporations like Safaricom[36], one of East Africa's most profitable companies, which spun out M-Pesa, Kenya's mobile payment system which is now ubiquitous, play an important role in creating an enabling environment by running challenges and competitions for aspiring entrepreneurs, by collaborating with universities, and most importantly by training technical talent with on-the-job training. Nairobi is also home to numerous international technology companies like IBM, Microsoft, Intel, Google, Cisco, Huawei, and Qualcomm who significantly contribute to the ecosystem's I-Cap and collaborate extensively with other stakeholders by funding some of the hubs and partnering with universities and government on specific projects. The presence of these international technology companies is of particular importance as it sends a distinct message to global stakeholders as to the potential and opportunities for developing and deploying technology solutions in a new context. As a consequence, it contributes to making a destination more attractive for other stakeholders as well. Attracting international capital for example is easier with the presence of globally renowned technology organizations, who implicitly can act as "validators" of an iEcosystem.

4.3.4 Government

Kenya's government receives mixed reviews from various stakeholders. On one hand, the government was instrumental in developing the infrastructure upon which Kenya's digital transformation is being built, particularly in terms of installing under water cables to provide broadband internet access. On the other hand, the government faces significant challenges with corruption as well as with legacy laws that are decades old and make life difficult for new companies. Coordination at the government appears to be difficult as well, with numerous ministries involved in policy making sometimes in competition among them.

In 2018 the Kenyan Ministry of Industry, Trade and Cooperatives announced the launch of the "Kenya Industry and Entrepreneurship Project" in collaboration with the World Bank. A $50 million project "to increase innovation and productivity in select private sector firms" by strengthening the innovation and entrepreneurship ecosystem and increasing firm-level productivity. On the ecosystem front, the program will support hubs, accelerators, incubators, and technology bootcamps "by engendering stronger

[36] https://www.safaricom.co.ke/

competition among them" and by fostering connections to international networks and local industries. It also aims to create linkages to SMEs to "strengthen their productivity and internal capabilities for innovation" (The Kenya Industry and Entrepreneurship Project, 2018).

Lastly, the Kenyan government is leading the development of Konza Technology City[37], a startup city 64 km outside of Nairobi acting as Kenya's technology hub and a place for the country to grow its technology industry. Konza is a $14 billion bet, and the governments aims the city to have 200,000 inhabitants working in business outsourcing in the next two decades.

4.3.5 Universities

Kenyan universities, similarly to its government, do not enjoy a high standing among the other ecosystem stakeholders. According to one of Nairobi's most well-known entrepreneurs, "graduates fresh out of university are, in general, not prepared to work in a technology company. They are not coming out of these institutions with the necessary skills. The people who do are usually the ones that are self-taught. That is quite disappointing. The universities in Kenya are too bureaucratic and not teaching the right stuff in the classes. Not across the board, but generally, students still learn the same computer languages that they were being taught eight years ago, even though current technology has changed" (Hersman, 2017). This view emerged in numerous conversations with other stakeholders; including an administrator at one of Kenya's leading ICT companies who stated that "a lot of projects that come out of universities have a very strong social focus, which is a terrible idea for your first business, which should prove that you can make money with your product," stressing how "trying to solve complex societal problems" is not an ideal place to start an entrepreneurial journey (Bhattacharya, 2018).

Universities like Jomo Kenyatta University of Agriculture and Technology, which was founded in 1994 and whose vision is to be a "university of global excellence in training, research, innovation and entrepreneurship for development", are actively working on product development and commercialization and pursuing partnerships with the private sector; others like the University of Nairobi opened Fab Labs and other makerspaces to encourage student innovators in fields such as health, yet the general feedback among stakeholders is that broader reforms are needed to transform public universities, remove bureaucratic hurdles, end political appointments to universities, and upgrade curricula.

Private universities like Strathmore University on the other hand enjoy a much stronger reputation among other stakeholders. Strathmore University runs the @iLabAfrica, an ICT innovation center that pursues research, supports student innovators, and works closely with government, industry and other funding agencies. The university's students are

[37] https://www.konzacity.go.ke/the-vision/

considered among the best prepared for careers in entrepreneurship related to ICT (as well as accounting).

4.4 Conclusion

Nairobi is one of the African continent's most dynamic and developed innovation driven ecosystems, but there is a sense that under the current circumstances its continued growth potential may be limited. The government and universities are considered the weak links by many of Nairobi's stakeholders, yet they play key roles in fostering an enabling environment so it is likely that Nairobi's future success will depend on the ability of the government to both improve regulations related to the ease of doing business and starting new companies as well as tackling endemic corruption. Universities on the other hand are in dire need to upgrade their curricula and reform their bureaucratic and overly politicized structures. Making it easier to start companies and growing the talent pool will lead to more entrepreneurial activity and success stories, easing some of the pressure on risk capital providers and likely attracting more local investors, who are currently betting on safer markets such as real estate. Corporations could play an even greater role by providing risk capital and investing in human capital through talent academies and collaborations with tertiary education institutions.

Chapter 5 – Freetown, Sierra Leone's iEcosystem Assessment

5.1 Introduction to Sierra Leone

Sierra Leone is a West African country of 7.5 million people. Facing the Atlantic Ocean, Sierra Leone shares a border with Liberia to the south-east, Guinea to the north and north-west, and the Atlantic Ocean to the south-west. An ethnically diverse population divided in 16 groups, Sierra Leone is a majority Muslim country, with 78 percent of the population practicing Islam, and 21 percent Christians. Sierra Leone enjoys remarkable religious tolerance with religious violence being extremely rare and Muslim and Christians interacting very peacefully. Sierra Leone too was a former British colony that gained independence from the United Kingdom in 1971. Today Sierra Leone is a unitary presidential constitutional republic governed by President Julius Maada Bio.

Sierra Leone's recent history has been tumultuous, with a decade long civil war coming to an end in 2002. On its road to recovery, the country has been hit by the Ebola crisis which struck the country in 2014 and forced it to declare a state of emergency. The country was declared Ebola free in 2016 and its capital Freetown was hit by several mudslides in August 2017 during the country's rainy season causing over one thousand casualties and displacing at least three thousand Freetonians. In 2018, Sierra Leone held its first elections without international observers and the country underwent a relatively peaceful transition of power after the opposition candidate Julius Maada Bio had been declared the winner of the elections.

Sierra Leone's new government is on a mission to transform the country by strengthening its institutions and the rule of law and by investing heavily in human capital by providing free quality education to all its citizens. The country's economy is still in recovery mode from the Ebola crisis, which caused its GDP to sink by 20 percent in 2015. The road ahead for one of the world's poorest countries to transform itself is arduous at best.

Sierra Leone's economy is highly dependent on its natural resource extraction, with diamond mining among its main exports. Other natural resources found in Sierra Leone are titanium, bauxite, gold, and rutile, while the majority of the population are engaged in subsistence agriculture. Figures 5.1 and 5.2 below show a snapshot of Sierra Leone's exports in 2017 and 2010 respectively (Observatory of Economic Complexity OEC), laying bare the country's dependence on natural resources, agricultural goods, and other low-value added sectors.

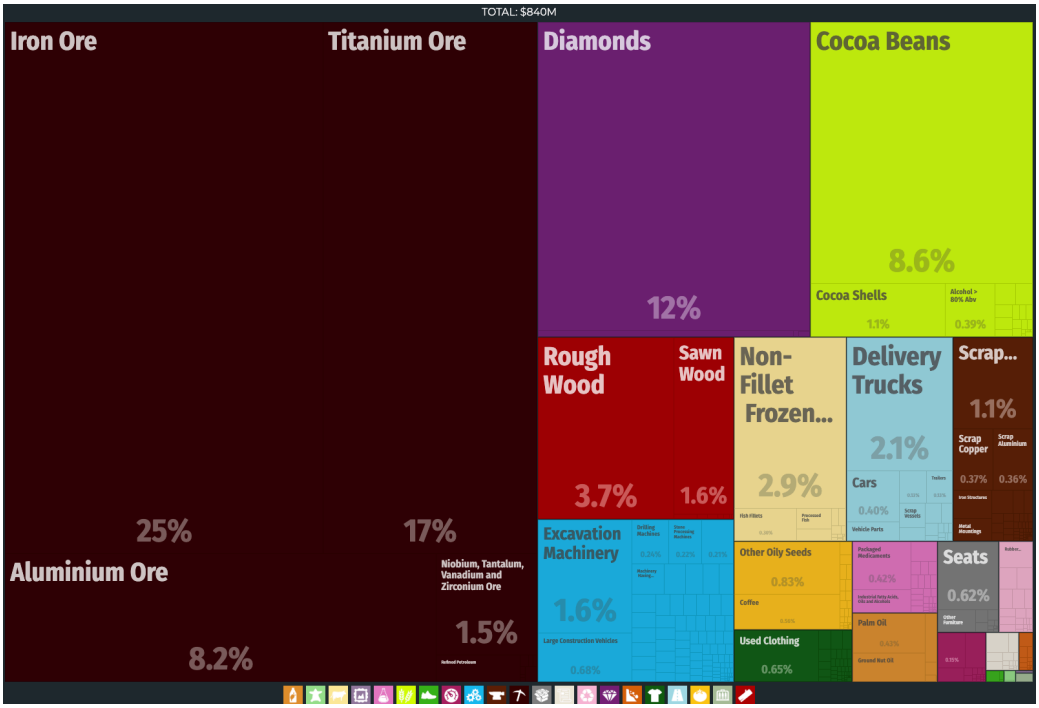

Figure 5.1: Sierra Leone's Exports in 2017.
Source: MIT Observatory of Economic Complexity

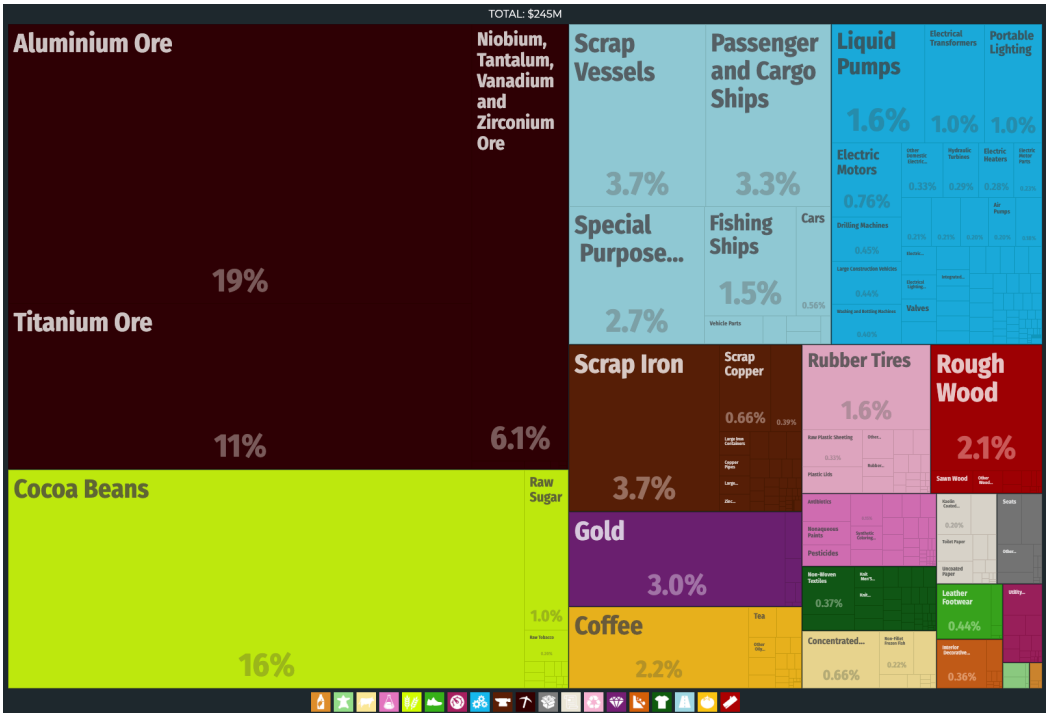

Figure 5.2: Sierra Leone's Exports in 2010.
Source: MIT Observatory of Economic Complexity

Sierra Leone's GDP per capita in 1960 was $140 and in 2017 it rose to only $499 ($1,530 at PPP), leaving Sierra Leone among the world's poorest countries, with more than half

its population living below the poverty line. During that same time, Sierra Leone's population grew from 2.3 million to 7.5 million citizens, experiencing a slower demographic growth rate than others like Ghana and Kenya. Official development assistance (ODA) and official aid have played and continue to play a significant role in the country's economy, with aid dependency presenting a real challenge. Table 5.1 below captures some of the statistics from 1960 to 2017.

Sierra Leone	1960	1990	2000	2010	2017
GDP per capita (current US$)	$140	$151	$139	$399	$499
GDP per capita (PPP $)	NA	$808	$723	$1,175	$1,530
GDP growth (annual %)	1.8	3.3	6.7	5.3	4.2
Population	2,297,110	4,312,246	4,564,297	6,458,720	7,557,212
Net ODA + aid received (current US$)	$6.7M	$59.3M	$180.6M	$458.3M	$537.6M

Table 5.1: GDP per capita, GDP annual growth, population, official development aid and official aid received. Source: World Bank Data, 2017.

Table 5.2 below captures some of Sierra Leone's economic, social, and infrastructure transformation over the last 15 years. The country's slow economic growth and high poverty incidence resulted in very high rates of official development assistance (ODA) as a percentage of gross national income, leaving ODA relatively stable at 21 percent of GNI in the last 15 years, making Sierra Leone heavily dependent on ODA. Agriculture's share of gross value added (GVA) increased from 51 percent in 2005 to 60 percent in 2018, while employment in agriculture slightly decreased from 66 percent to 60 percent. Industry's share of GVA halved from 11.6 to 5.8 percent, with employment in industry remaining constant at approximately 6 percent. Lastly, the GVA share of services remained relatively constant, with a slight reduction from 37 to 34 percent, even though employment in services went up by 6 percent in the same timeframe from 28 to 34 percent. The country's exports grew from $154M to $324M, and the country loses significant revenues due to the sale of many of its diamonds and precious metals on the black market. In the last 15 years many of Sierra Leone's citizens moved from rural to urban areas, with the urban population growing from 37 percent to 42 percent and cities absorbing many citizens in their informal settlements and in the informal labor market. Lastly, Sierra Leone internet users rose at a much slower pace than many other countries and to this date technologies like mobile money which are largely adopted in other countries are not yet employed by a majority of the population.

Sierra Leone	2005	2010	2018
Net Official Development Assist. received (% of GNI)	21.38	17.33	21.11
Economy: Agriculture (% of Gross Value Added)	51	55.2	59.9
Economy: Industry (% of Gross Value Added)	11.6	8.1	5.8
Economy: Services and other activity (% of GVA)	37.4	36.7	34.3
Employment in agriculture (% of employed)	65.9	63.7	59.8
Employment in industry (% of employed)	6.1	6.4	6.2
Employment in services (% of employed)	28	29.9	34
Unemployment rate (% of labor force)	3.6	4.3	4.4
International trade: exports (million current US$)	$154	$319	$324
Education: Government expenditure (% of GDP)	2.8	2.6	2.9
Urban population (% of total population)	36.9	38.9	42.1
Individuals using the Internet (per 100 inhabitants)	0.2	0.6	11.8

Table 5.2: Economic, Social, and Infrastructure Indicators for Ghana. Source: United Nations Data, 2018.

While other countries have undergone significant transformation, Sierra Leone has largely stayed behind, held back by its civil war, the Ebola crisis, and other structural and infrastructural challenges. However, upon visiting Freetown now one cannot but get the feeling of a country on the rise, with a sense of possibilities that was not present before. Numerous Sierra Leoneans are either returning to the country from extended stays abroad, some are even visiting for the first time, and many are eager to play a part in the transformation of the country, suggesting that the diaspora could play a substantial catalytic role in the early stages of the country's transformation. At the same time, the government has undertaken some steps towards transformation that are auspicious; key among these is the creation of the Directorate for Science, Technology and Innovation (DSTI), led by MIT and Harvard alum David Sengeh (formerly at IBM in Nairobi) who now serves as the country's first Chief Innovation Officer, whose vision is to "use science, technology and innovation to support the Government of Sierra Leone to deliver on its national development plan effectively and efficiently; and to help transform Sierra Leone into an innovation and entrepreneurship hub." What follows is a look at the foundation from which Sierra Leone's innovation driven ecosystem is starting its transformation.

5.2 Sierra Leone and Freetown's iEcosystem

Sierra Leone's innovation driven ecosystem is in its embryonic phase, based largely in Freetown, the country's capital and largest city, and home to approximately 1 million people. What follows is a closer look at Sierra Leone's current situation and where Freetown's iEcosystem currently stands.

5.2.1 Foundational Institutions

Sierra Leone is very much in country building mode. It is on a mission to rebuild its education system and provide free and quality education to all its young citizens, and it is on a mission to strengthen its institutions and the rule of law, and to find a new way to work with its many international donors that is aligned with the country's aspirations. Below is a look what the road ahead may hold.

The 2019 economic freedom report by the Heritage Foundation ranks Sierra Leone as the world 167th freest economy in the world with a score of 47.5, noting that "its overall score has decreased by 4.3 points, with a steep plunge in fiscal health and lower scores for labor freedom, monetary freedom, and business freedom." Among the country's economic freedom challenges, the report stresses "a restrictive regulatory environment, inadequate infrastructure, and weak enforcement of contracts. Protection of property rights is nearly nonexistent. The financial system remains in post–civil war recovery mode and lacks capacity. The government has taken some steps to improve the legal framework, tax administration, and public debt management to address pervasive corruption" (Heritage Foundation, Sierra Leone Economic Freedom, 2019).

Transparency International's corruption perception index ranked Sierra Leone 129th out of 180 in 2018, with a score of 30/100, ranking it among the continent's most corrupt countries. On the 2019 World Bank's Doing Business Indicator Sierra Leone was ranked 163rd out of 190 with a score of 48.74/100. Figure 5.3 below shows a detailed view of Sierra Leone's score and ranking in each category analyzed. While starting a business is relatively easy in Sierra Leone, dealing with construction permits, getting access to electricity, registering property, getting credit, trading across borders, and resolving insolvency remain significant burdens with the country ranked in the world's bottom 30 in each of those.

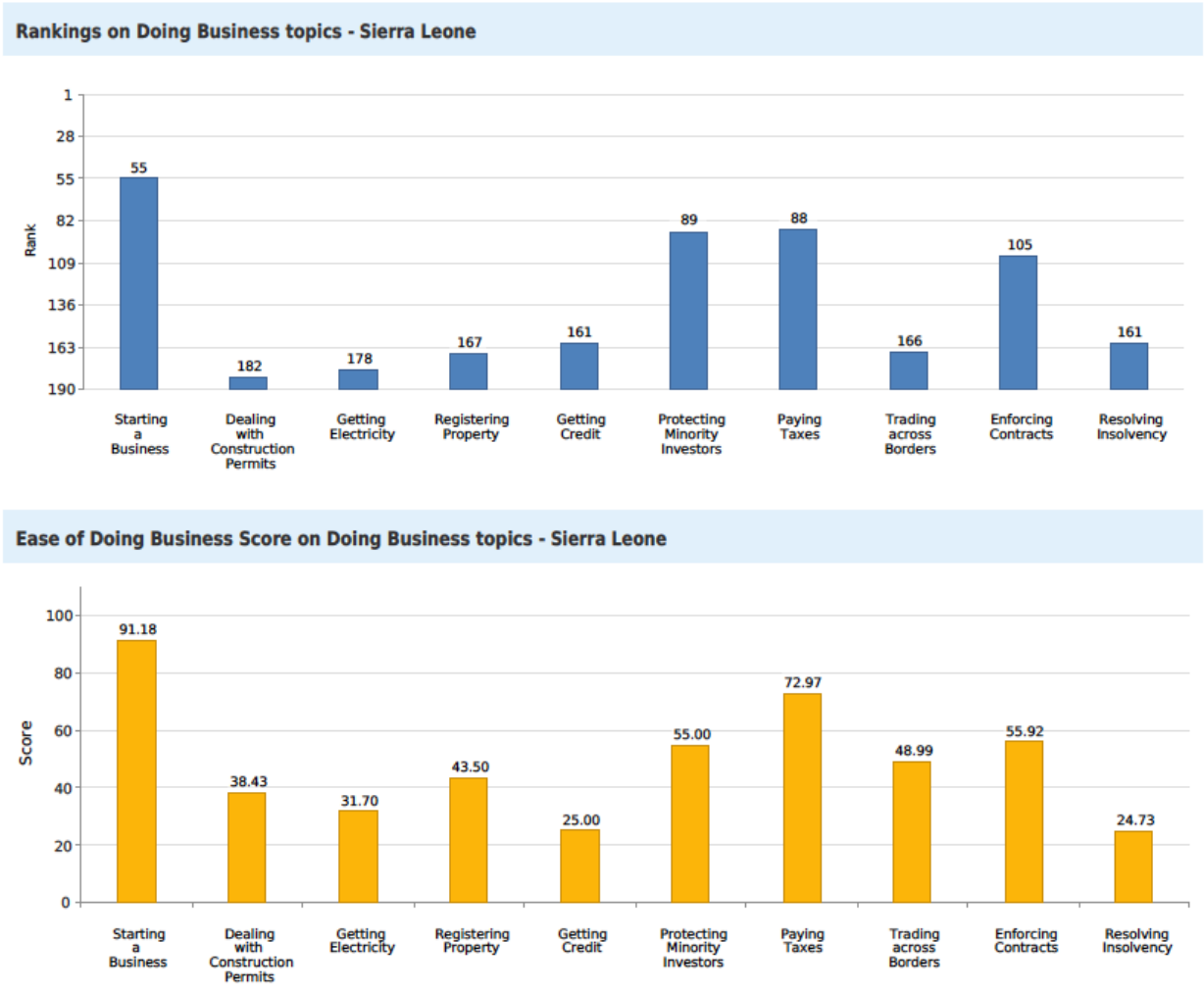

Figure 5.3: Ease of Doing Business Indicators for Sierra Leone, 2019. Source: World Bank (2019c).

Sierra Leone's starting position when it comes to its foundational institutions is very challenging. Significant aspects of the country's operating system need to be rewritten, both from a legal and policy perspective, but also from the point of view of its social norms.

5.2.2 I-Cap and E-Cap

Few people if any would look to Freetown or Sierra Leone as a place with high I-Cap and E-Cap. Below is a look at Sierra Leone's Innovation Capacity and Entrepreneurship Capacity in terms of inputs in human capital, funding, infrastructure, demand, and culture & incentives – unfortunately data is not as readily available as in the case of Ghana and Kenya.

Sierra Leone was ranked 134th out of 140 in the 2018 Global Competitiveness Index produced by the World Economic Forum. Figure 5.4 below details the country's score in its 12 categories. Sierra Leone is ranked below the average for sub-Saharan Africa in

most indicators, its highest placement in 106th position for its institutions, while its financial system is ranked lowest in 136th place.

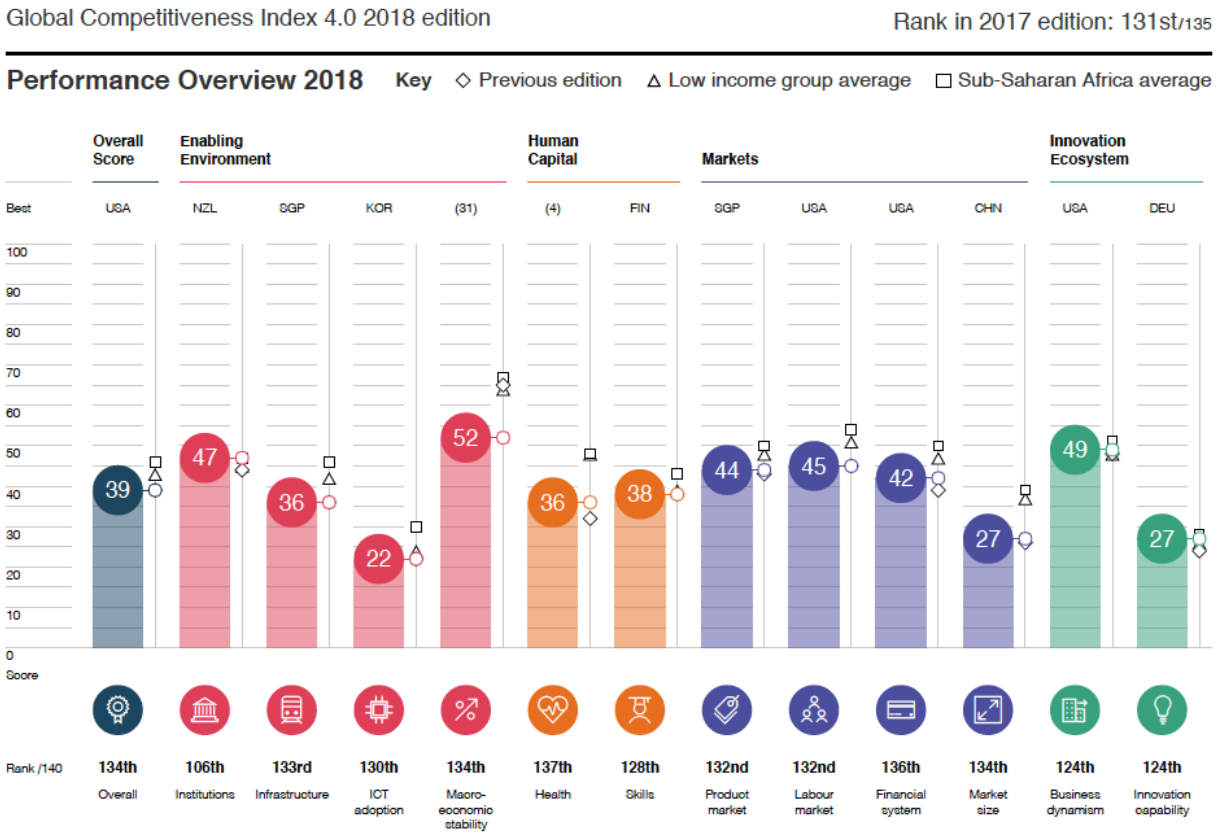

Figure 5.4: Sierra Leone's Global Competitiveness Index in 2018. Source: World Economic Forum, 2018.

In terms of **human capital** inputs Sierra Leone is ranked 128th for skills overall, performing at a similar level in many of the sub-indicators such as, with similar rankings in sub-categories such as the extent of staff training, quality of vocational training, and skillset of graduates (GCI). Sierra Leone invests about 3 percent of its GDP in education, a figure likely to increase with the new administration's priority on free quality education for all, while the quality of its education system was ranked 99th in 2017 (GCI).

In terms of **funding** inputs there is no data on Sierra Leone's investment in research and development, but the country's financial system is very weak, with a very low ranking in the availability of financial services (123rd), affordability of financial services (118th), ease of access to loans (128th), venture capital availability (111th). It is safe to assume that funding inputs are very hard to come by throughout the country.

In terms of **infrastructure** inputs, Sierra Leone was ranked 130th for ICT adoption, although mobile penetration is relatively high at 85%, while approximately 12 percent of the population are internet users (GCI). Internet bandwidth is very low, although no exact

data is available and only about 20 percent of the population have access to electricity, although black outs are frequent and the grid is very unreliable.

In terms of **demand** inputs, Sierra Leone lags far behind as well: 124th in capacity for innovation, 99th in multi-stakeholder collaboration, 131st in scientific publications, and 101st in patent applications.

Finally, in terms of **culture and incentives**, Sierra Leone is ranked 112th in quality of scientific research institutions, and no data is available on the number of graduates in science and engineering as well as on the number of researchers in the country.

Sierra Leone's I-Cap and E-Cap arguable are among the world's lowest. While entrepreneurship plays a big part in the daily life of many, particularly in the informal sector, few have received any formal business training. The country's infrastructure makes developing I-Cap and E-Cap very difficult as well, with access to electricity presenting one of the main obstacles. That being said, Sierra Leone does not lack talent, but rather opportunity. As the country finds new ways to create opportunities for its citizens it is possible that it will experience rapid growth in I-Cap and E-Cap for some time.

5.2.3 Comparative Advantage

It is hard to pinpoint what Sierra Leone's comparative advantage may be beyond natural resources. However, its natural riches, diamonds in particular, have failed to significantly contribute to the country's ability to raise revenues, although efforts are currently underway to reform how Sierra Leone sells its diamonds in a more transparent way that ensures significant tax revenues are invested in the communities where the diamonds were found[38]. The majority of the country lives in informality and subsistence farming is the main source of livelihood for the majority of Sierra Leoneans, so it is hard to see a comparative advantage in the primary sector either.

Freetown is home to one of the world's largest natural deep-water harbors in the world, and the city's harbor could be further built out towards establishing a logistics cluster for the region, but there are no such plans currently. Finally, in pure speculation, Sierra Leone may be able to claim its comparative advantage on its narrative; the narrative of transformation of a country whose history may be at a turning point and whose future for the first time appears to be more in its own hands. Sierra Leone may position itself as a small laboratory-nation open to innovative and novel approaches on its path do develop and improve the lives of its citizens (potentially like Estonia). The country's relatively small size and population, as well as the government's apparent willingness to provide an enabling environment to those who may wish to collaborate and find new avenues towards a better future, may entice others to invest in Sierra Leone.

[38] https://www.bloomberg.com/news/features/2018-12-18/the-peace-diamond-could-transform-sierra-leone-s-mining-trade

5.2.4 Strategy & Impact

Sierra Leone's government is poised to take a central role in transforming the country's innovation driven ecosystem. President Bio, in his opening address in May 2018, stated "science and technology is the bedrock for the development of any modern economy. My Government is setting up a Directorate for Science, Technology and Innovation to develop a framework for scientific research. Initially, this Directorate will be midwifed in the Office of the President but shall work closely with the Ministry of Technical and Higher Education." The Directorate for Science, Technology and Innovation (DSTI) aims to be at the center of the country's transformation by working on innovating both within government, but also by strengthening the country's ecosystem by "supporting a culture of innovation and entrepreneurship through targeted initiatives, investments, and incentives for individuals, startups, and industry" (DSTI, 2018). Many of Freetown's stakeholders stated that the city had been waiting for a champion of innovation to support their ongoing efforts and engender a feeling of community and collective action towards a future in which the country's economy transitions from an aid-dependence to market-independence. Time will tell if the government's strategy and DSTI's efforts pay dividend.

5.3 Freetown's iEcosystem Stakeholders

Freetown is home to an embryonic innovation driven ecosystem, very much in its early stages where. Young innovators and aspiring entrepreneurs are starting to congregate around hubs that provide an enabling environment with training, mentoring, and access to small amounts of seed capital. Universities are working to strengthen their entrepreneurial education by establishing dedicated innovation and entrepreneurship labs and initiatives. Some corporates, particularly in ICT, are eager to expand the talent pool and work with other stakeholders, while risk capital is still very scarce and available mostly from donor agencies, friends and family, and in some cases in the form of loans from local banks. Lastly, the government is starting to assume a leading role in coordinating and aligning stakeholders to set a common strategy to accelerate the country's iEcosystem. All of this is relatively new to Freetown and Sierra Leone; the country does not have a track record of fostering innovation driven enterprises and it is at risk of losing its brightest innovators to more advanced ecosystems such as Accra in Ghana or Lagos in Nigeria. What follows is a closer look at Freetown's stakeholders.

5.3.1 Entrepreneurs and Enablers

Freetown's technology entrepreneurship scene is nascent; Sensi Technology Hub[39] was the country's first innovation hub, established in 2014 during the Ebola crisis to develop mobile technology solutions to respond to the crisis. Sensi's work aims to "build a technology innovation community in Sierra Leone that will drive economic and social

[39] https://www.sensi-sl.org/

development through providing an open and stimulating community hub for young technologists and entrepreneurs to come together, develop their ideas and access cutting-edge tech, events, incubation programs and training. Sensi will unleash the untapped potential of young people interested in building businesses and making a difference in their careers." Sensi offers ICT training and business training and incubation to aspiring entrepreneurs, it also offers co-working space and ICT consultancy services for international organizations in Freetown. Most recently, Sensi started operating another hub in Freetown offering ICT training, as well as two hubs in shipping containers that "deliver tech and business education to young people in the provinces."

Innovations Axis[40] is Freetown's second and newest hub, launched in late 2018. Its mission is to "to enable and empower entrepreneurs to solve problems with potential for disruption, impact and scale." While Sensi Tech Hub works both with social innovators developing technology solutions that may not have a market as well as entrepreneurs, Innovations Axis works more like a traditional incubator and accelerator for the private sector, whose aim is to also work with the country's largest companies to create linkages between them and its entrepreneurs, as well as with universities, with an existing collaboration already in place with Limkokwing University of Creative Technologies[41]. Innovations Axis also runs Freetown Pitch Night[42], a monthly event where the city's innovators present their technology solutions in a networking event. Lastly, robotics NGO WeRobotics plans to establish the Sierra Leone Flying Labs in 2019 "to accelerate the positive impact of local aid, health, development and environmental projects by sustainably localizing appropriate robotics solutions" – in collaboration with the World Bank and Freetown City Council, one of the Flying Labs' first missions will be to produce updated maps of Freetown.

Freetown's aspiring technology entrepreneurs face significant challenges, from a legal and bureaucratic perspective entering a market can be difficult, particularly in the presence of established incumbents who may hold powerful relationships. Access to capital is also challenging, so it is often the case that talented entrepreneurs leave Freetown. This was the case for the founder of Track Your Build[43], an aerial intelligence startup whose founder relocated to Lagos, Nigeria to participate in a program run by Airbus. Other innovative companies based in Freetown are IDT Labs[44], "an ICT company with a focus on envisioning, designing and implementing technology solutions for development in West Africa. Since 2013, IDT Labs has been delivering customized ICT solutions for governments, organizations and businesses wanting to tackle social, developmental, and economic challenges" and Integems[45], a consulting firm that "aspires to integrate innovative Geographic Information Systems (GIS) and remote sensing technologies with geo-information, environmental management and research expertise

[40] https://www.innovationsaxis.com/
[41] https://www.limkokwing.net/sierra_leone/
[42] https://www.freetownpitchnight.com/
[43] http://trackyourbuild.com/
[44] https://idtlabs.xyz/
[45] http://www.integemsgroup.com/index.php

to effectively and efficiently respond to socio-economic, environmental and natural resource management challenges and opportunities." A common thread among innovative companies is to offer consulting services as a way to drive revenue, while in parallel they may develop in-house technology solutions.

Lastly, the country's many NGOs and international donor agencies are starting to invest in technology innovators to support them on their mission. According to UNDP, the country remains heavily dependent on aid, with about 50% of public investment programs financed by external resources." This means that the country's entrepreneurial ecosystem is developing with significant influence from the aid community, whose investments often tend to favor impact driven social innovation over market-based entrepreneurship.

5.3.2 Risk Capital

Because of its heavy reliance on official development assistance and aid, Sierra Leone's private sector is very weak and it is yet to develop a scene of investors willing to commit funds towards technology ventures. Cordaid, a humanitarian organization, runs a program to support high-growth SME ventures[46], where funding and training are provided to entrepreneurs, but not with a focus on science and technology entrepreneurship; and Ecobank[47], a pan-African bank, is known to provide loans to technology entrepreneurs. Village Capital[48], "a venture capital firm that finds, trains, and invests in early-stage ventures solving major global problems in agriculture, education, energy, financial inclusion, and health" is planning to enter Sierra Leone in 2019. The most readily available source of capital in Sierra Leone at present is donor funding, with the challenge that donor organizations have to disburse funding in alignment with their mission, and unless that mission is to strengthen the innovation driven ecosystem, the technology solutions often struggle to align business sustainability and profitability with social impact. Access to credit is still very difficult for entrepreneurs due to high interest rates, no credit ranking system, and a lack of staff trained to assess investment opportunities.

5.3.3 Corporate

The corporate sector, in particular the ICT sector, could play an important role in supporting Sierra Leone's nascent innovation driven ecosystem. Major telecom providers are Africell[49] (Lebanese owned) and Orange[50] (French owned). According to numerous stakeholders, Africell is now known to be investing to strengthen the telecommunications infrastructure. Orange conversely is said to invest significantly in its mobile infrastructure. While most of the country is connected via mobile phone, mobile money has yet to be largely adopted by the population, which still fears that network connectivity issues may

[46] https://www.cordaid.org/media/medialibrary/2015/03/SME-Ventures_2pgr.pd
[47] https://www.ecobank.com/
[48] https://vc4a.com/village-capital/
[49] http://www.africell.sl/
[50] http://www.orange.sl/

compromise the reliability of mobile money solutions. Among the telecommunications companies, Orange is most actively engaged with other stakeholders, with collaborations in the pipeline with the government's Directorate for Science, Technology and Innovation (DSTI) and a general openness to collaborate also with other stakeholders like universities to build the talent pipeline.

The business climate in Sierra Leone is a complicating factor for many corporate players (not only for entrepreneurs); the country's business sector is generally shock-prone leading to risk aversion when it comes to innovation and entrepreneurship. Afcom[51], one of the country's leading internet service providers for businesses (ISPs) is moving rapidly towards automation as a result of the many challenges it faces. The company went from 180 employees to approximately 40 in recent years because of a high tax rate, which led the workforce to prefer to be hired as contractors to pay lower taxes, and allowed many of them to also contract for competitors. Afcom's CEO reported that "at the end of the day you find yourself hiring an employee and for 12 months' salary you end up paying 19 to 20 months, so that's not sustainable, and the employee does not want to be salaried and pay 30 percent tax, they prefer to be independent consultants which are taxed less" (Suliman, 2018). As a result, Afcom decided to automate as much as it could and reduce its workforce, and while the company does work with some stakeholders like IDT Labs to develop digital payment solutions, it does not play an active role in the innovation ecosystem and maintains adversarial relations with the government.

Shankerdas & Sons[52] is the country's largest manufacturing company, with over 1000 employees and three divisions (industrial, commercial, and agricultural), the company produces many of the country's plastic household items, from PVC pipes to water storage tanks, to plastic bags, numerous soft and alcoholic beverages, furniture, and cosmetics. While no linkages to the innovation driven ecosystem have yet been established, Shankerdas is one of the country's corporate assets that could be activated. According to its owners "if we had sufficient electricity and were assured this, then our plant could grow from a 1,000 to a 3,000 strong workforce. The capacity and capability is there but the only constraint to progressing further is the electricity problem." This highlights the critical infrastructure challenges faced to further develop the private sector.

5.3.4 Government

Much of the optimism for Sierra Leone's innovation driven ecosystem results from the establishment of the Directorate for Science, Technology and Innovation (DSTI)[53] and recruiting Dr. David Sengeh, a prominent young technologist and innovator, as its Chief Innovation Officer. DSTI's identified 4 strategic pillars for its mandate from 2018 to 2023:

[51] http://www.afcom.sl/
[52] http://shankerdas.com/
[53] https://dsti.gov.sl/

- Data for decision-making to support governance through analytical methods and visualization tools
- Data systems and technology design to enable secure collaboration and cross-sector planning and collaboration within government
- Service delivery and citizen engagement to deploy solutions that address citizen needs and facilitate their engagement with government
- Ecosystem strengthening to support a culture of innovation and entrepreneurship through initiatives, investments, and incentives for individuals, startups, and industry

DSTI's mandate is very much one of collaboration, both within government as well as with the country's wider science, technology and innovation ecosystem. In terms of its institutional design, the decision to house DSTI at State House under the Office of the President may, may pay dividend in the long run. In Ghana and Kenya for example these efforts rest within ministries, which make collaboration and coordination with other ministries more complicated because of internal competition. Having presidential authority may legitimize DSTI in ways that may now work as well under other institutional arrangements. DSTI has a team of approximately 20 young technologists, lawyers, policy makers, designers, and creatives and very much feels like an innovation hub itself; something rare to find in a government office. With most of its staff having assumed their positions in the last 6 months the directorate is yet to build a track record, but memorandums of understanding have already been signed with local universities, other government agencies, UNICEF on the creation of a drone testing corridor in Sierra Leone, and the government of Estonia to foster e-Governance[54].

In addition to DSTI's efforts, the newly released Medium Term National Development Plan (MTNDP) for Sierra Leone includes numerous cluster areas with linkages to innovation driven entrepreneurship, from human capital development, diversifying the economy and promoting growth (by improving the productivity and commercialization of the agricultural sector, fisheries and the marine sector, tourism, and manufacturing and services), to infrastructure and competitiveness (by scaling energy production, transforming transportation systems and water infrastructure systems, waste management, and strengthening ICT).

What appears clear is that Sierra Leone's current government understands the importance and potential for developing its innovation driven ecosystem and that it aims to play a central role in its transformation.

[54] https://dsti.gov.sl/blog/

5.3.5 Universities

Freetown is home to several universities, the largest of which is the University of Sierra Leone which is composed by several different entities: the Institute for Public Administration and Management (IPAM)[55], Fourah Bay College[56] (the first Western style college in West Africa founded in 1827), the College of Medicine and Allied Health Sciences (COMAHS), as well as by other universities such as Njala University[57], BlueCrest College[58] (focused more on professional education in ICT), Limkokwing University, and the University of Makeni[59] (situated 2 hours north of Freetown with an MBA program focusing on entrepreneurship).

Academia is definitely lagging behind in supporting and enabling the innovation driven ecosystem. Curricula are outdated and not adapted to the local context (surveyed students in finance at IPAM were unfamiliar with mobile banking for example). Universities don't yet have innovation spaces and whatever entrepreneurship training there is, it is hard to see the results of it in the marketplace, as most entrepreneurs are returning diaspora Sierra Leoneans. Of note are Limkokwing University, with its Limkokwing Entrepreneurship Accelerator Platform (LEAP) program being developed in partnership with the Innovations Axis accelerator and incubator, and IPAM's plan to allocate a floor of a new building towards an innovation space for students to pursue entrepreneurial opportunities and get access to resources such as a maker space to be managed in collaboration with DSTI.

There is a profound need to train the teachers at universities and upgrade curriculum, strengthening the country's capacity to train scientist and engineers in a more practical way. While the government will invest heavily in education, it is yet unclear to what extent investments will affect tertiary education.

5.4 Conclusion

Sierra Leone's ambitions are probably as large as its challenges. While it is hard to know whether developing the country's innovation driven ecosystem should be a priority at this point given the many foundational challenges the country currently faces, from energy access to weak or non-existent intellectual property protection, to underperforming universities and a hindering bureaucracy, and a general risk-aversion, at a minimum, efforts to engender a sense of community and foster relationships among Freetown's stakeholders should be a priority. Most stakeholders are currently working independently and many are not aware of each other's efforts. Strengthening connections and maintaining open communication channels could ensure that opportunities are better

[55] https://en.wikipedia.org/wiki/Institute_of_Public_Administration_and_Management
[56] http://fourahbaycollege.net/
[57] https://njala.edu.sl/
[58] https://sl.bluecrestcollege.com/
[59] http://unimak.edu.sl/wordpress/

leveraged and efforts are not duplicated. In addition, Sierra Leone can count on a well-educated diaspora which seems poised to play a substantial catalytic role in the early stages of Sierra Leone's transformation, bringing know-how, resources, and often an entrepreneurial mindset that is more open towards embracing riskier market opportunities.

Chapter 6 – Towards a North-South Research and Technology Organization (RTO) in Sub-Saharan Africa?

The three previous chapters answered the question "what does the innovation-driven ecosystem currently look like in Accra, Nairobi, and Freetown?", setting the stage for this chapter's exploratory journey asking "could there be a Research and Technology Organization (RTO) established in sub-Saharan Africa (SSA) to operate as an innovation intermediary for North-South Cooperation? What might this RTO look like in Accra, in Nairobi, and in Freetown?". Before diving into the questions, the next section will introduce the concept of RTOs.

6.1 Introduction to RTOs

Research and Technology Organizations (RTOs) have been in existence for many decades and are considered "a well-known category of organizations in the national innovation systems of some of the world's most advanced countries" (Martinez-Vela, 2016). According to the European Association of Research and Technology Organizations (EARTO), RTOs have the following mission: "the core mission of Research and Technology Organizations is to harness science and technology in the service of innovation, to improve quality of life and build economic competitiveness" (EARTO, 2015). RTOs are most commonly present in advanced economies, where they serve as an important tool for industry and innovation policy to drive efforts aimed at enhancing competitiveness and economic prosperity, seeking to "impact and assist all established and emerging industries in their respective economies, without being narrowly specialized in a single technology" (Martinez-Vela, 2016).

In the academic literature RTOs are sometimes also referred to as research and technology institutes (RTIs), and many organizations and institutional arrangements that have similar characteristics to RTOs have been examined by scholars; these include innovation intermediaries (Howells, 2006; Tether and Tajar, 2008), project-based organizations (Gann and Salter, 2000; Hobday, 2000; Whitley, 2006), knowledge brokers (Hargadon and Sutton, 1997; Hargadon, 2002; Obsfeld, 2005), government support institutions (GSIs) (McDermott et al., 2009), and regional institutions (McEvily and Zaheer, 1999).

RTOs exist in numerous organizational forms and arrangements; they can be large well-established networks (or consortia) employing thousands, or individual organizations with small teams that are highly specialized and anything in between. According to a 2010 report by Technopolis (an innovation consultancy), the main focus of RTOs is to:

1. Tackle the needs of industry for knowledge-related services.
2. Focus on user or problem-oriented research for the benefit of society.
3. Assume some of the risks of industrial innovation, helping companies go beyond what they would be able to do alone.

RTOs are important bridges linking ideas and knowledge generated at research institutions such as universities and national laboratories with the marketplace, where private sector companies eventually aim to commercialize new products and services. Figure 6.1 below places RTOs along the innovation process.

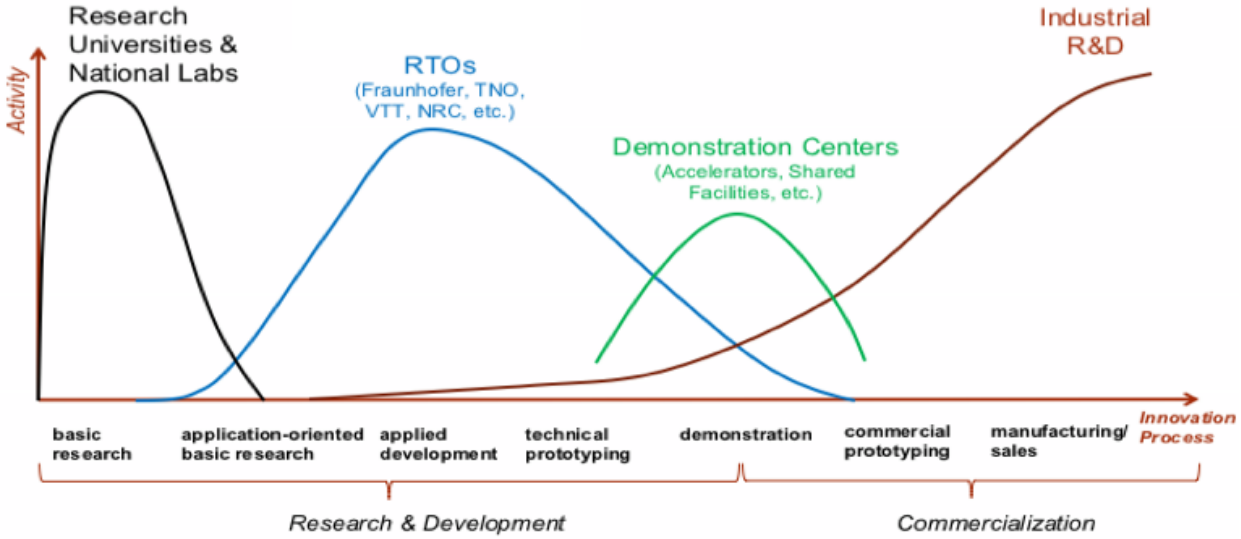

Figure 6.1: RTOs Bridging Basic Research and Commercial Industrial Application. Sources: Uygun, 2016 and Martinez-Vela, 2016

The context in which an RTO operates plays a very important role. According to Martinez-Vela (2016) "as actors in an innovation system (national, regional, or sectoral), RTOs, as are embedded in a context that shapes them. This implies, on the one hand, that RTOs are artifacts of history shaped by culture, politics, power structures, and a changing economic landscape. And, on the other hand, that the internal operations of RTOs and their interactions with other organizations are affected by organizational routines and procedures, and by a legal and regulatory framework." In the context of developing countries, whose innovation-driven ecosystems are in their infancy, this can be particularly challenging, as the elements listed above may be hindrances to an ecosystem's growth.

In terms of activities, traditionally RTOs engage as innovation intermediaries by performing certain important activities. Zylberberg (2017) divides activities performed by RTOs into four categories; they can operate as:

Public Utilities – furnishing services aimed at inducing broad-based technological development or industrial upgrading in a given jurisdiction;

Knowledge Creators – collaborating with universities to produce original research that both advances knowledge and also creates possibilities for new products and services downstream;

Stakeholder Conveners – bringing small and medium size enterprises (SMEs), large firms, and research institutions together to solve specific problems;

Contractors – offering contract services and customized and off-the-shelf products.

RTOs may perform any combination of these roles simultaneously, from the very specialized ones focusing very narrowly on a specific role and set of activities to the very broad ones performing multiple roles.

In terms of funding, EARTO (2015) reports that on average its member RTOs in Europe receive approximately 30 percent of their core funding from the government, mainly to build capacity in science and technology, an additional 30 percent is from competitive grants from public and private sources for the purpose of technology development, while the remaining 40 percent is contractual income generated from industry with the specific purpose to diffuse and disseminate knowledge and technologies for specific purposes. Having diversified sources of funding for the RTO's various purposes is of great importance in ensuring that it has the ability to both respond to short-term needs but also long-term impact (Martinez-Vela, 2016).

RTOs are known to focus on certain themes which encompass the grand challenges they address; nested under the themes are focus areas, and nested under those are capabilities. For example, the Fraunhofer Institute[60], Europe's largest RTO based in Germany, focuses on the following themes: health and environment; security and protection; mobility and transport; production and supply of services; communication and knowledge; energy and resources. In Brazil, the Instituto de Inovação Senai[61], a national network of RTOs based on the Fraunhofer model, focuses, among others, on the following areas: biomass, advanced manufacturing, metallurgy, microelectronics, mineral processing, green chemistry, virtual systems, and mining technologies. In Switzerland, CSEM[62], an RTO specializing in microtechnologies, focuses its efforts on digitalization, precision manufacturing, and energy. RTOs pick themes and focus areas both based on a mix that combines the current realty, supporting existing industries, or with an aspired reality, supporting industries that are either not yet present in an innovation ecosystem or that may be entirely new. In the case of the latter, generally the country or region has capabilities in the new or emerging industry upon which it can build. Lastly, RTOs deploy capabilities through the project work in their focus areas, often in collaboration with universities and industry. According to Martinez-Vela (2016), "project-based work affords RTOs the ability to respond and mobilize capabilities in a flexible and customized way.

[60] https://www.fraunhofer.de/en/
[61] http://institutos.senai.br/
[62] https://www.csem.ch/

Importantly, it allows RTOs to assemble projects that bring together a unique set of capabilities (people and equipment), according to the goal of the project."

The 2016 comparative analysis benchmarking RTOs in Germany, the Netherlands, Canada, and Finland identified 5 key challenges and 5 key factors for success across RTOs. The challenges revolve around collaboration across institutes, interdisciplinary projects, attracting talent, navigating regional and national politics, and the internationalization of research and development. The key factors for success revolve around having a clear mission, public funding to build long-term capabilities, flexible organizing of customized projects, mobility of personnel across organizations, and specialists for different organizational functions (Martinez-Vela, 2016). The context in the countries listed above is significantly different from the context of Ghana, Kenya, and Sierra Leone. Establishing an RTO like the Fraunhofer Institute, Instituto de Inovação Senai, or CSEM in any of these countries would likely be a bad idea at this point, for the innovation-driven ecosystems of Accra, Nairobi, and Freetown do not yet have the innovation, entrepreneurship, and industrial capabilities that would be needed to justify the establishment of a more traditional RTO. This however does not mean that the question shouldn't be asked if there could be an RTO model designed specifically to work in the context of less developed countries, whose capabilities in terms of research and development and innovation-driven entrepreneurship are at a much earlier stage than those of established middle income countries with diversified knowledge-based economies like Brazil, or high-income countries like Germany or Switzerland. The next section will explore and speculate on what that model could look like.

6.2 An RTO for North-South Cooperation in Sub-Saharan Africa

Innovation happens by creating new knowledge or recombining existing knowledge in new ways. It can be new to the firm, new to a regional market or new to the world. What the case studies of Accra, Nairobi, and Freetown have shown is that their respective innovation-driven ecosystems, with their relative strengths and weaknesses, are along the beginning of a continuum relative to the world's more established innovation-driven ecosystems. Whether their entrepreneurs and innovators lack in training, know-how, equipment, or funding and opportunity; whether universities lack in qualified personnel or appropriate facilities to conduct research; whether governments struggle with bureaucratic tendencies and corruption; whether corporations are limited by market inefficiencies; whether risk capital providers are present or funding is mostly provided by philanthropy, all stakeholder groups face challenges and obstacles to enabling their innovation-driven ecosystems, some unique to their context, others shared. At the same time, a young generation of technologists, innovators, and entrepreneurs is emerging in each of these cities, finding new ways to deploy existing technologies to solve local problems, and sometimes developing entirely new ones to do the same. In this context, an RTO focused on catalyzing an innovation-driven ecosystem through North-South cooperation could provide a new model by operating in the Global South and sourcing capabilities in the Global North to meet local aspirations.

According to Zylberberg (2017), studies on RTOs largely focused on industrialized countries do not capture "the important function they take on in developing and emerging economies, including diffusing global industry standards and best practices." In the context of developing countries, where the goal is catching up with the world's advanced economies, industrial upgrading is arguably more important than knowledge creation, which is why knowledge diffusion should play a primary role, with knowledge creation following. For example, the mobile money revolution in Kenya was based on industrial and infrastructure upgrading and knowledge diffusion related the ICT sector. While global connectivity has significantly reduced the burden on knowledge diffusion, particularly in the digital realm, it has not brought about a wave of industrial upgrading based on knowledge now accessible via digital means. Skilled human capital as well as physical infrastructure in the form of equipment remain crucial for industrial upgrading.

Establishing which roles make most sense for an RTO in SSA is key, and while specific aspects are contingent on the context in which the RTO is to be established, some considerations apply generally. For example, the role of knowledge creator is the least likely for innovation ecosystems in their early stages. An RTO needs to be able to offer capabilities that a university or firm does not have to be a real knowledge creator. An RTO in SSA would be more likely well positioned to serve as a public utility and stakeholder convener, and to a certain extent also as a contractor, although there will likely be little resources for hiring contractors. Thus, an RTO focusing on these roles and operating at the intersection of an innovation ecosystem's stakeholders and global knowledge networks has the potential to emerge as a key innovation intermediary that can accelerate an ecosystem's development.

As mentioned earlier, RTOs are embedded in their context and shaped by the local circumstances on many dimensions. An RTO designed to foster North-South collaboration may be in a position to both transcend the local circumstances by accessing capabilities in the Global North not present in the Global South, and to positively influence the local circumstances by creating opportunities and linkages that may over time impact the innovation-driven ecosystem. It could significantly expand the opportunities to recombine existing knowledge in new ways, drawing from direct insights stemming from the perspectives of those in the Global South and their collaborators from the Global North.

Individual examples of North-South cooperation aligned with the model described above exist, yet they tend to be the result of ad-hoc projects and initiatives, rather than part of a systematized effort supported and facilitated by an RTO-like institution. One such example may be found in Tanzania. With a pressing need to procure updated maps of its islands, the government of Zanzibar faced a dilemma: its last maps were dated 2002 and cost approximately $2 million to produce by using satellite imagery combined with airplane imagery. With no funds to procure new maps the government of Zanzibar partnered with the World Bank and Swiss NGO Drone Adventures to launch the Zanzibar

Mapping Initiative[63] (ZMI). With a budget of $200,000 ZMI was able to acquire the technology and capabilities necessary to map the entire two islands using fixed wing drones, making ZMI the world's largest drone mapping project. Drone Adventures built capacity by training locals to operate the drones and interpret aerial data. Zanzibari drone pilots have since been invited by numerous other African countries to consult on similar projects and train local drone operators and GIS specialists and the technology diffused further on Tanzania's mainland. In 2018 the government of Tanzania announced the launch of the Lake Victoria Challenge[64] (LVC), asking what could happen if Africa can unlock the lower skies as a resource for mobility. According to the initiative, "drones offer a starting point for radically rethinking the region's mobility, lowering the price of transportation per kilo per kilometer to a minimum. In pioneering the development of an economically viable and secure droneport, the Lake Victoria Challenge is an advocate for ideas that can be adopted throughout Africa and the rest of the world." The LVC was born out of the seeds sown by the ZMI and the capabilities that came with it. An RTO for North-South cooperation could play a significant role in systematically identifying opportunities for technological diffusion like this one, capacity building and creating core competencies, and in supporting the emergence of private sector opportunities leveraging the newly acquired capabilities.

The goal of this section is to paint a picture of an RTO for North-South cooperation in broad brushstrokes. Some key aspects to consider revolve around institutional design. Firstly scope. What should be the focus of the RTO? How to develop a mandate and a mission that are not too broad and going beyond an innovation-driven RTO? Second, scale. Should this be a large RTO with 100+ employees or should it be small with 10+? Given the novelty, it is likely advisable to start with a smaller scale RTO that can rapidly adapt to changing circumstances and experiment with its role as a as a public utility, knowledge creator, stakeholder convener, and contractor in a flexible way.

Third, funding. Funding an RTO at the national level may be complicated, as governments have scarce means, competitive research funding is limited at the national level, and the private sector may be unwilling to allocate funding for contract work to an RTO, particularly in the beginning of its existence. This means that funding sources would more likely be international. One possibility may be to link the RTO to a specific country in the Global North, turning it into a publicly funded initiative supported by public agencies like the United States Agency for International Development (USAID), the Department for International Development of the United Kingdom (DfID), or the Swiss Agency for Development and Cooperation (SDC) for example. This would create direct linkages between the RTO and the innovation ecosystem of a country in the Global North, thus reducing the challenges for the RTOs employees to be well connected to relevant stakeholders in the Global North by bounding the geography in which to source capabilities for local projects with local stakeholders.

[63] http://www.zanzibarmapping.com/
[64] https://www.lakevictoriachallenge.org/

This model may be appealing to countries who already prioritize building capacity as part of their development and cooperation efforts. According to a former head of SDC, knowledge transfer is becoming increasingly prevalent in the development and cooperation strategy of countries like Switzerland, the United States, and others, particularly at the institutional level (see the example in Ghana's collaboration with German universities of applied sciences). The RTO could operate as a platform able to work across a broad spectrum, from supporting institutional efforts with systemic implications (particularly with university and government stakeholders) to ad-hoc initiatives that could support individual sectors and address specific challenges (as in the example of ZMI above).

Another possibility may be to seek philanthropic support for the RTO and establish a consortium of member institutions throughout the Global North who are willing to participate in the opportunities created by the RTO. The consortium model would have the advantage of more narrowly defining which organizations to source collaborators from, but it may also mean that these are spread throughout multiple countries.

Finally, human resources. Attracting the right people will be one of the principal keys to success of the RTO. A mix of subject matter expertise related to priority sectors combined with a creative mindset and outstanding networking skills are key ingredients to this RTO model's success, for they need to fulfill four key goals:

1. Know the local ecosystem and its stakeholders very well;

2. Have good knowledge of the ecosystem and stakeholders in the Global North (whether tied to a specific country or a consortium of institutions, or other);

3. Strong technical and industry knowledge to the extent the work is about industrial upgrading; and

4. Based on 1 and 2, be able to identify the right opportunities to develop themes, focus areas, and capabilities around them in a targeted way.

This puts a certain emphasis on the importance of the physical location of the RTO in an innovation-driven ecosystem. To fulfill these objectives, it needs to become an attractive meeting point for local stakeholders to convene as well as a landing place for international stakeholders.

The following sub-sections will explore and speculate what the model of an RTO presented above could look like in the context of each of the case studies presented in previous chapters. The objective is not to compare them in terms of picking a best location, but rather thinking about how the RTO might differ depending on the local context in which it is established.

6.2.1 An RTO Innovation Intermediary for North-South Cooperation in Accra

Accra is poised to experience positive growth in its innovation-driven ecosystem in the coming years. With many of the individual components necessary to establish a well-functioning technology development system, an RTO for North-South cooperation could play an important role in supporting and accelerating Ghana's transformation. The challenges faced by Ghana and Accra are much less foundational in nature than those faced by Sierra Leone and Freetown for example, meaning that the RTO's work as an innovation intermediary would be much less about supporting the creation of a system providing the foundational enabling conditions for transformation, and much more about identifying specific challenges related to existing or potential opportunities to develop areas of expertise fueling the growth of innovation-driven entrepreneurship and SMEs in particular.

Figure 6.2: Flights from Accra in May 2019. Source: FlightsFrom.com

An important aspect for any RTO operating on a North-South basis is its transit connectivity. Collaboration is more easily achieved where connectivity is easy and opportunities to reach a destination abound. Figure 6.6 shows that Accra's airport currently serves 31 direct routes. In West Africa Accra's air connectivity is behind that of Lagos, Nigeria and Abidjan, Ivory Coast, but the recent opening of a new terminal at Kotoka Airport in Accra may lead to more destinations and more frequent service.

Particular opportunities for the RTO in Ghana may lie around supporting the expansion of the manufacturing sector though technological capacity, supporting agro-based

industrial development, and exploring opportunities around health-based technologies. In the manufacturing sector, opportunities may be linked to some of Ghana's comparative advantage around the export of its natural resources. For example, creating new opportunities for value-addition along the cocoa value chain could be a subject area for the RTO to focus on. This could be achieved by identifying a set of capabilities and technologies necessary to advance this and establish ad-hoc projects that tie together Accra's stakeholders such as universities, entrepreneurs, and existing SMEs in the food processing industry for example, linking them with appropriate stakeholders from the Global North able to supply both know how and possibly equipment and training necessary to develop this vertical. At the university level for example, collaborations that enhance applied research could be pursued with tertiary educational institutions whose research interests overlap. Specific programs and initiatives to foster innovative ventures around the entire value chain could be established in partnership with some of Accra's enablers, such as MEST, Impact Hub, or the Ghana Climate Innovation Center. The focus could be on a combination of digital innovations that enhance the sector, for example by developing platforms to transact and access information, as well as physical innovations with more direct industrial applications to process goods. Projects in this focus area could be nested under a broader priority theme for the RTO revolving around agricultural technology (ag-tech). Examples of different RTOs that address agricultural issues include the Brazilian Agricultural Research Corporation EMBRAPA[65] in Brazil and the Council for Scientific and Industrial Research CSIR[66] in South Africa.

While this is just a general speculation of what the RTO may focus on in Accra, additional research is needed to understand if activities such as those listed above are indeed local priorities, as the RTO should act as an intermediary in meeting local aspirations, rather than as a goal setter for local aspirations while also providing a strategy and roadmap for stakeholders to engage with.

6.2.2 An RTO Innovation Intermediary for North-South Cooperation in Nairobi

With the most mature innovation-driven ecosystem among the three case studies, Nairobi appears very well suited for an RTO for North-South cooperation, with numerous opportunities starting in the domain of information and communication technology (ICT). Kenya's rapid adoption of mobile based technology has given rise to a broad suite of innovative businesses offering mobile based services, from payments to access to market information for the agricultural sector, to the ability to access off-grid electricity through mobile banking and credit. An RTO in Nairobi could position itself as a relevant innovation intermediary in the ICT sector by working in areas of relative weakness in the ecosystem. At the university level, the RTO could strengthen innovation capacity by developing specific research and training programs aimed at upgrading capabilities at the university level while also possibly offering internships for students to work on its own ICT projects. Improving capabilities at the university level, one of the perceived weaknesses in

[65] https://www.embrapa.br/en/international
[66] https://www.csir.co.za/

Nairobi's innovation-driven ecosystem, could set the stage for increased collaborations with the private sector. One way in which this could be achieved is by looking at the example of Ghana's technical universities (TUs), who transitioned from polytechnics to TUs in collaboration with German universities of applied sciences as a result of a nationwide reform. Weak linkages between SMEs and innovation-driven enterprises with universities are representative of an ecosystem that is not operating at its potential, thus addressing the pain points is a necessary step before stronger linkages can be established. Undertakings like these, however, have a longer time horizon as the intervention is at the institutional level.

The agricultural sector plays a substantial role in Kenya's economy as well, with the majority of the country living in rural areas, thus similarly to Ghana agricultural technology may be a worthwhile focus area for the RTO. Additionally, Kenya is home to a major port in Mombasa and the country's regional integration affords it access to a larger market, suggesting that export led growth through trade could be an area of particular importance to the country's continued development. In this sense, the RTO could play an important role in bridging the digital with the physical around developing opportunities to grow the manufacturing sector potentially helping increase productivity with the introduction of new manufacturing technologies such as robotics and automation more broadly. The presence of global corporations like IBM, Microsoft, and others represents an asset for the ecosystem that may be leveraged further through an RTO.

Figure 6.3: Flights from Nairobi in May 2019. Source: FlightsFrom.com

Nairobi has been a transit hub in West Africa for many decades, and this aspect has played to its advantage in establishing global connections that made establishing a

regional presence in Nairobi advantageous for many firms. Figure 6.3 shows that Nairobi airport currently serves 63 destinations, which are heightened by the presence of another hub at a two hours flight from Nairobi in Addis Ababa, Ethiopia where 100 destinations are served.

Nairobi's size may be both an asset as well as a hindrance. On one hand, there are many more stakeholders which make for a richer environment, but on the other hand collective action may be more difficult in a larger context that counts numerous stakeholders that are fragmented. As in the case of Accra, significant additional on the ground research is needed, particularly among the industrial sector, to more accurately explore relevant opportunities for an RTO.

6.2.3 An RTO Innovation Intermediary for North-South Cooperation in Freetown

Accra and Nairobi's innovation-driven ecosystems have more in common with each other than either of them has with Freetown. The context of Freetown and Sierra Leone is substantially different in that the county's development is significantly behind that of Ghana and Kenya. The challenges in Freetown are much more foundational: access to electricity is very scarce and significantly limits the growth of the private sector, institutions are generally weaker, and access critical inputs like talent, knowledge, and capital is much scarcer than in Accra or Nairobi. This means that an RTO in Freetown would play a substantially different role, aimed much more at building foundational capacity in science and technology rather than embarking on more advanced projects.

For example, university collaborations with the RTO in Freetown may revolve more around building technical expertise in areas such as ICT for development, or entrepreneurial and management competencies. This would not be the case in Accra or Nairobi, where those competencies are already at a more advanced stage in these areas. Additional collaboration may happen in the form of technical assistance between the RTO and its international stakeholders and the Sierra Leonean government to build capabilities among its bureaucracy.

One of Freetown's unique opportunities revolves around its size and moment in history. It is a small and peaceful city, safe for visitors, and it is at a moment in history where for the first time in the last decades there is optimism about the future, having left crises such as the civil war and the Ebola epidemic behind. Many Sierra Leoneans in the diaspora are moving back or even returning to visit for the first time in decades, bringing with them both small amounts of capital as well as their international experience. At the same time, the city's small size is such that collective action and coordination among stakeholders may be easier than in larger contexts. An RTO for North-South cooperation could play an important catalyzing role in plugging into global knowledge networks to source relevant capabilities for an innovation-driven ecosystem in its very early stages.

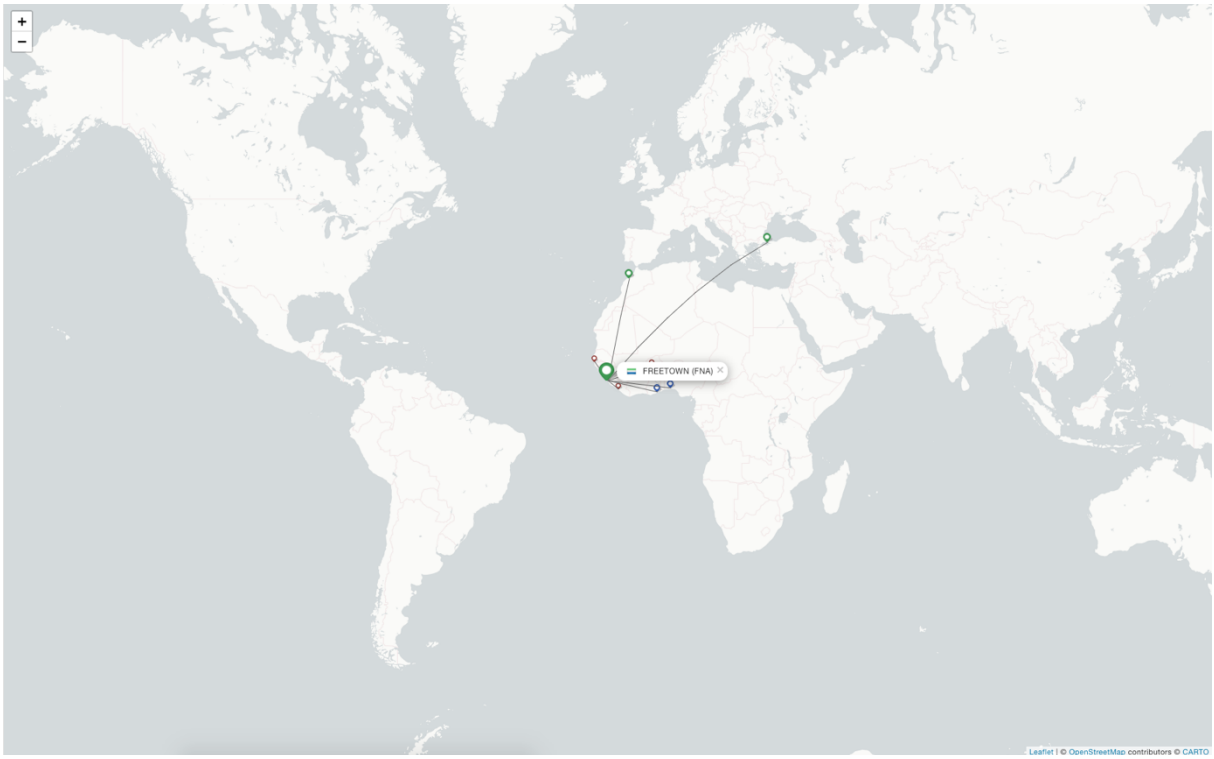

Figure 6.4: Flights from Freetown in May 2019. Source: FlightsFrom.com

Accessing Freetown is more complicated than many other cities. The city's airport offers few flights to few destinations as shown in figure 6.4 (which is missing connections to Paris and Amsterdam that are offered a few times per week). Its geographic location requires transiting by ferry across the bay to reach the city, thus it is unlikely that Freetown may evolve as a transit hub based on its air connectivity. The sea, with the city's convenient location and natural deep-water harbor is more likely to play a role in Sierra Leone's global connectivity.

Because of the structure of Sierra Leone's economy and its weak private sector, it is likely that activities undertaken by the RTO have a strong participation and input from the NGO sector, which is so prevalent in Freetown, presenting both opportunities as well as structural challenges.

6.3 Conclusions

This chapter has introduced both the RTO as a known form of innovation intermediary in industrialized countries, as well as a possible new form of RTO for North-South cooperation based in low and low-middle income countries. While the idea for a new form of RTO has been presented in very broad form, additional work is needed to further develop and refine it.

What appears clear is that to a certain extent characteristics of the RTO for North-South cooperation remain similar regardless of the context in which it is to be established, while

others are context-dependent. The modus operandi and the conceptual idea of an organization acting as a public utility, knowledge creator, stakeholder convener and contractor is similar in each context, while the thematic, topical, and capability focus is much more context specific and depending on the assessment of each innovation-driven ecosystem. At the same time, it has proven difficult to link the assessment of each city's innovation-driven ecosystem effectively with the speculatory nature of imagining themes and priority areas for this new RTO.

An experimental pilot phase may be the best way to find the answers both to what themes and focus areas make the most sense, and more importantly to whether this model can be as good in reality as it may sound on paper. More discussions with stakeholders as well as a deeper survey of the landscape will be necessary.

Chapter 7 – Conclusion

Innovation-driven ecosystems are on the rise in sub-Saharan Africa. While it is too soon to assess their impact in transforming the continent, it is clear that they have the potential to unlock a new path towards prosperity, providing opportunities in particular to young technology savvy citizens. What follows is a summary the work presented in this thesis coupled with reflections on understanding innovation-driven ecosystems in the context of sub-Saharan African countries, and on imagining a new way for North-South Cooperation around the concept of Research and Technology Organizations (RTOs).

The MIT iEcosystem framework used to analyze the innovation-driven ecosystems of Accra, Nairobi, and Freetown has proven a valid lens through which to understand a complex multi-stakeholder ecosystem. However, it also presented some limitations specific to developing countries. On Innovation Capacity (I-CAP), the definition should be expanded from "the capacity of a place to develop 'new-to-the-world' ideas and take them from inception to impact" to include ideas that are new to the firm or new to the market. In the same context, Entrepreneurial Capacity (E-CAP) could be investigated more thoroughly in the informal sector, something this thesis failed to do, although some examples of initiatives on innovation and entrepreneurship designed for informal communities emerged during conversations with stakeholders in Ghana, Kenya, and Sierra Leone. On the human capital front, the diaspora is a critical element for many developing countries, particularly in the early stages, as the diaspora can unlock both new capabilities, provide funding, and meaningfully contribute to creating a culture that embraces entrepreneurship and innovation. Infrastructure, particularly around international air connectivity, is another key aspect that ought to be stressed, as the ability to easily access an ecosystem facilitates the circulation of talent, ideas, and knowledge. Lastly, when it comes to comparative advantage a country's environment in terms of economic and political stability in particular, can be particularly relevant relative to neighboring and regional countries. Both Ghana and Kenya have a regional comparative advantage dictated by their political and economic strength respectively, which suggest that "being less bad" than your neighbors may enough to become an attractive destination.

As this thesis has shown, Accra, Nairobi, and Freetown are home to very different innovation-driven ecosystems, at different levels of maturity, and with different strengths and weaknesses. What they have in common is a core belief among many stakeholders that what they are doing is important and has transformational potential. There is a tangible sense of excitement, opportunity, and optimism towards the future that is common to each city. Challenges, be they a lack of infrastructure, poor governance and corruption, or market failures, are seen through a "can do" lens imbued with the spirit of entrepreneurialism to tackle challenging problems and to leverage market opportunities, not as crippling obstacles that are unsurmountable.

As Accra's case study has shown, its innovation-driven ecosystem is poised to grow and mature, possibly around a diverse set of competencies. With a comparatively strong academic and tertiary education sector, as well as a track record of political stability that makes it the outlier in the region, the potential for growth appears substantial, and confidence in Accra is confirmed by the recent launch of Google's AI Lab. Areas such as agriculture and health could emerge as fields of domain expertise for Accra's innovation-driven ecosystem, with substantial employment opportunities for citizen developed along respective value chains. Accra's ability to become a regional leader in science, technology and innovation will also depend on its ability to address challenges such as energy provision, tackling corruption, strengthening infrastructure, and continuing to reform its education sector.

As Nairobi's case study has shown, it enjoys the most mature innovation-driven ecosystem among those investigated. The quality of life, paired with its strong global transit connections, have made Nairobi an attractive destination both for returning diaspora as well as international organizations and corporations, which coupled with indigenous technical talent have given rise to Nairobi's tech ecosystem. The sustainability and future growth potential of Nairobi's ecosystem will depend on addressing some foundational challenges related to universities and government in particular. In contrast to Ghana, university graduates are not perceived to be well prepared by the private sector, leading to what some believe is a bias favoring entrepreneurs coming from abroad, either from the diaspora or expatriates. The government, which was a key contributor in enabling the mobile money revolution with its early investments in ICT, appears to have struggled to keep up with providing an enabling environment and playing a central role in driving transformation.

As Freetown's case study has shown, its innovation-driven ecosystem is the least developed among those analyzed. The country's recent history has been full of substantial challenges, but for the first time in the last two decades there seems to be a growing sense of optimism among Sierra Leoneans. A new government committed to transforming the country into a regional hub for innovation and entrepreneurship is leading the charge amid substantial foundational challenges such as poor infrastructure education, and health, high corruption, a weak private sector and heavy reliance on aid and development assistance. Whether Sierra Leone will emerge as a success story of radical transformation the like of Rwanda remains to be seen, but if its government's visionary strategy for transformation spills over to other sectors, and if highly skilled diaspora members continue to return to participate in this process, Freetown's innovation-driven ecosystem is poised for rapid growth.

The inevitability of emerging and growing innovation-driven ecosystems across African cities led this author to suggest that it may be worth joining local, national, and regional efforts across the continent aimed at strengthening these innovation systems through science, technology and innovation. In this context, it makes sense to begin thinking of an innovation intermediary; a knowledge broker acting at the intersection of local

ecosystems, catalyzing stakeholders locally through systematic work, while also injecting competencies and capabilities drawn from leading knowledge networks, most of which are found in the Global North.

From a research point of view this thesis is just a start, and there are numerous additional questions worth exploring further. While it builds on an existing analytical framework, further research into refining the framework for the context of sub-Saharan African countries (and other developing countries) may be needed. The case studies of Accra, Nairobi, and Freetown should also be investigated in more depth, particularly in terms of understanding current industrial capabilities, where linkages to innovation-driven ecosystems may lead to rapid productivity gains and increased national, regional, and international competitiveness. Further analysis to more precisely understand the role of NGOs and donor funding in each city's ecosystem should also be undertaken, with the objective to understand the extent to which donors contribute or hinder to the development of nascent innovation-driven ecosystems, and to understand if any interventions are needed to optimize their role. On innovation-driven ecosystems themselves, further investigating and understanding the extent to which they have the ability to transform low-income countries and generate employment opportunities is advisable. While there is some evidence on this already, particularly around the impact of mobile money, it is worth looking beyond that. Lastly, more research is warranted on the idea of establishing a Research and Technology Organization for North-South cooperation in the context of countries with limited industrial capabilities, particularly around identifying case studies of similar organizations established in low-income countries. It would be of interest to understand how funding invested in such an RTO model compares with funds invested in traditional forms of official development assistance and development aid.

From a practitioner point of view, this thesis aims to be a call to action for institutional imagination at the intersection of science, technology and innovation, and North-South cooperation. We may be witnessing the beginning of a golden age for collaborative problem solving, where the barriers for individuals and institutions to collaborate across regions and national borders are rapidly shrinking. While the idea of radically reimagining RTOs and experiment with the creation of an RTO for North-South Cooperation will definitely need further investigation, it builds on the ambitions that Africa and Africans have developed for themselves; where science, technology and innovation are to play a central role in the continent's transformation towards an innovation-led, knowledge-based economy. Experimenting with new forms of collaboration to meet those aspirations may be an idea whose time has come.

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