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Foreword

Today, Africa faces significant employment challenges, exacerbated by the fact that 95% of the population between the ages of 15 and 24 work in the informal economy. Recent World Bank figures show that young people represent 60% of the unemployed population in Africa, noting that the youth population of Africa is set to double by 2050. There is an urgent and clear need to stimulate the creation of high-quality jobs to support socio-economic development for the individual as well as the continent. One way of addressing this challenge is the development of public policies across the continent that supports the creation of a healthy and vibrant ecosystem for entrepreneurship and innovation.

This book provides an insight into past and current innovation practices in Africa, with a focus on entrepreneurial ecosystems with specific examples across different sectors. It delves into issues associated with the earliest phases of innovative entrepreneurs, including phases of pre-entrepreneurship activity. The transition to the rise of incubators, technology hubs, and digital ecosystems is explored, within the context of the impact of technology transfer into Africa. Particularly, it argues that the full potential of technology transfer for development is not fulfilled in many African economies. With this in mind, the authors present a guide for technology commercialisation in the new industrial era. Ultimately, key to success, and critical, is the government policies that support eentrepreneurship, innovation, and technology commercialisation. A critical review is presented in this book, and a map for potential transformative innovation policies in Africa is advanced.

I commend the editors of this book, international renowned experts, for undertaking this critical review and putting forward suggestions to tackle the huge employment deficient across the continent. This book will provide guidance and context to government agencies across Africa involved with addressing innovation and commercialisation of technology, as well as providing best practice for establishing an entrepreneurial ecosystem that ultimately addresses the biggest challenge for the growing African youth population.

I commend this book to all interested parties and stakeholders—academics, students, innovators and entrepreneurs, policymakers, business professionals and society at large—in fostering innovation, creativity and entrepreneurship, boosting productivity, and addressing the significant development and employment challenges in Africa.

May 2020

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Entrepreneurship, Technology Commercialisation, and Innovation Policy in Africa

The role of entrepreneurship, innovation, and public policies in helping Africa achieve the objective of harnessing the impending population growth has been acknowledged at continental and national government levels across Africa. Public policies, development strategies, and frameworks, for example, the African Union's Science, Technology and Innovation (STI) Strategy for Africa (STISA-2024), emphasise the need to focus on "promoting entrepreneurship and innovation" and "providing an enabling environment for STI development in the African continent", respectively (STISA-2024, p. 10). STISA also speaks to the importance of strengthening research and innovation ecosystems, capacity building, and provision of support to entrepreneurs.

This emphasis on entrepreneurship and innovation is further echoed in national STI and development policies in continental frameworks including the African transformation agenda (Agenda 2063), the Continental Education Strategy for Africa, CESA 2016-2025 (CESA 16-25); and the global UN's Sustainable Development Goals (Agenda 2030, the 17 SDGs) which African countries subscribe to. Nevertheless, the processes, approaches, and policies required to unlock the full potential of entrepreneurship and innovation for Africa's development and prosperity are far from clear.

A situational analysis of Africa's efforts[1] at development by promoting entrepreneurship, technology commercialisation, and innovation, and the role of public policies reveal various gaps and challenges. A critical analysis of these efforts unveil various reasons why the respective initiatives, projects, or programmes have produced less than optimum outcomes. Among the many structural issues faced by the continent, a few fundamental dimensions relate to the lack of strategic long-term approaches (e.g. through diagnostic analyses; technology watches and societal challenges mappings), persistent internal and external barriers to effective governance, large investments gaps in human capital and knowledge infrastructure, the disconnection between policy and society/reality implementation contexts (degree of place-based component, inclusiveness), the lack of systematic

[1]For example, efforts since 1960 when the majority of the countries became independent.

monitoring and impact assessment tools and frameworks (evidence base for public policy) as well as the low level of integration among African science and innovation systems.

The concepts discussed and ideas put forward in this book contribute to addressing the identified gaps by providing new insights on entrepreneurship, technology commercialisation, and innovation policy in Africa. The background and perspectives are in line with international agenda (e.g. SDGs); African continental agenda (Agenda 2063, STISA-2024, CESA 16-25); and national entrepreneurship, science, innovation, research, and policy agenda in African countries. Furthermore, the contents of the book reflect standards and practices advanced in indices such as Global Entrepreneurship Development Index (GEDI), and Global Innovation Index (GII) in relation to their usefulness and applicability in African contexts.

This book takes an innovation systems approach in exploring the issues around entrepreneurship and innovation. The chapters unpack entrepreneurship and entrepreneurial ecosystems, technology commercialisation, innovation, and innovation policies in Africa. The work of the editors cover these thematic areas. Detailed information is provided in the sections and chapters that follow.

What is in this book?

Entrepreneurship, Entrepreneurial Ecosystem, and Innovation in Africa

The first part addresses issues related to the specificities of entrepreneurship in African contexts and the key features of innovation systems and ecosystems for entrepreneurs. It brings together conceptual, policy, and empirical discussions about the dynamics of entrepreneurial activities on the continent.

Technology Commercialisation in Africa

The second part adopts a more market-oriented perspective to critically examine existing and emerging models for technology commercialisation. It underlines the major issues/implications for entrepreneurship from policy, practitioner and managerial perspectives.

Future Directions for Entrepreneurship, Technology Commercialisation, and of Innovation Policy in Africa

The third part focuses on theories and frameworks for Science, Technology and Innovation (STI) policy in Africa and opens up future perspectives on novel policy governance models for innovation, entrepreneurship, and technology commercialisation. The relevance of existing STI policymaking and implementation frameworks is discussed in the context of pressing societal challenges and in alignment with global development agenda.

Keywords Entrepreneurship and economic growth • Technology commercialisation and competitiveness • Transformative innovation policy • Digital economy and skills • Innovation systems

1. **Entrepreneurship, Innovation, and Technology Policy for Transformative Change in Africa: Perspectives, Policies, and Practices**—Chux Daniels and Joe Amadi-Echendu
   Africans seek a prosperous continent based on inclusive growth and sustainable development. The Africa Union Commission Agenda 2063 recognises that transformative change driven by innovation, technology, and entrepreneurship is paramount in order to realise the aspirations. Transformative change relates to transformations in socio-economics, technologies, and politics in ways that neither exacerbate inequality and exclusion nor impose adversity on ecology and the environment but engender justiciable equity, inclusivity, and sustainability. The viewpoint reiterated here and throughout the book is that practicable policies that engender knowledge creation, innovation, and technology commercialisation through entrepreneurship are essential towards achieving the aspirations articulated in Agenda 2063.

Entrepreneurship, Entrepreneurial Ecosystem, and Innovation in Africa

2. **The Readiness of Innovation Systems for the Fourth Industrial Revolution (4IR) in Sub-Saharan Africa**—Mafini Dosso, Chisom Ihebuzo Nwankwo, and Youssef Travaly
   This chapter discusses the level of readiness of innovation systems of sub-Saharan African economies for the 4IR. The readiness here refers to at least four dimensions or pre-requirements of the 4IR: (digital) infrastructure, education and skills, governance and demand readiness, and research and innovation potential. Besides many structural and investment deficiencies, local business ecosystems are rather hostile for the growth and scale-up of micro-, small-, and medium-size enterprises (MSMEs). Moreover, barriers to technology diffusion and adoption undermine MSMEs' innovation and creative capabilities. Use cases and applications of emerging technologies are spreading, albeit sparsely, across the continent and national and African-led initiatives open relevant windows of opportunities for the sub-Saharan African region to reap the benefits of the 4IR.
3. **Addressing Digital and Innovation Gender Divide: Perspectives from Zimbabwe**—Aretha Mare
   Technologies have found their way into our everyday existence. While technologies hold the promise of unprecedented opportunities for disenfranchised communities, conversations around women's access to digital technologies in Africa remain a topical issue. Access to digital technologies in most of

sub-Saharan Africa is limited to the passive use of mobile phones—one reason for this being the lack of, or inadequate levels of digital skills. Based on a practitioner's experience and provision of digital skills training for about six (6) years within multi-annual projects in Zimbabwe, the chapter puts forward that interaction with digital technologies, supported by reliable infrastructure and the right policy environment, are critical factors for the building of computational thinking and entrepreneurial skills among women and girls in STEM and ICTs. The chapter ends with recommendations for policy and practice and suggests roles that relevant stakeholders can play to build the computational and innovative capacity of women and girls in Africa.

4. **Mapping Entrepreneurial Ecosystem for Technology Start-Ups in Developing Economies: An Empirical Analysis of Twitter Networks Between Start-Ups and Support Organizations of Nairobi's Digital Economy**—Raphael M. Martins, Eunkyung Park, Daniel S. Hain, and Roman Jurowetzki
The literature on entrepreneurial ecosystem places emphasis on understanding the surrounding business environment for entrepreneurial activities of individual actors in a system, typically at the city or regional level. While gaining prominence as a useful concept to provide guidance for innovation and entrepreneurship policy, the framework at its current stage faces conceptual as well as empirical challenges with regard to the structural boundary of the ecosystem and the measurement of it. This chapter aims to jointly address these issues by deploying a novel combination of methods and data sources to map the interaction within a dynamic emerging ecosystem in Nairobi, Kenya. We do so by identifying start-ups and investors utilising data from CrunchBase and exploring the dynamics of the relevant actors in the Twitter network, where we use manual categorisation as well as data-driven community detection algorithms to identify social networks in the ecosystem. We identify distinct communities in the ecosystem based on the technological focus, the types of support organizations, and interaction patterns in the network. We show how technology start-ups in developing economies are connected to support organizations of various geographical origins, which imply that ecosystems for supporting entrepreneurship can emerge across borders.
5. **What Do We Know About Nascent and Young Innovative Entrepreneurship in Africa?: Insights and Perspectives from Morocco**—Azzioui Ilyas and Sandri Serena
This chapter brings survey-based evidence on the early phases of entrepreneurship or start-up development in Morocco's entrepreneurial and innovation system. The qualitative research relies on face-to-face semi-structured interviews with more than 40 start-ups sampled from the EMNES project. An originality of the study, and also a main contribution to the literature, resides in the deeper investigation of and distinction between nascent vs. young knowledge-intensive innovative entrepreneurs in a developing country context. In doing so, the study carries out new contextual evidence on an underexplored

topic: the early stages or pre-entrepreneurship phases. Key features unveiled cover the motives and driving factors, skills and experience profiles, type of innovation and industry, role of intellectual property and R&D, source of advice and funding as well as the extent of completion of gestation activities and survival/growth perspectives. In doing so, the study underlines the most pressing challenges of nascent and young knowledge-intensive innovative entrepreneurship in Morocco, while paving the way for further context-specific data collection, monitoring, and policy-relevant analyses in the field of entrepreneurship development.

Technology Commercialisation in Africa

6. **Challenges of the Agribusiness Sector in Kenya and Opportunities from Smart Specialisation Policies**—Anna Masłoń-Oracz, Anthony Wahome and Andrew Njiraini
   Agriculture is a high-policy concern in Kenya due to the very important role it plays in ensuring food security for the nation, employment creation, and trade revenues. However, the country faces a myriad of challenges including a continued decline in the production and productivity of local farms. This chapter discusses key challenges of the agriculture sector in Kenya. Then, it outlines the relevance of place-based approach to competitiveness such as smart specialisation strategies in order to help fostering Kenya's agricultural innovation system(s), while tackling some of its key challenges. The chapter concludes that further research, awareness raising, and pilots activities would help identifying concrete synergies for adopting smart specialisation strategies in order to enhance the impacts of innovation on food security, sustainable employment, and growth.
7. **A Guideline for Technology Commercialisation in the 4IR**—Joe Amadi-Echendu
   In this era of the fourth industrial revolution (4IR) with corresponding trends in globalisation and globalism, technology commercialisation encompasses the packaging of one or more 'candidate' technologies towards satisfying human needs and desires in a manner that not only create greater wealth for individuals and businesses but also lead to sustainable development of society at large. In this chapter, the discussion of technology commercialisation is premised on the wider ethos of value instead of the narrow emphasis on financial gain. Innovation index, the **t**echnology-**a**pplication-**p**roduct/service-**m**arket framework, and entrepreneurship are highlighted as theoretical and philosophical foundations for technology commercialisation. The discourse is drawn from empirical evidence extrapolated from published literature, experience from teaching, research, and numerous practical exercises conducted by students, as well as coaching and mentoring of budding entrepreneurs. For both the novice

and the experienced practitioner, the content of the chapter may be considered as a concise guideline on technology commercialisation.

8. **New Entrepreneurial Narratives in Urban West Africa: Case Studies of Five Innovation Hubs and Communities**—Mafini Dosso, Fatima Braoulé Méïté, Gilles Ametepe, Cyriac Gbogou, Gildas Guiella, and Daniel Oulaï
Youth-led innovation communities and networks are reshaping Western Africa's technology and entrepreneurial ecosystems in major African cities such as Abidjan, Accra, Bamako, Dakar, Lagos, and Ouagadougou. Members of these innovation communities are holding the pen, and they are writing new urban and rural community narratives across the region. This chapter gives voice to five West African innovation hubs and communities. It presents their social mission using the lenses of the founders. It builds upon prior mapping of African technology hubs (or tech hubs) and draws insights from a series of interviews and conversations mainly held in 2019. The case studies also shed some light on technology diffusion and commercialisation within the innovation hubs and associated communities.
9. **Corporate's Enterprise and Supplier Development (ESD) for SMMEs Through Incubation Programme**—Nthabiseng Kenosi and Elma van der Lingen
South Africa's post-apartheid government initiated the broad-based black economic empowerment (BBBEE) policy with the aim of empowering the previously disadvantaged citizens of the country, address inequality, eradicate poverty, and improve economic growth. The policy requires large international corporations to partner with local black-owned small- to medium-sizedmicro-enterprises (SMMEs), where the enterprise and supplier development (ESD) element of the BBBEE score card and incubations are used as a vehicle. This chapter will discuss what support services are provided to SMMEs, the business partnership structures that are formed, and factors such as knowledge/skills transfer, intellectual property rights, and benefits derived, and challenges.

Future Directions for Entrepreneurship, Technology Commercialisation and Innovation Policy in Africa

10. **Research and Innovation Uptake Landscape in Rwanda: Analysis of the STI Framework**—Parfait Yongabo
The use of scientific knowledge for society development requires enabling frameworks that allow the connection between knowledge production and use. STI policies and institutional arrangement are seen as a point of departure for such enabling frameworks. However, there is a need for understanding how individual countries are addressing the STI policies and institutional-related issues as a means for increasing the potential for the use of scientific knowledge for development. This chapter assesses STI policy setting, institutional

framework, and capacity building mechanisms in the Rwandan context. It discusses ways for operationalising research and innovation uptake frameworks based on existing driving and constraint factors for research and innovation development in Rwanda. A structured literature review, survey, and data mining were used for collecting needed data for this study. The study shows a promising progress in science, technology, and innovation policy and institutional framework development, whereas the lack of trust among stakeholders, low research capacity, lack of funding, and low collaboration among actors were the major challenges. The establishment of an operational national innovation system and a contextualised triple helix model were identified as among the better options to be explored for accelerating the facilitation of research and innovation uptake in Rwanda.

11. **A Critical Review of Policy Instruments for Promoting Innovation in Manufacturing Small and Medium Enterprises (SMEs) in South Africa**—John Mugabe, Kai-Yang Chan and Hendrik C. Marais
The growth, productivity, and competitiveness of small and medium enterprises (SMEs) are dependent on their innovation capabilities and performance. It is in recognition of this truism that governments have adopted different policy instruments to promote innovation in SMEs. This chapter critically reviews policy instruments for promoting innovation in manufacturing SMEs in South Africa. There is scant evidence-based analysis of how various national policy instruments influence innovation performance of manufacturing SMEs in the country. Based on a review of literature, a firm-level survey, and interviews with policymakers and representatives of SMEs, and two stakeholders' workshops, we identify national policy instruments that impact on innovation by manufacturing SMEs. The study shows that the instruments have not been effective in promoting innovation in SMES because of weak policy mix and inconsistency, weak capacity of government to adjust policy instruments to target systemic innovation deficits, and institutional disarticulation within government departments. It suggests a reconfiguration of policy instruments and related institution to focus on the challenge of enhancing the innovation performance of the enterprises.
12. **Challenges and Constraints for Government Agencies Supporting Firm-Level Innovation: Some Reflections from South Africa**—David Kaplan
This chapter explores technology-based firms within the national systems of innovation in South Africa and the important contributions that such firms make in enhancing technological and innovative capacities in addition to achieving developmental goals. It highlights the challenges that such firms face in accessing government support as they seek to expand and develop. Among the many findings, the chapter concludes that context is important. Governments need to have clarity on the most binding constraints to the firms' development and focus the support on those constraints. Lastly, it is vital that

governments pay particular attention on the roles that public servants, ministries, and agencies play in the design and delivery of innovation policy instruments to ensure effectiveness.

13. **Mapping the Potentials for Transformative Innovation Policies in Africa: Evidence from Cote d'Ivoire and Nigeria**—Chux Daniels and Mafini Dosso
This chapter provides an assessment of available evidence with regard to place-based and transformative innovation policy in Africa. Using case studies of Côte d'Ivoire and Nigeria, the chapter highlights gaps in policymaking in the two West African economies exploiting recent advances in innovation policy theory and practice. The discourse builds on the latest advances in innovation policy theory and practice in order to offer a more structured view of African countries' potentials for better-informed innovation policymaking decisions and for more impactful innovation investments. Issues ranging from governance, coordination among innovation stakeholders, funding, human capital, infrastructure, and evidence gaps are discussed in terms of their influence on innovation strategy and policy implementation given economic, social and environmental, and sustainability imperatives.

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Entrepreneurship, Innovation, and Technology Commercialisation for Transformative Change in Africa: Perspectives, Policies and Practices

Chux Daniels and Joe Amadi-Echendu

1 Introduction: The Transformative Agenda in Africa

The Africa Union Commission (AUC) African transformation agenda, Agenda 2063, sets out the development pathway for the continent's next fifty years (AUC 2015a, b). Agenda 2063 articulates seven bold and ambitious aspirations, encapsulated in the "*The Africa We Want*". The first aspiration and topmost in the list of priorities is the need to achieve "a prosperous Africa based on inclusive growth and sustainable development" (AUC 2015a, p. 2). Research, innovation, and the commercialisation of technology through entrepreneurship are essential for achieving the desired level of transformative change in Africa in order to realise the aspirations articulated in the Agenda. Transformative change, as used in this context, relates to transformations in socio-economic goals, technologies, and politics in ways that do not exacerbate inequality and exclusion but engender justiciable equity, inclusivity and sustainability.

In practical terms, Agenda 2063 is a call to action for inclusive transformation and sustainable development. It advocates the deployment of technology and innovation, in entrepreneurship efforts to transform Africa towards inclusivity and sustainable development. The agenda calls for "support for innovation", and "well educated and skilled citizens, underpinned by science, technology and innovation" (AUC 2015a, p. 2), "investments in science, technology, research and innovation" (p. 3), and capable and skilled African citizens who can "contribute significantly to innovation and entrepreneurship" (p. 9).

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This emphasis on technology, innovation and entrepreneurship is further echoed in national science, technology and innovation (STI) and development policies; such STI policies are further articulated in other continental frameworks including the AUC's Continental Education Strategy for Africa, CESA 2016–2025 (CESA 16–25 (AUC 2016)); and the STI Strategy for Africa (STISA-2024) (AUC 2014; see also AUDA-NEPAD (2019) for more perspectives on Africa's Innovation Outlook). STISA-2024, for example, stress the need to focus on "promoting entrepreneurship and innovation" alongside "providing an enabling environment for STI development in the African continent" (AUC 2014, p. 10). STISA also speaks to the importance of strengthening research and innovation ecosystems, capacity-building and the provision of support to entrepreneurs.

With the sluggish global economic outlook since the 2008 financial crisis (IMF 2019), now exacerbated by the COVID-19 pandemic; protecting lives, economies and jobs in Africa is a major concern and priority (UNECA 2020). Therefore, while idea generation and creativity are primal, the challenge remains to convert the resulting research outputs, knowledge, technologies and innovations into products and services that support livelihoods. Commercialising technologies—that is putting the ideas and technologies into productive use in ways that address development challenges be it commercial, social, environmental or otherwise—is vital. This is innovation. Transforming technologies into productive use and such means that address development challenges, brings us to one of the key themes of this chapter and the entire book: technology commercialisation for transformative change. We do not go into details on technology commercialisation in this chapter. Chapter 7: A Guideline for Technology Commercialisation in the 4IR is specifically dedicated to the topic.

The link between innovation and entrepreneurship is important. However, there is also an important link between technology, particularly *Society 5.0* cum 4IR technologies, and entrepreneurship. It has now become clearer to Africa's leadership that digital technologies, in combination with entrepreneurship, presents huge opportunities for addressing Africa's socioeconomic and development challenges (such as job creation, increasing productivity, delivering education and healthcare). To this end, the AUC recently finalised and launched the Digital Transformation Strategy for Africa (2020–2030), DTS (AUC 2020) on 18 May 2020. The overarching goal of this strategy is to help foster vibrant enabling digital technology and entrepreneurial ecosystems that can support startup environments, promote innovation and "make digitally enabled socio-economic development a high priority" (AUC 2020, p. 1).

Digital technologies and digitalisation are influencing and shaping the transformations we observe across Africa. For instance, the narrative around Africa's development is changing and radically shifting. Economic growth pathways are now being explored beyond the traditional extraction of mineral and natural resources (see Fig. 1; also AfDB 2020); to include emphasis on technologies and innovation. In addition, there are more focused attention on exploring avenues to exploit growth opportunities through digital technologies, digitisations and digitalisation, ecommerce, and advanced/disruptive technologies. At senior leadership, government and policy levels, the discourse is now starting to include, for example, discussions on accelerating Africa's development, transformation and industrialisation through digital

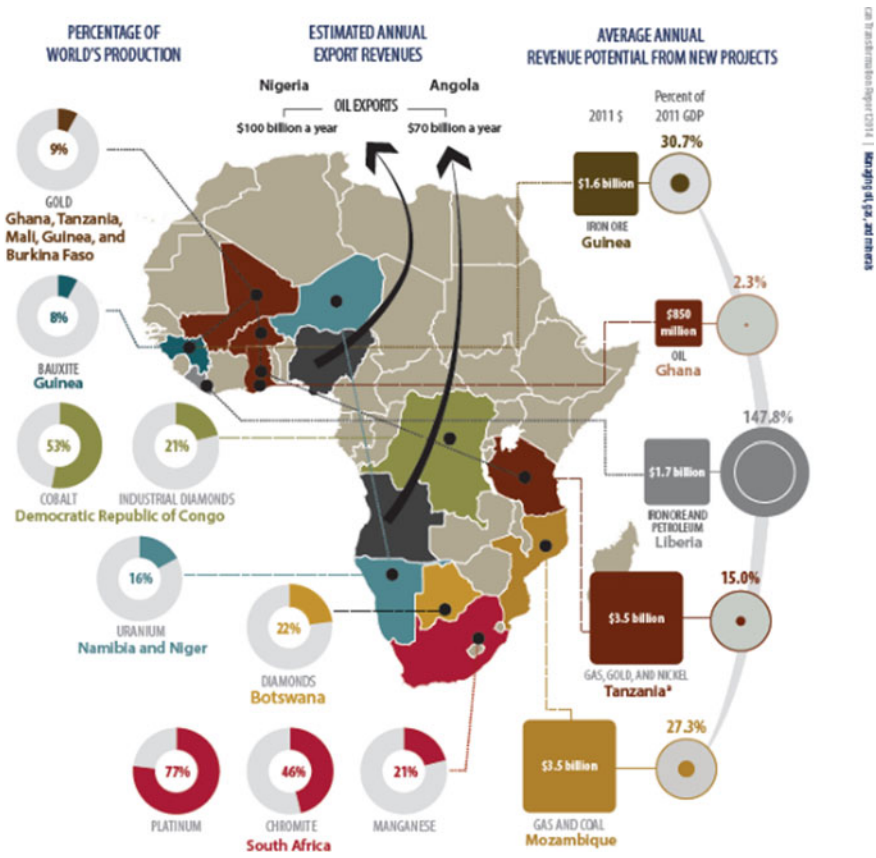

Fig. 1 Examples of Africa's natural resource wealth. *Source* ACET, 2014, p. 131

technologies, digitilisation and (youth) techno-preneurship (AUC 2020; Daniels and Tilmes 2020). Relatedly, national governments across the continent are now beginning to revise and update relevant policies and strategies (such as STI, ICT or software policies) with relevance to digital technologies, formulate data policies, or set up commissions on the Fourth Industrial Revolution (4IR). These are positive developments and radical changes in the right direction. The trend currently observed is an evolution from science and technology (S&T) through STI policies to digital policies and strategies (AUC, 2020). As Africa makes progress in digital technologies and digitalisation, indicators and metrics for measuring the digital entrepreneurship ecosystems (DEE), using an agreed Digital Technologies and Entrepreneurship Index, will be essential for monitoring and evaluating progress and the contributions of digital technologies to socio-economic development and transformative change.

Despite the progress and positive trends articulated above, a situational analysis of Africa's efforts[1] at development (through the promotion of entrepreneurship, technology commercialisation, innovation and public policies), reveal that various gaps and challenges remain. A critical analysis of these efforts unveil several reasons why the respective initiatives, projects or programmes have produced less than optimum outcomes. Among the many structural issues faced by the continent, fundamental structural gaps include the lack of strategic long term approaches, persistent internal and external barriers to effective governance, large investments gaps in human capital and knowledge infrastructure, the disconnection between policy and society, weaknesses in the implementation of policies and strategies, the lack of systematic monitoring and impact assessment tools and frameworks (evidence base for public policy), as well as the low level of integration among African research, and STI systems.

In relation to technology, digital technologies and digitalisation for transformative change in Africa, the structural issues sumarised above are important barriers and factors to consider and address, if the continent is going to harness digital technologies and digitalisation for economic growth and development. Some of the key issues for digital transformation include the need to (i) significantly increase broadband and connectivity, and strive towards reaching universal broadband access in Africa (ITU/UNESCO 2019; OECD 2017); (ii) ensure that digital revolution and transformation contribute to addressing national, continental and the global UN's Sustainable Development Goals (SDGs) (TWI2050 2019); (iii) building capabilities and skills where they do not exist and strengthening them where currently exist (ACBF 2017; AOSTI 2013); (iv) reduce the cost of data while improving access, and (v) establish appropriate policies and regulations; alongside indicators, frameworks, systems and processes for measuring progress in the digital economy (OECD 2014).

Agenda 2063 and STISA-2024 makes explicit connections among innovation, entrepreneurship and technology. Relatedly, various policies recognise the importance of other enablers, such as, investments, capabilities and (digital) skills, and education, as articulated in CESA 16–25 (AUC 2016; 2014). These enablers are essential to promoting, enhancing and harnessing innovation, entrepreneurship and technology for development and transformation.

As the preceding discussions show, it is no longer in doubt that innovation, entrepreneurship, technology and public policies can play important roles in supporting Africa's economic growth and development aspirations (UNCTAD, 2019; World Bank, 2019). In realisation of this fact, stakeholders perspectives and practices are evolving, and policies[2] and strategies are being put in place at continental, regional and national government levels across Africa. Nevertheless, the processes, approaches, and practical steps required to unlock the full potential of innovation and entrepreneurship, and technology commercialisation for Africa's development and prosperity are far from clear. This chapter, and the entirety of the book, contributes in this regard by helping to improve the reader's knowledge and understanding of the

[1] For example, efforts since 1960 when the majority of the countries became independent.

[2] For example, the African Union (AU) Policy and Regulation Initiative for Digital Africa (PRIDA).

various ways that innovation, entrepreneurship, and technology commercialisation can improve the prospects of Africa's development and prosperity.

The concepts discussed and ideas put forward in this handbook contribute to addressing the identified gaps by providing fresh insights on entrepreneurship, technology commercialisation, and innovation policy in Africa. The background and perspectives are in line with international agenda of inclusive development, such as those articulated in the SDGs. In addition, the ideas advanced are in alignment with continental frameworks for development, for example, the Transformation Index and DEPTH (ACET 2014; see also ACET 2020). DEPTH is an African Transformation Index based on a set of transformation indicators: Diversification of production processes, putting in place mechanisms that help ensure that Exports are competitive, increasing Productivity across all sectors, Technology upgrade and application throughout the economy. The ultimate goal is to achieve improvements in Human well-being across the continent.

Furthermore, as discussed earlier, the ideas on innovation, entrepreneurship, technology commercialisation, and innovation policy in Africa put forward in this chapter and the rest of the book also align with, and draw from key Africa's continental agenda, strategies and policies, including Agenda 2063, STISA-2024, and CESA 16–25; alongside national entrepreneurship, science, technology, innovation, research and policy agenda in African countries. Finally, the contents of the book reflect standards and practices advanced in indices such as Global Entrepreneurship Development Index (GEDI),[3] and Global Innovation Index (GII)[4] in relation to their usefulness and applicability in African contexts.

What is in this book? Summary of the sections and chapters.

This book takes an innovation systems approach in exploring the issues around entrepreneurship, innovation and technology commercialisation and public policies, at systems level. The chapters unpack entrepreneurship and entrepreneurial ecosystems, technology commercialisation, innovation, and innovation policies in Africa. Although innovation (or STI, more broadly) policy is the focus, the discussions on policy apply to public policies in general, with particular emphasis on policies with bearing on innovation, such as industrial policies, research policies, finance policies, and procurement policies.

Innovation, entrepreneurship or technology, including the commercialisation of technologies, are not very useful in themselves except they lead to transformative change. To reiterate, by transformative change in this sense we refer to change that address specific pressing development, economic, social and environmental challenges confronting Africa and the world in general.

We group the chapters into three parts as follows, starting with Part I: Innovation, Entrepreneurship and Entrepreneurial Ecosystem in Africa; Part II: Technology Commercialisation in Africa; and, Part III: Future Directions for Entrepreneurship, Technology Commercialisation and of Innovation Policy in Africa. We provide brief summaries of the three different parts of the book below.

[3] https://thegedi.org/.

[4] https://www.globalinnovationindex.org/Home.

2 Part I: Innovation, Entrepreneurship and Entrepreneurial Ecosystem in Africa

In Part I we address issues related to the specificities of innovation, entrepreneurship and the entrepreneurial ecosystems in Africa. The chapters in this section focus on some of the key features of innovation systems and ecosystems for entrepreneurship in Africa. Together the chapters provide insights that help the reader to gain deeper understanding of conceptual, policy and empirical dynamics of innovation and entrepreneurial activities on the continent. Issues related to the readiness of the innovation systems for entrepreneurship in Africa (Chapter 2: The Readiness of Innovation Systems for the Fourth Industrial Revolution (4IR) in Sub-Saharan Africa) and strategies for addressing gender challenges in STEM and ICT, based on perspectives from Zimbabwe are covered in Chapter 3: Addressing the Digital and Innovation Gender Divide: Perspectives from Zimbabwe. This Chapter 3, Addressing the Digital and Innovation Gender Divide: Perspectives from Zimbabwe, also emphasise the importance of addressing gender divide in digital technologies and strengthening digital skills for women and girls. This is because, according the author, as we rise on the digital technologies and digitalisation value chain, the number of women engaged 'with' technologies drops significantly.

Chapter 4, "Mapping Entrepreneurial Ecosystem for Technology Start-ups in Developing Economies: An Empirical Analysis of Twitter Networks between Start-ups and Support Organizations of Nairobi's Digital Economy" maps the entrepreneurial ecosystem for technology start-ups and entrepreneurs using Nairobi's digital economy ecosystem as the illustrative case. The insights provide empirical analysis of Twitter networks between start-ups and support organizations, and provides useful lessons for other African countries and developing economies of similar status to Kenya. Lastly in this part of the book, in Chapter 5, we explore the question "What Do We Know About Nascent and Young Innovative Entrepreneurship in Africa"? Insights and Perspectives from Morocco, we explore the question "What do we know about nascent and young innovative entrepreneurship in Africa? The author provide insights and perspectives from Morocco to help answer the question and enrich the reader's understanding of the innovation and entrepreneurship ecosystems in Africa.

3 Part II: Technology Commercialisation in Africa

Part II adopts a more market-oriented perspective and critically examines innovation alongside *existing, emerging and future* models for technology commercialisation. The discussions in the chapters underline the major issues for innovation and entrepreneurship from sectoral, policy, practitioner and managerial perspectives. And implications the technology commercialisation. Chapter 6, in unpacking the challenges of the agribusiness sector in Kenya and opportunities from Smart Specialisation Policies delves deeper into Africa's innovation systems by investigating the agricultural innovation systems and agribusiness sector in Kenya. The analysis and discussions help to highlight opportunities for applying smart specialisation policies and strategies in achieving transformative change. Chapter 7, A Guideline for Technology Commercialisation in the 4IR provides a guideline for technology commercialisation in the 4IR era. This is followed by context-specific insights on new entrepreneurial narratives in urban West Africa, case studies of five innovation hubs and communities (Chapter 8, "New Entrepreneurial Narratives in Urban West Africa: Case Studies of Five Innovation Hubs and Communities"). Chapter 9 "Corporate's Enterprise and Supplier Development (ESD) for SMMEs Through Incubation Programme", focus on corporate enterprises and supplier development for small, micro and medium enterprises through the analysis of an incubation programme in South Africa.

4 Part III: Future Directions for Entrepreneurship, Technology Commercialisation and Innovation Policy in Africa

Part III focus on theories and frameworks for research, STI and policy in Africa. Chapters in this section of the handbook help to open up future perspectives on policy formulation, implementation, evaluation and governance models for innovation, entrepreneurship and technology commercialisation. The relevance of existing STI policymaking and implementation frameworks is discussed in the context of pressing societal challenges and in alignment with global development agenda. Part III starts with Chapter 10 "Research and Innovation Uptake Landscape in Rwanda: Analysis of the STI Framework", which examines the landscape for research and innovation uptake in Rwanda, an analysis of the STI framework and implications for entrepreneurship and technology commercialisation. This is followed by a critical review of policy instruments for promoting innovation in manufacturing small and medium enterprises in South Africa (Chapter 11: A Critical Review of Policy Instruments for Promoting Innovation in Manufacturing Small and Medium Enterprises (SMEs) in South Africa Entrepreneurship, Technology Commercialisation and Policy: Perspectives from SMEs in Africa). Chapter 12, "Challenges and Constraints for Government Agencies Supporting Firm Level Innovation: Some Reflections from South Africa" is a reflection on the challenges and constraints that government agencies face in supporting firm-level innovation in Africa. The chapter builds on insights from a government innovation agency in South Africa.

In concluding Part III and the book, in Chapter 13"Mapping the Potentials for Transformative Innovation Policies in Africa: Evidence from Côte d'Ivoire and Nigeria", we map the potentials for transformative innovation policies in Africa, based on evidence from Cote d'Ivoire and Nigeria. The chapter, using two West African economies, examine recent advances in innovation policy theory and practice in Africa and highlights some of the gaps in policymaking across the continent. The discourse builds on latest advances in innovation policy theory and practice in order to offer fresh insights on African countries' potentials for better-informed innovation, but also public policies in general, and policymaking. It is hoped that by implementing the ideas put forward in this chapter, public policies can lead to better development impacts across the continent. Issues ranging from coordination among innovation stakeholders, funding, human capital, infrastructure, and evidence gaps are discussed in terms of their influence on innovation strategy and policy implementation given economic, social and environmental and sustainability imperatives.

References

ACBF (2017) Africa Capacity Report 2017, Building Capacity in STI for Africa's Transformation

ACET (African Centre for Economic Transformation), (2014) 2014 African Transformation Report: Growth with Depth. ACET, Accra, Ghana

ACET (2020, forthcoming) African Transformation Report 3. Accra, Ghana: ACET

AfDB (African Development Bank) (2020) African Economic Outlook 2020: Developing Africas Workforce for the Future. AfDB. https://au.int/sites/default/files/documents/38116-doc-african_economic_outlook_2020_.pdf

AOSTI (African Observatory of Science, Technology and Innovation) (2013) Science, Technology and Innovation Policy-making in Africa: An Assessment of Capacity Needs and Priorities, AOSTI, Working Papers No. 2

AUC (African Union Commission), (2014) AU Strategy for Science, Technology and Innovation for Africa 2024, STISA-2024. African Union, Addis Ababa

AUC (2015a) Agenda 2063, The Africa We Want, Popular Version. AUC, Addis Ababa

AUC (2015b) Agenda 2063, First Ten-year Implementation Plan 2014–2023. https://www.un.org/en/africa/osaa/pdf/au/agenda2063-first10yearimplementation.pdf

AUC (2016) Continental Education Strategy for Africa (CESA) CESA 2016–2025. Addis Ababa, AUC

AUC (2020) The Digital Transformation Strategy For Africa (2020–2030). Available at https://au.int/sites/default/files/documents/38507-doc-dts-english.pdf. Accessed May 2020

AUDA-NEPAD (African Union Development Agency) (2019) African Innovation Outlook III. Johannesburg, South Africa: AUDA-NEPAD

Daniels CU, Tilmes K (2020, forthcoming) Leveraging Innovation Policies and Digital Strategies to Drive Transformative Change in Africa, In: African Transformation Report 3. Accra: ACET

IMF (2019) World Economic Outlook, July 2019: Still Sluggish Global Growth. https://www.imf.org/en/Publications/WEO/Issues/2019/07/18/WEOupdateJuly2019

ITU/UNESCO (2019) Connecting Africa Through Broadband A strategy for doubling connectivity by 2021 and reaching universal access by 2030—Broadband Commission Working Group on Broadband for All: A "Digital Infrastructure Moonshot" for Africa. https://www.broadbandcommission.org/Documents/working-groups/DigitalMoonshotforAfrica_Report.pdf

OECD (2014) Measuring the Digital Economy: A New Perspective. https://www.oecd.org/sti/ieconomy/9789264221796-sum-en.pdf

OECD (2017) Key issues for digital transformation in the G20. Report prepared for a joint G20 German Presidency/OECD conference Berlin, Germany 12 January 2017. https://www.oecd.org/G20/key-issues-for-digital-transformation-in-the-G20.pdf

TWI 2050—The World in 2050 (2019). The Digital Revolution and Sustainable Development: Opportunities and Challenges. Report prepared by The World in 2050 initiative. International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria. www.twi2050.org, available at: https://www.die-gdi.de/uploads/media/TWI2050-for-web.pdf

UNCTAD (2019) Digital Economy Report 2019. Value creation and capture: implications for developing countries. New York: United Nations

UNECA (United Nations Economic Commission for Africa) (2020) COVID-19 in Africa: protecting lives and economies. Addis Ababa, Ethiopia, Economic Commission for Africa

World Bank (2019) Nigeria Economic Update: Accelerating Economic Expansion, Creating New Job Opportunities. https://www.worldbank.org/en/country/nigeria/publication/nigeria-economic-update-accelerating-economic-expansion-creating-new-job-opportunities

Entrepreneurship, Entrepreneurial Ecosystem and Innovation in Africa

The Readiness of Innovation Systems for the Fourth Industrial Revolution (4IR) in Sub-Saharan Africa

Mafini Dosso, Chisom Ihebuzo Nwankwo, and Youssef Travaly

1 Introduction

The African continent is at the dawn of the Fourth Industrial Revolution (4IR), a profoundly transformative global process shaping the paths of our societies, economies, and cultures. A key distinctive feature of successive industrial revolutions is the energy resource being used to power our societies: while the first industrial revolution is powered by coal power plants, the second by electricity and oil power plants, the third by nuclear and natural gas power plants, the fourth industrial revolution will be powered by green energies. Technical achievements across the consecutive industrial revolutions is another key distinctive feature. From the first to fourth IR, we have witnessed successively the advent of steam engines, internal combustion engines, computers and robots and finally Artificial Intelligence, the Internet of Things, 3D printers and genetic engineering.

At the confluence of the digital, physical, and biological systems, the 4IR is already transforming our training, labour, production, business and innovation systems in unique ways (Schwab 2016; UN DESA/DPAD 2017; De Propris and Bailey 2020). The issues at stake and leapfrogging opportunities are even more considerable for agrarian systems that prevail in African economies. Estimates from the Next Einstein Forum underline that about 10 trillion per country will be needed to support the digital

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transition.[1] This figure underlines that the current levels of investments are far below the critical thresholds that would allow the continent to reap the benefits from the 4IR.

The new and emerging (combination of) technologies, materials and technology-enhanced processes and systems bring a wide array of possibilities for agricultural and industrial modernisation in sub-Saharan Africa. At the same time, the 4IR, and the pervasiveness of technologies 4.0, also impose or prompt new policy and regulatory approaches (AfDB 2019; UNIDO 2017). Nevertheless, many economies in sub-Saharan Africa still significantly rely on Industry 2.0 technologies and labour-intensive industries, thus reducing considerably the scope to compete at the global level. It means that there are also considerable risks to fail short of taking advantage of new technological developments. This will be the case if the appropriate scales of infrastructural, financial and skilled human resources are not committed in both the short and long terms.

This chapter reminds important challenges of the transition of sub-Saharan African countries towards Industry 4.0. It focuses on the readiness of their innovation systems in terms of infrastructure, education and skills, governance and demand and research and innovation potential (Sect. 2). Sect. 3 discusses the main challenges of micro, small and medium size enterprises (MSMEs) that dominate sub-Saharan African domestic fabrics. Then, Sect. 4 presents the upcoming Nigeria Cleantech Innovation Programme (NCIP) for start-ups and SMEs of the Federal Ministry of Science and Technology of Nigeria and it brings forward key recommendations from the Next Einstein Forum in order to upgrade African value chains. Section 5 provides a few concluding remarks.

2 Main Challenges for Digitalisation and Industry 4.0 in Sub-Saharan Africa

2.1 Infrastructure Readiness

Insufficient quality infrastructure affects the readiness of sub-Saharan African economies for the digital transition. The needs in terms of infrastructure are numerous and transversal. They refer to both basic transportation and mobility, to electricity and (fresh) water supply and distribution, to the information and communication technologies (ICTs) as well as to the facilities and equipment for undertaking science, technology and innovation (STI) activities (laboratories, biosafety labs, prototyping and demonstrations platforms and environments, technical and scientific equipment, tech hubs, incubators and accelerators, etc.).

[1] See at https://nexteinstein.org/wp-content/uploads/2020/02/SC-RW-OPS-03-02-2020-RFQ-WRITTEN-TRANSLATION.pdf.

Figures 1 and 2 picture the accessibility to electricity and internet for available sub-Saharan African economies. Access-to-electricity indicators compare for 48 countries the percentages of rural and urban population having access to electricity (bottom axis) and the time required to get the electricity, which is the number of days to obtain a permanent electricity connection (top axis). It captures the median

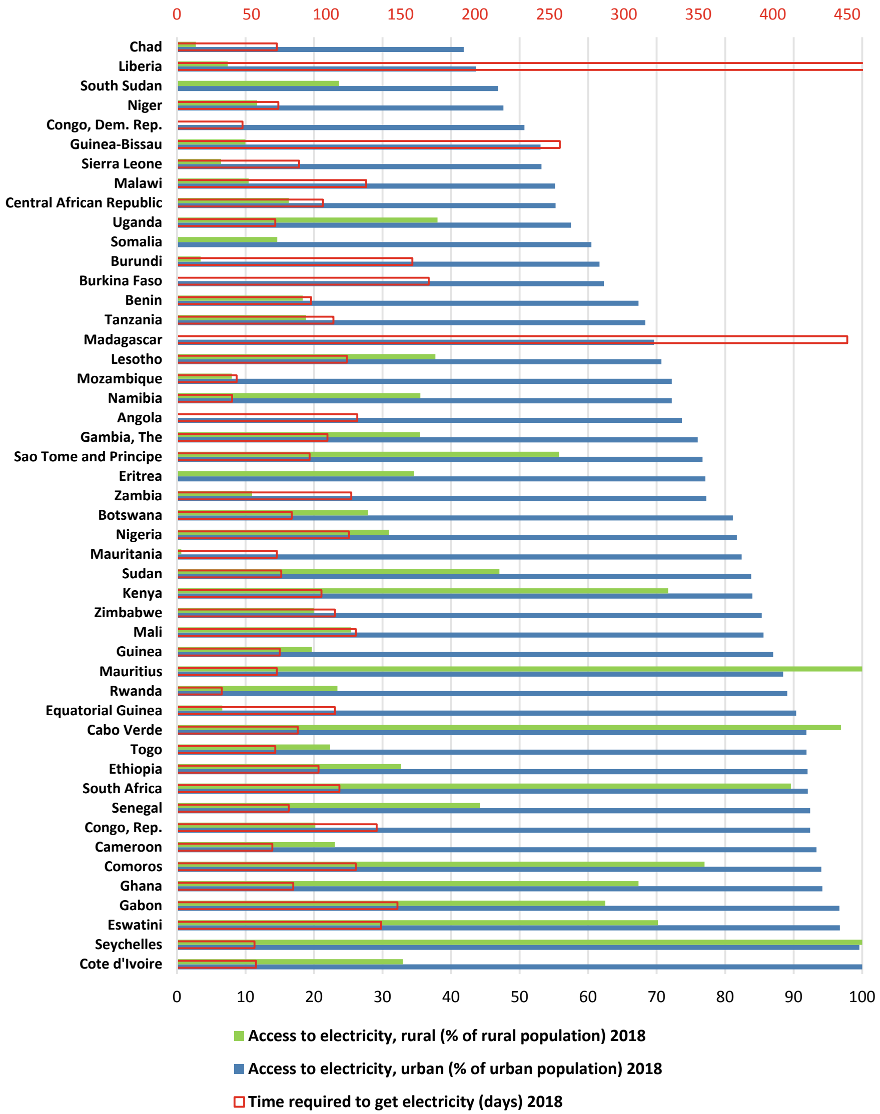

Fig. 1 Accessing electricity in rural and urban areas in sub-Saharan Africa (2018). *Sources* Authors' elaborations from World Development Indicators, WDI (World Bank Group)

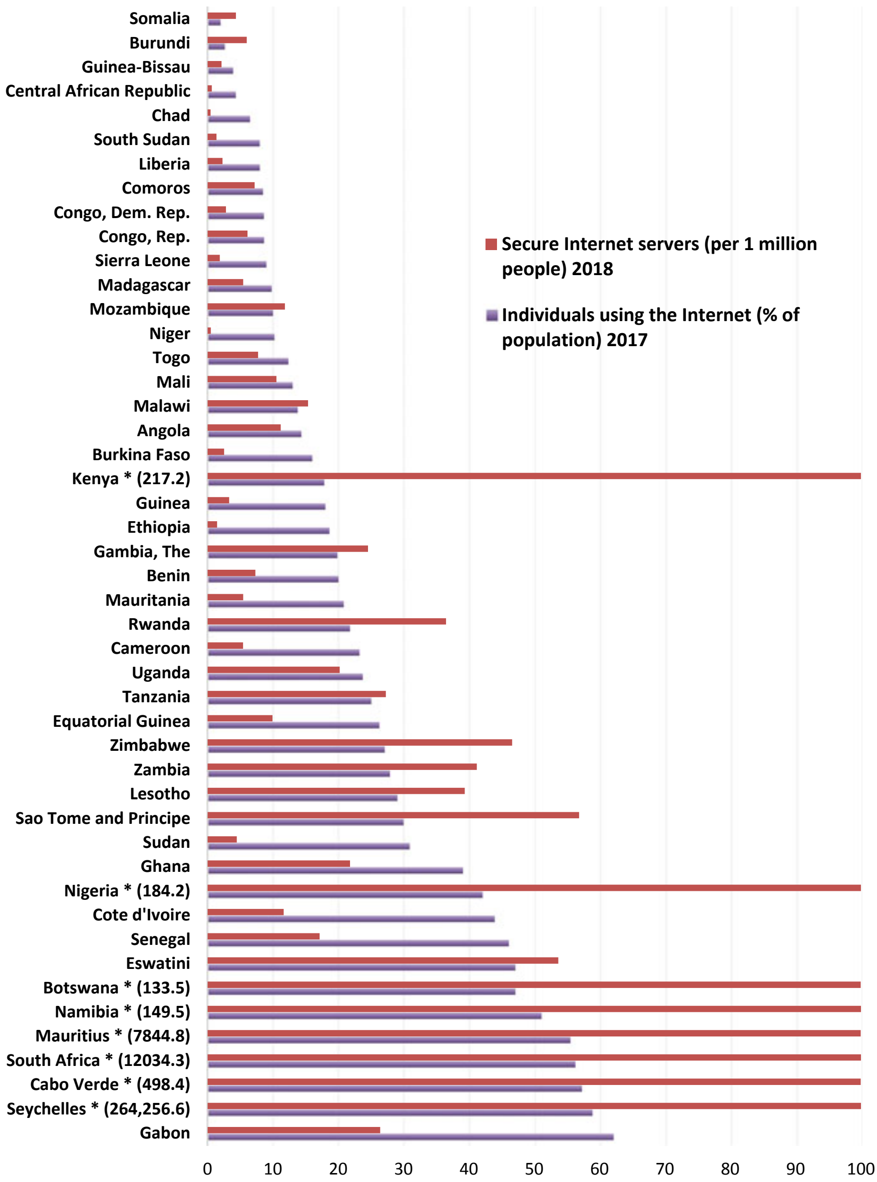

Fig. 2 Accessing (secure) internet in sub-Saharan Africa (2017 and 2018). *Sources* Authors' elaborations from World Development Indicators, WDI (World Bank Group). *Notes* * For readability purposes, the maximum of secure servers is set at 100, but values for the related countries are in brackets with the country name. For Sierra Leone, the number of severs is the value for 2017. Accessing internet via a computer, mobile phone, personal digital assistant, games machine, digital TV etc

duration that the electricity utility and experts indicate is necessary in practice, rather than required by law, to complete a procedure. Internet-related indicators capture the number of individuals who have used the internet (from any location) in the last 3 months and the number of internet servers per one million people (Fig. 2).

Besides the clear-cut electricity divide between urban and rural areas (except for Islands nations), only 15 countries out of 48 can reach about 90% or more of their urban population.

Less than 10% of the rural population in nine countries have access to electricity in 2018. The rural urban divide is even more so in countries such as Cameroon, Republic of Congo, Equatorial Guinea, and Mauritania where the gap is superior to 70%. A key implication is that these intra-country divides are seriously undermining the ability to achieve inclusive (digital) transitions and to reduce socio-economic inequalities. 'Time to get electricity' does not show more optimistic pictures as it can take more than 150 days to obtain a permanent electricity connection in Madagascar, Liberia, Guinea Bissau, Burkina Faso and Burundi.

Accessing to internet through a computer, mobile phone, personal digital assistant, games machine, digital TV or other devices is still a 'luxury good' across the majority of sub-Sahara Africa. Six out of the 47 economies—Gabon, Seychelles, Cabo Verde, South Africa, Mauritius and Namibia – have more than 50% of their population using internet in 2017, while the percentages for all sub-Saharan African economies remain well below this threshold. The number of secure internet servers, here referring to the number of distinct, publicly trusted TLS/SSL certificates,[2] suggest that the continent is not yet ready to embrace the digital revolution.

The fast penetration of mobile phones and smartphones on the continent can generate inclusive impacts if countries are able to leverage upon existing technological solutions and to ensure a wider access to stable electricity and internet, especially in rural and remote areas. Alternative projects led by world corporate IT giants exist. They aim to implement rural wireless broadband through spectrum sharing technologies, which can open up local markets to novel ICT service providers and eventually more affordable solutions (Chawdhry 2017; UNESCO Institute of Statistics (UIS) 2015).

2.2 Education and Skills Readiness

Important gaps remain for sub-Saharan Africa to reach critical masses of human capital to achieve transformation in priority economic sectors. On the continent, this requires efforts at all levels of education and for curricula development from early childhood and basic education to higher education levels. The policy frameworks of the African Union, namely—the Continental Strategy for Technical and Vocational Educational and Training (AUC, African Union Commission 2018); the

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[2]See thematic explanations and survey outputs at https://www.netcraft.com/internet-data-mining/ssl-survey/.

Continental Education Strategy for Africa 2016–2025, CESA 16–25 (AUC 2016) and; the Science, Technology and Innovation Strategy for Africa, STISA 2014–2024 (AUC 2014) – reaffirm the pressing need to enhance the scale and quality of our education and training systems, as well as the training of our trainers or teachers and professors. The latest decade's efforts from international and continental institutions to stimulate pan-African cooperation for excellence researchers, education and vocational training translate these commitments to foster skilled labour and human capital bases across the continent.

The Pan African University is an academic network of existing African institutions operating at graduate level. It is a continental flagship initiative of the African Union Commission in 2011. To date, more than 1200 students across the continent have graduated from the PAU. The PAU is made up of seven thematic institutes located for their majority within existing African universities, as it follows:

- The PAUWES, the PAU Institute for Water and Energy Sciences, including Climate Change at The Abou Bekr Belkaid University of Tlemcen in Algeria;
- PAULESI, the PAU Institute for Life and Earth Sciences, including Health and Agriculture at The University of Ibadan in Nigeria;
- PAUSTI, the PAU Institute for Basic Sciences, Technology and Innovation at The Jomo Kenyatta University of Agriculture and Technology in Kenya
- PAUGHSS, the PAU Institute for Governance, Humanities and Social Sciences at The University of Yaounde II in Cameroon and;
- The PAVEU, the Pan African Virtual and e-university (Cameroon);
- The Entrepreneurship Hub (Algeria).[3]

The Africa Higher Education Centers of Excellence (ACE) initiative of the World Bank has already supported more than 40 centers of excellence across the continent. ACE I has targeted 19 centers in West and Central Africa and ACE II targets 24 centers in Eastern and Southern Africa. Since 2013, the two programmes have contributed to enhance quality post-graduate education and research collaboration with a focus on five priority areas that include industry, agriculture, health, education and applied statistics.

Grasping technology and innovations opportunities from the 4IR in order to achieve industrial transformation agendas depends on the availability of local Science, Technology, Engineering, and Mathematics (STEM) graduates and capabilities for excellence research. According to Blom, Lan and Adil, the large STEM gap in sub-Saharan Africa actually relates to the low quality of basic education in science and mathematics; a bias towards disciplines such as the humanities and social sciences rather than STEM and; the high dependency on international research funding which prioritize health and agricultural research (Blom et al 2016). Together with traditional education systems, training programmes for entrepreneurship culture and talent will allow local workers to contribute to the creative destruction processes and to cope with the disruptions of the new and emerging technologies (World Economic Forum, WEF 2019).

[3]https://pau-au.africa/.

The integration and upgrading of regional and global industrial value chains will remain a promise if the matching between 4IR's human capital requirements and the local labour supplies does not materialise. Briefly, it means that although national industrial transformation agendas and objectives are ambitious, they may not actually favour the construction of sustainable local knowledge bases. In this perspective, further coordination across ministerial departments and structures and, target public–private and university-industry partnerships would actually enhance the supply of relevant skills, while eventually reducing local unemployment. Moreover, improving the readiness of our training environments and classrooms for the 4IR is contingent to the availability of computers, computer-assisted instructions and laboratories with access to stable electricity and high-speed internet. So far, they remain very scarce (UNESCO Institute of Statistics (UIS) 2015).[4]

2.3 Governance and Demand Readiness

Rationales for supporting transitions to industry 4.0 are numerous owing to its expected impacts on our well-being and our economies (Dosso 2020; UNIDO 2017; Schwab 2016). The 4IR calls for new policy developments and adaptive governance to seize the opportunities and anticipate on the potential societal impacts of technologies on different users groups, with a particular attention on the most vulnerable socio-economic groups, the informal sector activities and users from rural areas. Due to the pervasiveness of novel and emerging technologies, the responses will combine multilevel policy mixes and instruments that will entail long-term interactions across different geographical levels of governance, together with specific needs for coordination and collaboration across ministries and thematic agencies, among others.

Policy technical and management skills and, policy learning in the forms of regular capacity-building/upgrading programs are thus instrumental to ensure an effective implementation of more agile and anticipatory governance schemes. With the current obsolete governance systems, African economies will hardly cope with the spatial and temporal issues raised by the 4IR. The latest policy recommendations from the AfDB underline at least four action areas, including a coordinated vision consistent with other pan-African policy frameworks and initiatives, the institutions preparedness and institutional creation for data challenges, collaborative governance and agile regulations and the setting up of inclusive institutions for the diffusion of the 4IR technologies (AfDB 2019).

Besides the nascent regulatory frameworks for digital technologies, policy learning and upgrading should also take place in the areas of competition, consumer

[4] See also estimates of the share of households with a computer at home from 2005 to 2019 at https://www.statista.com/statistics/748549/africa-households-with-computer/.

data and privacy protection as well as for the elaboration of cybersecurity legal frameworks. The continent is increasingly becoming both a source and a victim of cyberattacks and financial companies and banks frequently report attacks and considerable losses. According to Kshetri, the main causes reside in the vulnerability of systems and lax cybersecurity practices, non-significant or non-existent dedicated organisational budgets, the shortage of specialist manpower, the lack of employees' and users' internet skills and weak legislation and law enforcement (Kshetri 2019). Together with the difficulty to coordinate across territories or state and country borders, these factors may make the transition costs unbearable, even in front of the high potential benefits from the digitalisation and the 4IR.

Relatedly and in spite of rising online activity mainly from urban centres, it is clear that proactive users-oriented policy are essential to attenuate scepticism, to boost trust in digital transactions and to raise digital literacy levels. Here, the digital literacy goes beyond the ability to handle clear information through using digital media and platforms. Indeed end-users are the weakest link of the digital infrastructure and therefore cyber risks awareness becomes an integral dimension of digital or ICT policy planning on the continent (Nordvik et al. 2017). The dual challenge thus consists in seeking the balance and flexible governance to stimulate the demand for the adoption and diffusion of digital and industry 4.0 technologies, while promoting intellectual property protection, responsible online behaviours and preventing criminal uses.

2.4 Research and Innovation Readiness

Investment in research and development and local initiatives to support innovation are gradually expanding on the continent. However many indicators such as the gross expenditures on R&D (GERD), number of researchers, total scientific publications, patents and other intellectual property rights – locate sub-Saharan Africa in the lower reaches of the world STI rankings (UNESCO 2015; WIPO 2019).[5] Although innovation hotspots are also emerging on the continent, it appears that they do not match with corresponding high innovation densities. Africa, likewise Latin America, is still at the tail of the knowledge globalisation trends. Moreover, the continent increasingly relies on technological knowledge developed outside Africa, sourcing knowledge for instance from US-, Western Europe- and China-based inventors (WIPO 2019).

Figure 3 above suggests a significant geographical concentration in the production of scientific knowledge. In the region, South Africa and Nigeria have relevant potentials to position themselves as regional driving forces to unlock continent-wide science collaboration and synergies. Moreover, recent estimations of the scientific collaboration intensity suggest that African science seems either to be increasingly influenced by non-African agendas or to be more integrated in the global science agendas (Cassi, Dosso and Mescheba 2018, see also AOSTI 2013).

[5] See also R&D data release for 2018 at: https://uis.unesco.org/en/news/rd-data-release.

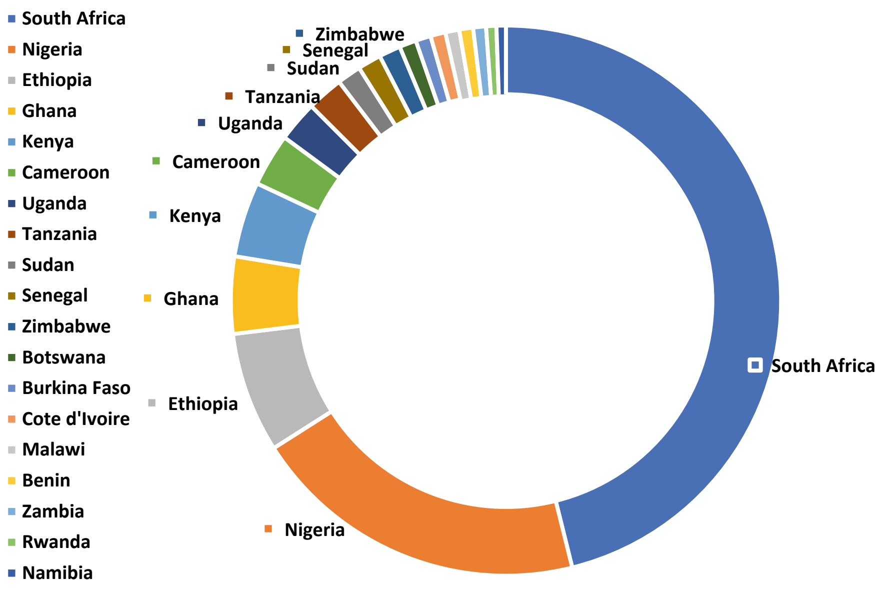

Fig. 3 Scientific and technical journal articles 2018. *Sources* Authors' elaborations from World Development Indicators (World Bank Group). *Notes* Scientific and technical journal articles refer to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences

Initiatives are flourishing on the continent in the form of incubators, accelerators, digital co-creation spaces (see Dosso et al. and their references, *this book*), innovation funds and prizes, doctoral grants schemes, scientists mobility programmes, technology transfer and exploitation offices, international cooperation projects, networks and centers of excellence and science and technology parks. Yet, African firms tend to innovate through acquisition of machinery and equipment, rather than by undertaking R&D activities (AUDA-NEPAD 2019). The prospects for adoption of enabling technologies are much narrower if one considers also the low propensity to innovate in universities and government research institutions; they are even so for the creation of new technologies in the digitalisation era.

Increasing the funding for research and innovation will be instrumental to keep the related achievements alive and sustainable. Bridging these initiatives is not only desirable but also vital to ensure that synergies emerge towards achieving sustainable transitions. In parallel capacity building for STI policy implementation and the uptake of place-based and strategic approaches to STI-led transformation could unleash greater outcomes from the low resources available for STI activities in the sub-Saharan African region (Dosso et al 2017, Dosso 2019; Daniels and Dosso, this book).

3 Readiness of Local Ecosystems' Actors for the 4IR

Improving the business ecosystem and support services is one of the three lines of recommendations of the AU-EU Digital Economy Task Force (AU-EU DETF 2019). The business climates are gradually improving across the region in particular for business creation, for handling construction permits and getting credit; at the same time, African businesses take more than 90 h for imports documentary compliance and pay taxes more than 36 times a year against a global average of 23 times (World Bank 2020). Figure 4 below gives an overview of the main business obstacles for SMEs in sub-Saharan Africa. Access to finance and to stable electricity are the two main challenges of SMEs, which are also subjected to some competition of informal sector activities. Political instability and tax rates come as the following barriers for SMEs' operations in the region.

The environments remain quite hostile for the survival and growth of small and medium size enterprises (SMEs). In contrast, they provide 80% of jobs and represent 90% of all companies on the continent. In their search for funding, SMEs have to overcome multiple obstacles including the lack of functional capital markets, the low visibility next to investors, high interest rates and often inexistent government-led

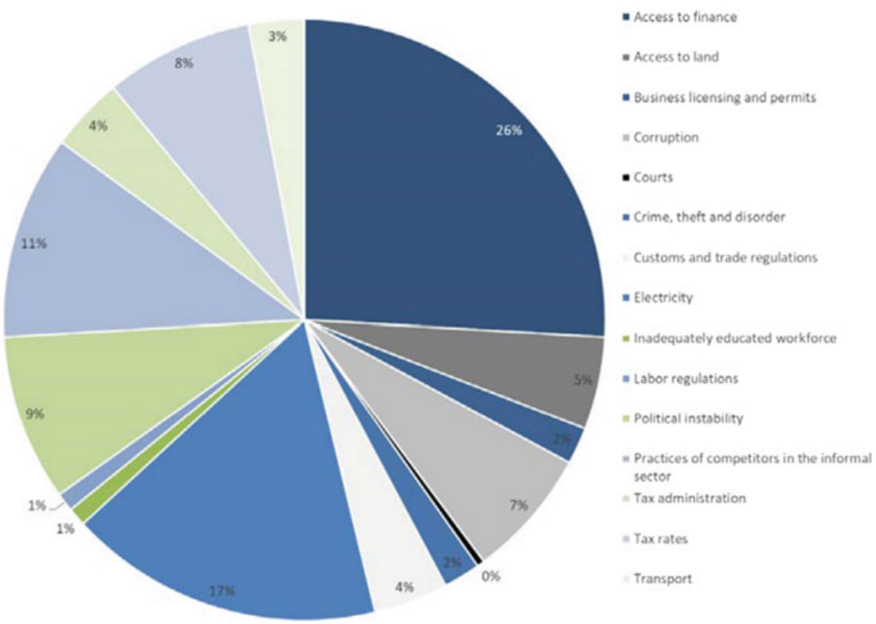

Fig. 4 Business obstacles of SMEs in sub-Saharan Africa. *Source* World Bank Enterprise surveys. $N = 13{,}722$ (number of enterprises-years). Survey years: 2011–2017 in sub-Saharan Africa. See the reference to the World Bank Enterprise surveys at: https://www.brookings.edu/blog/africa-in-focus/2018/11/30/figures-of-the-week-financing-for-small-and-medium-sized-enterprises-in-sub-saharan-africa/

SMEs strategy (LSEG Africa Advisory Group 2019).[6] Other intrinsic factors limit the access to finance such as the ownership, the lack of managerial capacity and experienced top management, of financial reporting skills and mature business and technology development models.

The low readiness of physical and digital infrastructure and funding systems for the digital transition further fragilize local ecosystems' actors, mainly SMEs. This picture contrasts with the trends for venture capital and digital start-up financing, which are reaching records in a few economies and sectors on the continent. In addition of peers- and network support from local actors such as accelerators or networking platforms, the adoption or development of financial and technological innovations may actually help easing the access to funding. The opportunities for innovation are numerous, so are the challenges of SMEs in the digital transition. The new technologies offer several prospects for SMEs in terms of enhanced production and productivity, new business models, traceability, access to information and local markets or retailers, farmers and services providers relationships, product customisation, logistics and supply chains management as well as for accessing regional and global markets and value chains. However, important barriers for technology diffusion and the uptake of technology-based innovations remain the low awareness, trust and technology literacy, the constraints to technology adoption, the absence of technology watch and market intelligence capabilities and a local culture often not favourable to practices and knowledge sharing. Furthermore, with more than 80% of the workforce active in the informal sector, the risks for inequality-enhancing digitalization are real, especially for women and the most vulnerable socio-economic groups. Indeed, with a lower propensity to access and use mobile technology and internet, women are at threat from a greater inequality as compared to their male counterparts (AUC 2020).

A recent set of studies funded by the African Development Bank provides in-depth perspectives of disruptive technologies—namely AI, IoT, Big Data, 3D printing, Blockchain and drones—across selected sectors and a few African economies including Cameroon, Morocco, Nigeria, South Africa and Uganda (see Table 1 for descriptions of major disruptive or emerging technologies). The sector of interests reflect the High 5s Agenda of the African Development Bank (AfDB): Feed Africa (agriculture); Improve the quality of life for the people of Africa (health, education, smart cities); Industrialize Africa (industry and services); Integrate Africa (regional integration); Light up and Power Africa (energy).[7]

[6]See additional thematic reports on Africa capital markets at https://www.lseg.com/resources/lseg-africa-advisory-group.

[7]See AfDB (2019) for a synthesis report; all individual case studies are available at https://4irpotential.africa/ (Access May 2020). The report was prepared by the joint venture composed of the consulting firms Technopolis Group, Research ICT Africa and Tambourine Innovation Ventures under overall coordination of Thierno Mountaga Diarra, Principal IT Solution Architect at the AfDB.

AfDB's High 5s Agenda builds upon the Ten Year Strategy (TYS) for 2013–2022, which supports the achievement of inclusive growth and the transition to green growth through five operational priorities: infrastructure development, regional economic integration, private sector development,

Table 1 Brief description of key emerging technologies (Technopolis Group 2019)

Emerging technologies	Description
Artificial intelligence	System recognising complex patterns, processing information, drawing conclusions and making decisions. System which may evolve in the future and which would be truly autonomous in its reasoning and thinking and be able to improve itself entirely independently from humans
Big Data analytics	Complex process of examining large and varied data sets (Big Data) to uncover information including hidden patterns, unknown correlations, market trends, customer preferences and other relevant insights that can help organisations make informed decisions
Blockchain	Delivery of computing services (servers, storage, databases, networking, software, analytics, and intelligence) over the internet ('the cloud')
Fifth-generation wireless (5G)	Latest iteration of cellular technology engineered to greatly increase the speed and responsiveness of wireless networks
The Internet of Things (IoT)	System of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction
Autonomous vehicle	Driverless vehicle that can move and guide itself without human input
Drone	Unmanned flying vehicle that is controlled remotely
Additive Manufacturing	Process of producing products by computer-aided, layer-by-layer addition of material(s), application of this 3D printing technology on an industrial scale
Quantum computing technologies	Quantum computers leverage quantum mechanical phenomena to manipulate information, relying on quantum bits, or qubits

(continued)

Table 1 (continued)

Emerging technologies	Description
Virtual reality (VR)/Augmented reality (AR)	VR: artificial, computer-generated simulation or recreation of a real-life environment or situation AR: technology that layers computer-generated enhancements on top of an existing reality in order to make it more meaningful through the ability to interact with it
Robotics	Industry related to the engineering, construction and operation of robots (machine designed to execute one or more tasks automatically with speed and precision)

Source elaborated by Technopolis Group, reference in AfDB 2019

The country case studies confirm that the use of enabling or emerging technologies is either nascent or 'not very present' in the selected sub-Saharan African countries. Yet the potential applications and impacts are considerable, while local pockets of innovation dynamics emerge with the increase of use cases in different industries (see the country cases for Cameroon, Nigeria, Uganda and South Africa at https://4irpotential.africa/; IMF 2019; UNECA 2017).

Increasing the adoption rates and digital capabilities of SMEs in sub-Saharan Africa also implies to raise awareness and the capabilities of local industrial and business associations and chambers of commerce. They are key ecosystems-enabling actors thanks to their information, networking, promotion and training activities, to their regular interactions and to their privileged proximity with local companies. They are well positioned to accompany SMEs in their digital transition and their uptake of enabling technologies. Nevertheless, several capability and infrastructural challenges still undermine the awareness raising in the sector and their own digital transition, thus further reducing the readiness of local ecosystems for the fourth industrial revolution.

governance and accountability, and skills and technology. See the details of each priority area at: https://www.afdb.org/en/high5s.

4 Perspectives from the Nigeria Cleantech Innovation Programme and the Next Einstein Forum (NEF)

4.1 Nigeria Cleantech Innovation Programmes (NCIP) for Start-Ups and SMEs

Nigeria's population is the seventh largest in the world, with more than 202 million people. The country represents over 50% of the West African Market, with a Gross Domestic Product (GDP) growth of 1.8% in 2018. Nigeria is a lower middle-income developing country with a GDP per capita of $2,028.18 in 2018 (World Development Indicators, World Bank Group). Nigeria has a growing population of MSMEs also supported by the new interventions of the federal government through the central Bank of Nigeria. Nevertheless, there are still enormous challenges, especially in the development of clean technology for MSMEs in the country. The country fails to provide affordable technology in terms of energy, machinery and power to an increasingly number of medium and small-scale businesses, which should be the key drivers of the local economy.

Major factors that are hampering the growth of MSMEs in Nigeria are the following ones:

- Lack of technology innovation platforms specifically tailored for and targeted to clean energy technologies, Start-ups and SMEs;
- Inadequate capacity to encourage and contribute to the dynamism of SMEs in clean technologies innovations, market transformation and economic growth;
- Lack of financial schemes, requirements and procedures to access financing for clean energy projects and limited government financial incentives to support industrial enterprises in the uptake of innovations in clean energy technologies;
- Inadequate capacity for the mentoring of start-ups and entrepreneurs actively involved in cleantech innovations;
- Limited coordination amongst sectorial players on market intelligence research;
- Insufficient enabling regulatory environment to actively support innovations in SMEs clusters;
- Limited examples and insufficient dissemination of success stories of SMEs-led technology innovations, leading to persistent low attention to change and to high-risk/capability-gap perception.

The Nigeria Cleantech Innovation Programme (NCIP) is a flagship programme of the Federal Ministry of Science and Technology (FMST)[8] and the Board for Technology Incubation (NBTI). National policies that support the programme include the National Science, Technology and Innovation roadmap (NSTIR) 2030, the National Policy on Environment, the Renewable Energy Policy and the Economic Recovery and growth Plan (ERGP) 2016–2020.

[8]See the programmes and projects of Nigeria's Federal Ministry of Science and Technology at https://scienceandtech.gov.ng/programmes/.

The NCIP for Start-ups and SMEs intends to build on national initiatives with the aim to foster innovation ecosystems in the country through the promotion of clean innovative technologies and solutions. Under the following thematic areas, the NCIP is expected to empower at least ten thousand 10,000 Nigerian businesses with clean green technology by the year 2023. The thematic areas include:

(1) Creation of a national platform to promote clean technology innovations and business models in Nigeria.
(2) Provision of an advanced investment and commercialization support for select technology start-ups and SMEs.
(3) Institutionalisation of a policy and regulatory framework for a strengthened national cleantech entrepreneurship ecosystem.

The target domains and technologies include for instance solar powered factories and machinery, Greenhouse Gas (GHG) emission-compliant machines and factories, adequate waste disposal plans and procedures, technology transfer abilities for local businesses in Nigeria, technology incubation centers for specific industries, funding and pitching opportunities from venture capitalists and angel investors, as well as for world class Nigeria-made goods.

The outputs of the programme expected to start in 2020 include:

- Identifying and supporting cleantech innovators and entrepreneurs in seven key sectors of the economy: Education, Health, Energy, Waste Management, Water, Green Cities and Transportation;
- Promoting the upscaling, commercialization and market adoption of innovations of Clean Technology Startups and MSMEs in Nigeria;
- Delivering on global environmental benefits including reduction in emissions, fossil fuel consumption, ground water contamination, Food security amongst others;
- Strengthening the national technology incubation system through the nurturing of nascent industries;
- Harnessing the resources of local and international partners to invest and support cleantech innovations, products and services developed by Nigerian MSMEs;
- Providing a strong mentorship platform for the Cleantech MSMEs;
- Creating a platform for massive job creation and green socio economic transformation. National Science, Technology and Innovation (NSTI) Policy.

The programme should rely on a mix funding mainly from international organisations with the co-financing of the Federal Ministry of Science and Technology and private investors (business angels, venture capitalists and innovation hubs).

4.2 Transitions Towards Green and Sustainable Production Systems: Perspectives and Recommendations from the Next Einstein Forum

The Next Einstein Forum (NEF) is a platform that connects science, society and policy in Africa and the rest of the world. NEF advocates the exploitation of science for human development at the global level and the contribution of Africa to the global scientific community. NEF stimulates African scientific renaissance and puts forward the ability of Africa not only to host the next Einstein, but also to make Africa a global science and technology hub. NEF has four interrelated programmes including the following ones:

- The NEF Global Gathering are biennial gatherings of political science and industry leaders with a strong focus on youth and women.
- The NEF Policy Institute provides continent wide benchmarking activities and indexes other White Papers and opinion as well as ongoing roadmapping process for Africa's digital economy.
- The NEF Community of Scientists made up of NEF Fellows and Ambassadors. The NEF Fellows Programme showcases the best young scientists from Africa on the global stage. NEF Ambassadors are the young science and technology champions, one from each African country where he or she leads the organization of the Africa Science Week.
- The NEF Platform is a public engagement platform, focusing on content disseminated online and on social media.[9]

The inaugural forum took place in Senegal in 2016. In 2018, the event has gathered over 1500 delegates from 91 countries, with over 50% of participants under 42 years of age with at least 40% of women. The exchanges and debates focused on the ways to advance on the transitions towards green national energy systems, to boost investment for women in STEM and the training of all national medical students and current medical practitioners in Preventive, Predictive and Personalised Medicine (PPPM) practices by 2022.

Research at the NEF also addresses new economies and the 4IR with a thematic focus on the Digital Economy, the Low Carbon Economy, the Circular Economy, and the Shared Economy. A main aim is to assess the readiness of the continent from the human capital, policy and investment perspectives.

The transition to green energy and sustainable production systems come with "new" economic models as well as important opportunities for the formalisation of "ancient" economic models. The economy of the future is certainly digital, but it will equally be circular, shared, and low carbon. Latest trends confirm an increasing attractiveness for Uber like services, the increase of Airbnb users and Airbnb like

[9] More information is available at https://nef.org/.

services and a nascent recycling culture. Programmes and use cases of renewable energies are also rising in many countries and communities of the continent.[10]

Emphasis on cost and risk sharing is not new on the continent and it has come about out of necessity. This is the case of the informal monetisation of assets such as sharing a car or renting out a spare room. African populations have also been experimenting with the sharing economy, albeit informally. Moreover, on the continent, the majority of countries rely heavily on fossil fuels and comprehensive waste management strategies remain rare.

Africa has what it takes both in terms of culture and in terms of resources to embrace the circular economy. "All that is left is to create a continental blueprint to ensure that the transition is inclusive and job creating, particularly for young people and women."[11] This continental blueprint should in addition ensure that the following recommendations are accounted for :

- Design the Sustainable Mobility's trajectory for the Continent: policies, regulations, investments and partnerships required to implement green mobility;
- Drive a responsible digital transformation in healthcare that tactfully balances high tech and low-tech solutions, that ensures it can be designed and managed locally minimizing the dependency on external expertise, funds, technology or unreliable energy sources for instance;
- Pave the way for the future of payments in the African financial sector by framing policies and the role of each stakeholder in driving innovation and the adoption of the digital economy in the financial sector;
- Enable digital sovereignty by anticipating the possible damages from the digitalisation in particular on Africa considering the decentralized extraction of data through communication networks developed and owned by non-African tech companies;
- Build economy specific skillsets through "Best Practices Academia-Industry Partnerships" to: (1) strengthen research and tech transfer in higher education to foster innovation and start-up creation; (2) create a job pipeline of skilled labour on the continent fit for the new economies (digital, gig, low carbon, circular etc.);
- Foster inclusive AI solutions through regulations and policies that support the development of safe and inclusive solutions. This will allow African actors to tap

[10] In 2017, Little Cabs, a car sharing company run by SAFARICOM saw explosive growth, hiring 2,300 drivers and gaining 90,000 active accounts in its first five months.

Rwanda has developed a strategy to harness energy from the few green energy resources. The strategy is deployed in partnership with a private company with the objective to set up a methane gas plant with a capacity of 56 MW (estimated costs of $200 million) with the government providing the required infrastructure to connect the new plant to the national grid. This is in addition to other projects such as Hakan Peat Power plant, and Rusumo hydropower plant under construction with a capacity of 80 MW to be shared between Rwanda, Burundi, and Tanzania.

In Burkina Faso, SMEs have developed agro-ecological projects where traditional skills and new methods make it possible to reuse production residues to make improved compost or treat compost. See NEF reference at https://nexteinstein.org/wp-content/uploads/2020/02/SC-RW-OPS-03-02-2020-RFQ-WRITTEN-TRANSLATION.pdf.

[11] Same link as right above.

into the expected $15.7 trillion that AI will add to the global economy by 2030 in order to accelerate its economic development.

5 Concluding Remarks

Sub-Saharan Africa is not yet ready to embrace the digital and the fourth industrial revolutions. Shortages in terms of infrastructure for mobility, stable electricity supply and distribution, secure internet and water management affect the daily livelihood of populations. They also continuously undermine and even halt MSMEs business and production activities. The low preparedness of our human capital, research and innovation systems, financial markets, and the obsolescence of governance schemes add to the infrastructural deficiencies. The risks to lag further behind and the costs of opportunities can be considerable for our fragile socio-economic systems.

Nevertheless, some use cases of enabling technologies that spread sparsely across the continent suggest that digitalisation and the 4IR technologies can indeed find their way through sub-Saharan African economies. For the revolution to take place, many forces should come together to connect the isolated actions and to reconcile top-down and bottom up perspectives for a broader diffusion of digital and emerging technologies. Such integrative actions are even more instrumental for the continent to be at the forefront of scientific and technological revolutions.

African-led actions and initiatives are flourishing such as the African Continental Free Trade Area (AfCFTA), the Next Einstein Forum (NEF), the African Academy of Sciences and national academies and Smart Africa, among other ones. They bring multi-stakeholders' answers to pressing challenges that the continent has to overcome to build up strong science capabilities, a digital single market and a single continental market for goods and services.

Other pre-requirements of the third and fourth industrial revolution relate to the strength of intellectual property (IP) systems in the context of interrelated innovation systems. However, the current situation indicates that MSMEs in sub-Saharan Africa lack an adequate understanding of IP protection or fear the theft of ideas and projects. Owing also to the scarcity of IP law specialists, MSMEs are therefore not able to assess properly the costs and returns of the investments to protect, defend and exploit their innovations. The potential losses and the opportunity costs may be considerable for the sub-Saharan African MSMEs, economies and communities.

References

AfDB (2019) Potential of the Fourth Industrial Revolution in Africa. African Development bank Group: Abidjan, Côte d'Ivoire

African Observatory of Science, Technology and Innovation (2013) Assessment of Scientific Production in the African Union, 2005–2010, Malabo: The AOSTI

AUC, African Union Commission (2018) Continental strategy for technical and Vocational Educational and Training (TVET). Available at https://au.int/en/documents/20181022/continental-strategy-technical-and-vocational-educational-and-training-tvet

AUC, African Union Commission (2016) Continental Education Strategy for Africa (CESA) CESA 2016–2025. Addis Ababa, AUC

AUC, African Union Commission (2014) AU Strategy for science, technology and innovation for Africa 2024, STISA-2024, Addis Ababa: African Union

AU-EU DETF, AU-EU Digital Economy Task Force (2019) New Africa-Europe Digital Economy Partnership—report of the EU-AU Digital Economy Task Force. Available at: https://ec.europa.eu/digital-single-market/en/news/new-africa-europe-digital-economy-partnership-report-eu-au-digital-economy-task-force

AUC, African Union Commission (2020) The digital transformation strategy for Africa (2020–2030). Available at https://au.int/sites/default/files/documents/38507-doc-dts-english.pdf. Accessed May 2020

AUDA-NEPAD (African Union Development Agency) (2019) African Innovation Outlook III. Johannesburg, South Africa: AUDA-BEPAD

Blom A, Lan G, Adil M (2016) Sub-Saharan African science, technology, engineering, and mathematics research: A decade of development. World Bank Study. Washington, DC: World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/23142

Cassi L, Dosso M, Mescheba W (2018) What drives scientific integration in Africa? Evidence from publications. In: EAI international conference on technology, R&D, education and economy for Africa (TREE). https://doi.org/10.4108/eai.21-3-2018.2275740

Chawdhry P (2017) Chapter 15: Digital infrastructures—Section 15.1: Telecommunications and the internet, in European Commission, Joint Research Centre, Science for the AU-EU Partnership: building knowledge for sustainable development. Luxembourg: EU Publications

Daniels C, Dosso M (this book). Mapping the Potentials for Place-based and Transformative Innovation Policies in Africa: Evidence from Côte d'Ivoire and Nigeria. In: Daniels, Dosso and Amadi-Echendu (this book), Entrepreneurship, Technology Commercialisation, and Innovation Policy in Africa, Springer Nature.

De Propris L, Bailey D (eds) (2020) Industry 4.0 and Regional Transformations. London: Routledge. https://doi.org/10.4324/9780429057984

Dosso M (2019) Industrie et innovation pour un changement structurel et un développement territorial durable en Afrique. Annales des Mines, Réalités industrielles, CGE, Paris. https://annales.org/ri/2019/resumes/aout/04-ri-resum-FR-AN-aout-2019.html#04FR. Access May 2020

Dosso M (2020). Technological readiness in Europe—EU policy perspectives on Industry 4.0, in De Propris L, Bailey D (ed) (2020). Industry 4.0 and Regional Transformations. London: Routledge, https://doi.org/10.4324/9780429057984

Dosso M, Meite Braoule FAG, Gbogou C, Guiella G, Oulaï D (this book). New entrepreneurial narratives in urban West Africa: case studies of five innovation hubs and communities—Special Chapter in Daniels, Dosso and Amadi-Echendu (this book), Entrepreneurship, Technology Commercialisation, and Innovation Policy in Africa, Springer Nature.

Dosso M et al. (2017) PART 2. Chapter 1. Research & Innovation, in European Commission, Joint Research Centre, Science for the AU-EU Partnership: building knowledge for sustainable development. Luxembourg: EU Publications.

IMF, International Monetary Fund (2019) *Fintech in Sub-Saharan African countries, A game changer?* Departmental Paper Series no 19/04. Washington DC, USA, Africa Department, IMF

Kshetri N (2019) Cybercrime and Cybersecurity in Africa. Journal of Global Information Technology Management 22(2):77–81. https://doi.org/10.1080/1097198X.2019.1603527

LSEG Africa Advisory Group, (2019*). The challenges and opportunities of SME financing in Africa.* London Stock Exchange Group (LSEG) Africa Advisory Group (recommendations). Available at: https://www.lseg.com/sites/default/files/content/documents/Africa_SMEfinancing_MWv10.pdf

Nordvik JP, Igor Nai Fovino I, Rana A, Mahieu V, Di Gioia R (2017) Chapter 15: Digital infrastructures—Section 15.2: Digital services and online security, in European Commission,

Joint Research Centre, Science for the AU-EU Partnership: building knowledge for sustainable development. Luxembourg: EU Publications.
Schwab K (2016) The Fourth Industrial Revolution. World Economic Forum, Cologny
UN DESA/DPAD (2017) The impact of the technological revolution on labour markets and income distribution. Frontiers Issues, July 31st. Available at: https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/2017_Aug_Frontier-Issues-1.pdf
UNECA, United Economic Commission for Africa (2017) Blockchain technology in Africa—DRAFT Report. November 2017, Addis Ababa. Available at: https://www.uneca.org/sites/default/files/images/e1701284_concept_note_egm_22_november_2017.pdf. Access June 2020)
United Nations Industrial Development Organization, UNIDO (2017) Industry 4.0 opportunities behind the challenge. Available at https://www.unido.org/sites/default/files/files/2017-11/UNIDO%20Background%20Paper%20on%20Industry%204.0_27112017.pdf
United Nations Educational, Scientific and Cultural Organization, UNESCO (2015) UNESCO science report: towards 2030, Paris, France, retrieved from https://en.unesco.org/unesco_science_report
UNESCO Institute for Statistics, UIS (2015) Information and communication technology (ICT) in education in sub-Saharan Africa a comparative analysis of basic e-readiness in schools. Information paper 25, August, UNESCO Institute of Statistics, UIS: Montreal
WIPO, World Intellectual Property Organization (2019) The Geography of Innovation: Local Hotspots, Global Networks—World Intellectual Property Report 2019. WIPO, Geneva
World Bank (2020) Doing Business 2020: Comparing Business Regulation in 190 Economies. Washington, DC: World Bank. © World Bank. Available at https://openknowledge.worldbank.org/handle/10986/32436
World Economic Forum (2019) The Global Competitiveness Report 2019. World Economic Forum, Cologny/Geneva Switzerland. Available at https://www3.weforum.org/DOCS/WEF_THEGLOBALCOMPETITIVENESSREPORT2019.PDF

Main Source of Data

World Development Indicators, World Bank Group: https://databank.worldbank.org/reports.aspx?source=world-development-indicators

Addressing Digital and Innovation Gender Divide: Perspectives from Zimbabwe

Aretha Mare

1 Introduction

Digital technologies influence and shape every sphere of our everyday existence—from education and health to agriculture, transportation and communications. While technologies hold the promise of unprecedented opportunities for disenfranchised communities, conversations around women's access to digital technologies in Africa remains a topic for debate. Access to digital technologies in most of Sub Saharan Africa is limited to the passive use of mobile phones—one reason for this being the lack of, or inadequate level of digital skills. Sadly, these mobile devices are hardly used to enhance any form of computational thinking or innovation. Long-standing issues such as lack of education and exposure, employment and income, entrepreneurial support and unfavourable policies significantly lower women's ability to fully exploit opportunities presented by digital technologies. In addition, it is argued that lack of access to digital skills reinforces the digital gender gap for women in Africa, hence, the need to reflect on the different issues holding women and girls back from advancing in the technology sector.

Regardless of the high incidence of mobile phones that saw 20 million new mobile subscribers added in Sub Saharan Africa between 2017 and 2018 alone, digital skills remain very low especially amongst women (GSMA 2019). The Broadband Commission set up by UNESCO identified three tiers of digital skill levels—basic functional skills, generic skills and higher level skills (West et al. 2019). Digital literacy skills[1] have been recognised as imperative for sustainable development. Despite efforts to

[1] Digital literacy is the ability to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital technologies for employment, decent jobs and entrepreneurship(. It includes competences that are variously referred to as computer literacy, ICT literacy, information literacy and media literacy (Nancy et al. 2018 p.6).

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close the digital skills divide, evidence still shows that the digital gender gap is growing (West et al. 2019). In Africa, there are increasing efforts to bring together players in the women in STEM movement to share ideas and experiences, collaborate and build a unified voice. Such programs include the TechWomen[a] program and ESkills4Girls.[b] Furthermore, regional grassroots-led policy and practice initiatives such as i4Policy[c] and Alliance for Africa's Intelligence (A4Ai)[d] are gaining ground in building that unified voice and pushing for policy reforms at the continental level based on the mantra 'a prosperous Africa for us by us' challenging the notion of externally driven policy initiatives.

This chapter highlights various ways in which women and girls can be enabled to leverage digital technologies and contribute to achieving Africa's Agenda 2063 and the Sustainable Development Goals (SDGs). The discourse focuses on initiatives that promote the participation of females in science, technology, engineering and mathematics (STEM), and also in information and communications technologies (ICTs). The chapter is structured as follows. Section 1 introduces the topic and arguments, Sect. 2 articulates key issues identified in the digital gender divide literature and Sect. 3 includes a case study of STEM/ICT initiatives in Zimbabwe. Section 4 discusses the similarities, differences and tensions identified in research and practice from the case studies and Sect. 5 provides recommendations for policy practice.

2 Focusing on STEM Skills

The African Union (AU) published an ambitious strategy called Agenda 2063[2] which aspires to build a prosperous Africa based on inclusive growth driven by all, especially, women and the youth (AUC 2015 p.1). The Agenda lists science, technology and innovation (STI) amongst the 12 identified priority areas stressing that technology is an enabler for attaining continental development goals (African Union 2014 p. 8). To support Agenda 2063, the AU also produced a 10-year strategy called Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024) whose mission is to "accelerate Africa's transition to an innovation-led, knowledge-based economy." (AUC 2014 p.11). Both policy documents emphasize that building a robust Science, Technology, Engineering and Mathematics (STEM) workforce is a critical component of achieving the "Africa We Want" (AU 2014). This position concurs with Atkinson and Mayo (2010) who state that science and technology (S&T) based innovation is impossible without a workforce educated in (STEM). These actions signal a policy shift from a constricted focus on poverty reduction which lacked consideration for the key role that STI could play in alleviating this poverty (Chataway et al. 2005).

[2]Agenda 2063 is "Africa's blueprint and master plan for transforming Africa into the global powerhouse of the future. It is the continent's strategic framework that aims to deliver on its goal for inclusive and sustainable development and is a concrete manifestation of the pan-African drive for unity, self-determination, freedom, progress and collective prosperity pursued under Pan-Africanism and African Renaissance" (AUC 2015).

2.1 Why the Need for STEM Skills?

Extensive scholarly work, research and policy documents attest to the significant role that STEM plays in driving innovation, which in turn contributes to economic growth, competitiveness and employment creation (Rosenberg 2004; Ismail 2018). Predicting trends in the 21st Century, the World Bank reported that economic progress would be driven by the ability to innovate and to relay that knowledge (World Bank 1998). Amidst a rising population and dwindling resources in Africa, achieving significant economic growth that is both inclusive and sustainable requires thinking of creative ways to produce more from the limited resources (Rosenberg 2004). This ability to 'think of creative ways' can be enhanced through acquisition of STEM skills, particularly in the younger generation, women and girls included. This inclusion of women and girls in STEM education and skills development is essential to progress in STI, fostering economic growth and achieving the SDGs (Daniels et al. 2017). Atkinson and Mayo (2010) use allegories that as factories are to industrialisation, so is STEM labor force to a technology economy; thus emphasising the need for STEM education.

2.1.1 Skills Gap—Bridging the Supply of STEM Skills in Africa

Reports estimate a shortfall of five million scientists and engineers in Africa, 80% of new students opt for non-STEM studies instead (Hooker 2017 p.14). Several issues contribute towards this STEM skills deficit and they vary in source and scope. The skills gap could be attributed to a mismatch between industry requirements and educational focus indicating the need for closer collaboration between industry and academia. Another mismatch is the failure of STEM education to address local development needs, thus not bringing value and impact to the society. Therefore, there is a need to redefine school curricula so that students can acquire skills which are transferable, versatile, resilient and useful to the society (Ismail 2018). Most Africans are engaged in the informal sector where women constitute about 70% of the workforce, but, studies and policy responses focus on formal jobs (Madzwamuse and Kouakou 2018). Current discourses on innovation and emerging technologies such as Artificial Intelligence (AI) are a good example of this disconnect. As policy responses towards the fourth industrial revolution (4IR) are being tabled, they should incorporate these realities to avoid deepening already existent digital inequalities (Madzwamuse and Kouakou 2018).

2.1.2 The Gender Gap in STEM/ICT—From Skills Gap to Gender Gap

The corresponding relationship between technology and society indicates that technologies themselves are not gender neutral and must, therefore, be tailored to become relevant and useful to all, including women and girls (Harwood 2011; Rajahonka and

Villman 2019). This process of 'tailoring' the technologies requires attainment of education and skills by everyone, in ways that ensure that women and girls are not excluded. The level of education in a society has an effect on technology uptake, hence, women's lower uptake of technologies can be attributed to disparities in education and income levels in favor of men (Benhabib and Spiegel 2005). Sadly, women constitute two thirds of illiterate adults worldwide and the majority live in developing countries (United Nations Statistics Division (UNSD) 2015). The magnitude of the gender gap in STEM is highlighted in the next section. The AU has, however, published several policies in an attempt to redress this gender gap in STEM. These policies include the Addis Ababa Action Agenda, the Nairobi Declaration and the AU Strategy for Gender Equality and Women Empowerment under Outcome 1.3 (Technology & E-inclusion) (West et al. 2019; AU 2018). These policies demonstrate willingness by the AU to address the current gaps.

2.1.3 Why is the Gender Gap in STEM Topic Important?

The United Nations Education, Scientific and Cultural Organisation (UNESCO) states that access to STEM education is a human right (UNESCO 2017 quoted in Ismail 2018). However, evidence shows that across the world only 30% of female students pursue STEM related higher education studies (Ismail 2018). The figures are much lower in fields such as engineering and computer science, which range from 7 and 17% respectively (UNESCO 2015). Women currently represent only 30% of ICT workers in Europe and have created only 9% of ICT applications (Rajahonka and Villman 2019; Petray et al. 2019). Women are, thus, underrepresented in creation and design of solutions which considerably lowers their contribution towards innovation and economic growth. Researchers forecast that the STEM gender gap will adversely affect the future of women's work if action is not taken to capacitate women and girls in STEM forthwith (Madzwamuse and Kouakou 2018). Modern jobs are highly integrated with digital technologies and thus, demand competencies in STEM to fully exploit the opportunities they present (Madzwamuse and Kouakou 2018).

What could be the reason then for the STEM gender gap? Contrary to common belief, studies indicate that girls are not technophobic. Instead, they outdo boys in using digital tools such as blogging (referred to as pink content), but, are overtaken in the use of more complex digital technologies (Hayes 2008). This preference of one over the other necessitates further investigation given that digitalization has been proven to increase opportunities for women in business and self-development (Rajahonka and Villman 2019).

> Women and girls are 25% less likely than men to know how to leverage digital technology for basic purposes, 4 times less likely to know how to programme computers and 13 times less likely to file for a technology patent (West et al. 2019 p.4).

The above statement shows that the number of women engaged 'with' technologies drops significantly as we move up the value chain of digital skills. To add another layer, women and girls in rural areas have lesser access to digital technologies and hence lower uptake than their urban folk. The correct reading of a country's STEM competencies should, thus, reflect the rate of diffusion in rural areas where the majority stays (The World Bank 2008). In Africa, where 60% of the population lives in the rural areas, more attention should be given to the internal diffusion of technologies (UNECA 2017; The World Bank 2008).

2.2 *What Are the Causes?*

According to Yu (2017), hindrances that limit the uptake of STEM by women and girls can be placed into three categories—the development of interest; the acquisition of skills and penetrating the workforce. Barriers to entrepreneurship (monetizing STEM) could be included as an additional category since women face various impediments in technology entrepreneurship. The list is not exhaustive, but, focus here is placed more on factors that are in line with the mandate of this paper.

2.2.1 Barriers to Developing Interests

Fewer women occupy leadership and influential positions in the STEM sector which makes it difficult for girls to access and relate to female role models and consider STEM as a career of choice. Only 24% of all jobs in the digital sector are occupied by women and in developing countries men have 2.7 times more opportunity to work in the digital sector than women (West et al. 2019; Petray et al. 2019). Patriarchal cultures entrench gender inequalities, limit access to facilities and resources for women and girls. As a result, girls and women are similalrly exposed to violence online as offline, effectively intimidating and sealing off the space for girls, who would otherwise, explore opportunities there. Patriarchy also reinforces financial dependence and imposes power and control over women's decisions thereby throttling choices into and/or to remain in STEM (Yu 2017; Madzwamuse and Kouakou 2018).

2.2.2 Barriers to Developing Skills

The majority of science teachers are male teachers who sometimes have a preference for working with boys over girls (Yu 2017; Petray et al. 2019). These teachers reinforce gender stereotypes and relegate female students to menial tasks (considered 'girl-ish'). A survey conducted in Vietnam noted that for the Math subject, 65% of teacher interactions were with boys compared to only 35% interactions with girls (Yu 2017). Confidence levels in STEM decrease as girls grow older, dropping more rapidly at tertiary level due to lack of exposure and limited interaction time with technologies for honing STEM skills (Petray et al. 2019; Madzwamuse and

Kouakou 2018; West et al 2019). Another critical dimension is that girls are more modest with professing their abilities as compared to their actual performance which dampens their motivation and resilience (Petray et al. 2019). Here, perception of the system, in general, also comes into play. Students' choices are limited by how they perceive scarcity of resources such as laboratories and materials for practicals and the limited number of schools that offer science subjects at advanced level.

Petray et al (2019), challenge the leaky pipeline[3] metaphor citing it as a problem in itself in that it symbolises a singular pathway into STEM instead of making STEM attractive to all girls, what Atkinson and Mayo (2010) refer to as 'Some STEM for All' (Petray et al. 2019; Atkinson and Mayo 2010; Mosatche et al. 2013). Atkinson and Mayo (2010), instead, propose adopting the 'All STEM for Some' approach which only targets high achievers in STEM. On the contrary, Petray et al (2019) suggest that girls should be engaged from various capabilities and dispositions, giving opportunities to young women to explore their curiosity for innovation (Petray et al 2019). Weak digital literacy in the population limit the impact of technologies on economic activity in that users are less inclined to explore digital technologies for more economically useful activities such as building products and expanding markets (The World Bank 2008). Both approaches, 'All STEM for Some' and 'Some STEM for All' are essential to groom both creators and a market for the created products, respectively. It requires a certain level of competency to use and derive the most benefit from digital technologies.

2.2.3 Barriers to Entering the Workforce

Fewer women occupy roles at the frontiers of technological innovation such as machine intelligence—current predictions indicate that this technology will offer more rewards in terms of growth and compensation (West et al. 2019). Discrimination in the workplace manifests in various forms for women and include gender stereotypes and insensitivities, unpaid care work, unfair hiring processes and inflexible working hours (Yu 2017). Diversity in technology encompasses the ability to mirror the composition of society, for example, race, ethnicity, geography and socio-economic status. The values espoused by innovators are mirrored in the technologies they build, hence, the need to identify and prevent biases in the design, development and deployment process through a diverse workforce (West et al. 2019). A lack of diversity in the choice, manipulation and use of the data in building AI systems is likely to aggravate existing inequalities (Madzwamuse and Kouakou 2018). Organisations can go a step further and ensure that their systems are fully inclusive, moving from mere presence (diversity) to being given the platform to meaningfully contribute.

[3]The leaky pipeline refers to attrition at different stages of education and employment for women in STEM and ICTs despite increased recruitment of diverse students and staff (Watson & Froyd, 2007 in Petray et al., Australia).

2.2.4 Additional Barriers

The rate of female technology entrepreneurship and support given to female entrepreneurs is much lower than that of men, but, the proportion of women in informal business is higher (Madzwamuse and Kouakou 2018; Knowledge @Wharton 2019). In 2018, companies founded by women, globally, received only 3% of venture funds (Thygesen 2019). Digital technologies can lessen the burden to access skills, capital, markets and networking for women. The source of motivation for entrepreneurs differs, therefore, interventions should be tailored. For example, those who embark on entrepreneurship as an alternative for employment have different needs and commitment levels to those who do so to create value (Yu 2017).

2.3 Out of School Initiatives

Several initiatives across the continent have been launched to promote STEM amongst girls. Out of school initiatives (OSIs) are run by different names such as STEM, Coding, Robotics clubs or digital literacy programs. These initiatives are run by individuals, non-profit organizations or corporates through their corporate social responsibility (CSR) arms. They can be run independently or in partnership with relevant government departments. OSIs are set up to prepare girls with the knowledge and skills required for an innovation-led economy. Recruitment of participants is quite flexible based more on the girls' attributes, particularly, imagination and commitment (Petray et al. 2019). Inclusive participation is at the core of these activities ensuring that a girl's passion and curiosity for STEM is not inhibited by her background (Petray et al. 2019). OSIs identify and build on community assets—'resources in which poor people are rich' (Gupta 2013 p.18). These programs involve stakeholders who can influence girls' participation in STEM such as mentors, family, schools and the STEM-related industries (Petray et al. 2019). Hayes (2008) suggests that interventions should be made at the middle school level as it is the time that differences in perceptions about computers heighten.

2.3.1 What Can Be Done to Build Computational Thinking?

The role young women will play in STEM and in the fourth industrial revolution era will be determined to a large extent by changes in the educational system (Madzwamuse and Kouakou 2018). These changes should allow depth in digital design, innovation and engineering skills, incorporate gender sensitive delivery and dispel the notion that STEM curricula is irrelevant to girls (Madzwamuse and Kouakou 2018; Yu 2017; Petray et al. 2019). Adding the fun component is instrumental in increasing girls' curiosity for digital technologies, through for example, access to gaming and suitable games (Madzwamuse and Kouakou 2018; Yu 2017).

Inclusion should be mainstreamed in all programs and processes to avoid excluding girls who do not self-identify as the "STEM type"[4] (Petray et al. 2019; Hayes 2008). Schools should shun attributing hierarchies on subjects so that the blending of technical knowledge in STEM with soft skills is not hindered (Petray et al. 2019). Increasing the number of female STEM teachers will reinforce STEM as a female domain and increase girls' interest and confidence in STEM (Madzwamuse and Kouakou 2018; Yu 2017). The media plays a crucial role in sharing, amplifying, linking and making success stories of Women in STEM accessible to girls. Maker movements are a good example of some of the initiatives which encourage practical as opposed to abstract learning (de Beer et al. 2017). Grassroots campaigns such as hackathons and bootcamps, can help secure and sustain interest for girls to pursue STEM by delivering courses which empower girls to address community challenges through learning by doing, tinkering with various components (Madzwamuse and Kouakou 2018; Yu 2017). Field trips also help to connect theory to practice by gaining access to role models in their workspaces (Mosatche et al. 2013). However, mentors' should be trained prior to engagement with the girls to acquaint them with the objectives of the programs and any gender in STEM nuances which they may be blind to (Mosatche et al. 2013).

2.3.2 What About Entrepreneurship?

Entrepreneurial tendencies, like STEM identities, need to be developed early on by connecting science to real-life scenarios where the young women are empowered to identify and solve problems in their communities using technology (Mosatche et al. 2013). Technology and entrepreneurship interventions embed business development while providing access to devices and connectivity. When girls work with technologies created elsewhere and modify such technologies to suit their context, they exhibit some level of entrepreneurship and risk taking (Yu 2017; Rosenberg 2013). These programs should carry some form of incentive to reward both effort and ingenuity. The programs should also incorporate continuous learning and iteration for both the beneficiary and the convener (Mosatche et al. 2013).

2.3.3 Shortcomings/Areas of Improvement

A common challenge amongst Girls in STEM/ICT program initiators is the difficulty in managing impact assessment especially in the long term (Petray et al. 2019). This could be due to lack of competence in the area but mostly lack of funding and the difficulty to keep track of a highly mobile demography. Impact assesments are critical in advocacy work to convince governments to invest in STEM initiatives

[4]STEM identity is defined by Carlone and Johnson (2007) as a way in which individuals make "meaning of science experiences and how society structures possible meanings" (Carlone and Johnson, 2007 p. 1187).

based on concrete evidence. Finding work placements or internships for graduates of these programs is another challenge faced by conevors of these programs. Here, private sector partnerships are critical to offer the women and girls an opportunity to experience and familiarise themselves real world scenarios and increase their chances for employability.

3 Case Study—Zimbabwe

3.1 The Economic and Digital Context in Zimbabwe

Zimbabwe is a country in Southern Africa, known for its high levels 2018 of literacy which currently stands at 94.7% and is a result of policy focus towards education soon after gaining independence from Britain in 1980 (Government of Zimbabwe 2018; Sibanda and Makwata 2017). However, statistics on gender representation in STEM remain low and mirror those of the rest of the world. According to Zimbabwe National Statistics Agency (ZimStat), women constitute about 40% of enrolments in natural sciences but the figures are much lower in computer science (16%) and engineering (7%) (Zimbabwe National Statistical Agency 2016). The government recently launched the economic blueprint 'Towards an Upper Middle Income Economy by 2030' known as Vision 2030[5] and the Education 5.0 model which has a thrust towards innovation and industrialisation and is meant to catalyse the attainment of the vision. Surprisingly, the Science, Technology and Innovation Policy is silent on STEM gender representation measures and lightly mentions encouraging interest across gender (Government of Zimbabwe 2012). Notably, the government has set up 6 innovation centers at 6 state universities country wide to support research and development and they also intend to establish 10 industrial parks in each province (Chaparadza 2019; Government of Zimbabwe 2019a).

Increased interactions, transactions and activities online are shaping and accelerating the growth of the digital economy in Zimbabwe. This is supported by a high mobile penetration rate (87.7%) and increased access to the internet (51.9%) mainly through mobile phones, according to a report by POTRAZ (Potraz 2018). About 97.7% of internet users in Zimbabwe access the internet through mobile phones (Potraz 2018). Also, financial inclusion has increased due to the rapid diffusion of mobile money transfer systems positively impacting the welfare and the livelihoods of previously marginalized and unbanked populations. According to POTRAZ, mobile money subscriptions increased by 12.6% in the first quarter of 2018 (Potraz

[5]The new government is quite aggressive in its approach, and has recently launched Education 5.0 which is centered on the Heritage based philosophy in shaping future technology through innovation and industrialization (Government of Zimbabwe 2019b). The current economic blueprint, Towards an Upper Middle Income Economy by 2030, stipulates that the government will pursue bold steps to empower its entrepreneurs and cultivate innovation at every level (Government of Zimbabwe 2018).

2018). A widening gap in gender representation and skills; poor infrastructure, policy gaps and weak entrepreneurial support is, however, impeding progress in this sector (Johnson 2018). Zimbabwe is ranked 159 out of 190 countries on the Ease of Doing Business (The World Bank 2018). The regulatory environment obtaining in the country is not conducive for innovation, and is a major drawback to the growth of the entrepreneurial ecosystem in the country. It is difficult for start-ups to navigate the challenging regulatory terrains, including from registering the business to managing precarious monetary policies. On the other hand, the government has responded either indifferently or with heavy handedness towards potentially disruptive innovations.

In May 2018, the Reserve Bank of Zimbabwe (RBZ) banned crypto-currency trading highlighting two start-ups Bitfinance Private Limited and Styx24. According to the RBZ, the move was aimed at protecting and safeguarding monetary infrastructure and consumers' interests against money laundering and fraud amongst other vices. The Bitfinance company is still operating in other SADC countries (Reserve Bank of Zimbabwe 2018). Tait and Banda (2016) suggest the adoption of adaptive and proportionate regulation to ensure that innovations thrive at the different stages of development.

3.2 *Experience Implementing STEM Initiatives in Zimbabwe*

In this section, I share briefly on some of the work I have done training and convening women and girls in STEM initiatives in Zimbabwe in the past 6 years. Although mainly based in Harare, the capital city, I have also coordinated programs in other cities and in rural areas. Through these programs, young women go through coding, robotics, digital literacy and entrepreneurship courses to prepare them for the highly competitive world of work and business. The target groups are girls in high school, out of school youth and young women, mainly between 15 and 25 years of age. The programs are engineered to empower and equip women and girls with relevant digital skills so that they can become intelligent creators and users of technology. The main goal of these initiatives is to increase the number of female-led ICT and STEM based startups focusing on the grassroot. These initiatives have been supported mainly through volunteers and bootstrapping as well as partnerships with development agencies, schools, government ministries and agencies and corporate sponsorship, mainly Internet Service Providers (ISPs). The programmes have been focused largely on disenfranchised communities because, being underserved "does not entail poverty of the mind or morals" (Gupta 2013 p.18).

Initially, we implemented a global technology and entrepreneurship programme for girls locally (Technovation Challenge[6]). About 150 girls from Harare and Bulawayo participated. A total of 20 mobile app prototypes were built in that season

[6]The Technovation Challenge is an annual global competition for teams of young girlsto learn and apply the skills needed to solve real-world problems through technology. Available at https://technovationchallenge.org/.

alone. However, we stopped running this annual programme after only two seasons. There are challenges associated with implementing programmes developed in high income countries in less developed countries (see the proceeding section). After the competition, we noticed that there seemed to be no articulate support infrastructure to further develop the most promising prototypes. Eventually, we established an entrepreneurial support hub focusing mainly on the youth and female innovators. Still, gaps in systems, processes and infrastructure to support innovation and technology commercialisation in Africa. More than 1000 women and girls have since benefited from our digital literacy programs. Most of the beneficiaries have gone on to study sciences at advanced and tertiary level. Of the beneficiaries that decided to pursue other fields such as law and hospitality, they showed an appreciation of the enabling and crosscutting nature of digital technologies. Some of the girls have participated in pitch events, where they pitched their business before a diverse audience who included potential investors, gaining valuable feedback for their enterprises. Women already in STEM and ICT participated as coaches and mentors, including male STEM champions.

In addition, we trained 957 smallholder farmers, 727 of which were women, on mobile literacy for an international NGO in support of the rollout of mobile based bundled services. The purpose of the training was to stimulate the uptake and accurate use of the services amongst users, mainly women small holder farmers. Partners included a farmers' union organization for mobilization of beneficiaries, agricultural extension officers and mobile network operators for farming and product queries, respectively. Relatedly, STEM/Coding clubs have been established in some partner schools. One of the accomplishment is that both teachers and students have been trained as STEM champions as part of a project dubbed 'Digital Aspirations." Apart from the coding workshops, the project also had dialogue sessions where topics related to the digital economy where discussed by a diverse panel putting forth recommendations for both policy and practice. Furthermore, a team of students has been selected and trained in the past three years to represent Zimbabwe in the annual First Global Challenge,[7] a global robotics competition for students 14 to 18 years of age. Participants have gone on to present their ideas and results before policymakers[8] advocating for STEM Education policy reforms.

3.3 *Challenges and Opportunities*

After participating in our programmes and gaining interest in STEM, some students complained that their schools did not offer their desired STEM subjects

[7]FIRST Global is an annual global robotics challenge to ignite a passion for Science, Technology, Engineering, and Mathematics (STEM) among the more than two billion youths across the world. Available at https://first.global/.

[8]The Deputy Minister of Higher and Tertiary Education, Science and Technology Development and the Parliamentary Portfolio Committee on ICTs between September and November 2017.

at advanced level such as computer science. Also, some schools randomly designate subject areas in the lower classes which makes it difficult to change subject areas at a later stage, for example, a student designated to a commercials class would not be allowed to opt for sciences at advanced level. Implementing global programs locally is a good starting point but has its own set of challenges. First, the programmes use platforms that require a higher bandwidth of internet connectivity, which means internet access on its own is not enough but the quality of the connection too. In the first year the schools brought students to a central location (hub) for training sessions but complained that the programme was stretching their transport budgets. In the second year, we pivoted and as trainers travelled to the schools indeed. This stretched our capacity and the poor internet connections at the schools did not help much. Volunteer mentors could not faithfully commit to weekly meetings over a 12 week period without any form of incentive or support, either from us or their respective employers.

In addition, economic challenges in Zimbabwe have resulted in many industries shutting down. This means that there are less industries to absorb STEM graduates, further reinforcing negative perceptions and choice of STEM as a career of choice. Correspondingly, funding is scarce, therefore, necessitating the need to explore creative ways of sustaining digital technology initiatives aimed at improving the skills of women and girls. For the most part funding from development agencies is directed towards programmatic costs, making it difficult to sustain operations resulting in fatigue and burnout, withdrawal of both regular and permanent staff and susequent closure. Where available, financial support from the private sector is usually directed towards once-off events, instead of long term projects. Both public and private capital is needed to scale initiatives for greater impact.

Work placements for graduates from digital skills initiatives for women and girls are critical. The private sector can offer support by absorbing some of the graduates into the workforce through internships, outsourcing or permanent placements. Longstanding infrastructural issues such as internet connectivity, access to devices, materials and laboratory facilities and reliable electricity remain a major problem.

Despite these challenges, the tech and entrepreneurial ecosystem, though nasscent, is vibrant and growing. Figure 1 below is an ecosystem map for the Zimbabwean entrepreneurial community conducted by Briter Bridges in collaboration with ecosystem players in Zimbabwe. The map presents a picture of the entrepreneurial activities in Zimbabwe listing the startups according to the sector they operate in, supporters and events. The map also indicates that much of the entrepreneurial activities in Zimbabwe are around fintech and blockchain technologies. As the ecosystem grows further, it is imperative that programmes and policy interventions that aim to groom and support more female founded start-ups are established and adequately financed.

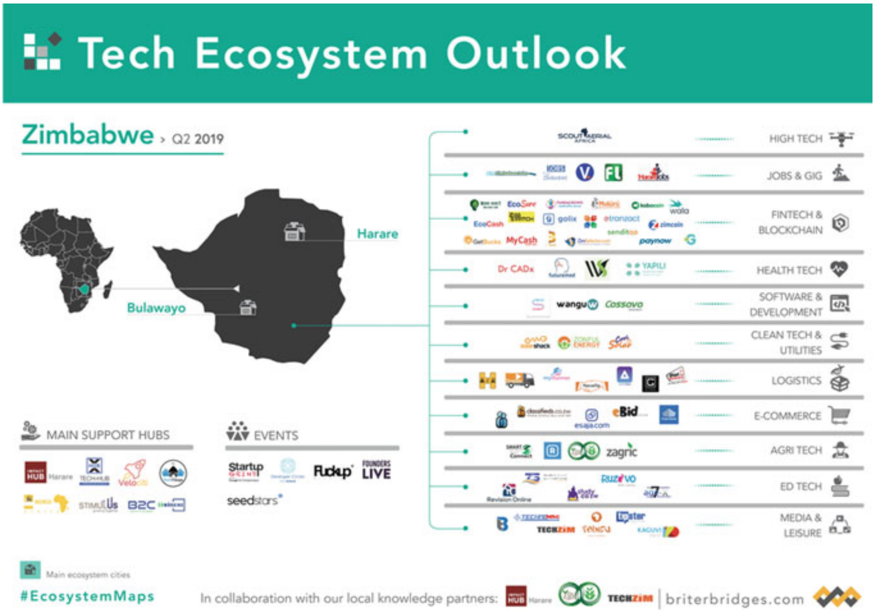

Fig. 1 Zimbabwe tech ecosystem outlook. *Source* brighterbridges.com

4 Discussion

This section discusses the tensions, opportunities and gaps identified from experience working in the Women and Girls in STEM and ICTs, innovation and entrepreneurial ecosystems in Zimbabwe and in the region. Some of the discussion points, are however, transversal in nature.

4.1 *Suitable Policies*

Appropriate government policies and regulations can help bridge the gaps discussed in the preceding sections and bring relevant players together, forming linkages between sectors and supporting innovation at grassroots level (Daniels 2014). I outline some areas where policies can promote the development of STEM and ICT skills amongst women and girls, drawing from my practical experience from running multiple programmes and initiatives in Zimbabwe.

Gender Equality in STEM: Current gender equity programs fail short in addressing the soft barriers such as cultural and social stereotypes and unconscious bias against women in STEM. Women and girls are solution oriented and given a conducive environment they can thrive. Our initiatives do not force STEM on girls; rather, we expose them to different possibilities so that they can make informed choices. Our programmes acknowledge the important contribution of the arts, creative and social studies to technology throughout the innovation process. Teachers play a crucial role in influencing career choices, it is therefore, imperative to bring gender mainstreaming to the education sector. Similarly, parents also play an important role and should thus be considered part of the solution in building STEM identities early on.

Curriculum and infrastructural reforms: Curriculum changes shifting emphasis to the practical element of learning are commendable though the roll out is ill-funded. Access to computer and science laboratories, internet and qualified staff is limited, especially for rural schools. Resource sharing could be introduced, for example between private boarding schools in rural settings and the rural schools in their proximity. There should be some flexibility allowed in choosing subjects to study at the different stages of high schooling. Schools in some areas do not offer science subjects at all at advanced level due to the cost associated with setting up laboratories prejudicing students interested in STEM within their jurisdiction.

Support for grassroots innovators: There is a policy gap on how innovators at grassroots can be supported or absorbed into mainstream innovation system. There is need to shift from traditional state dominated interventions to more coordinated forms which involve a variety of non-state actors. Daniels (2017) stresses the need to 'transform, rethink, or re-imagine innovation' in an all-encompassing, sustainable and solution oriented way (Daniels 2017).

4.2 Building Capabilities

Our projects are focused on building capabilities in technical know-how, financial management and improved soft skills which are necessary for both employability and entrepreneurship and to narrow the gap between women innovators and their male counterparts.

Technical skills—Movement towards a digital economy requires fluency in the use of digital tools and devices, and more importantly knowing how to create solutions. Making use of locally available resources, social capital and open technology tools and platforms can immensely reduce costs of implementation. Programs should be tailored to allow for both virtual and offline mentorship. Africans in the Diaspora can be incorporated into the mentorship matrix and assist in grooming young women's skills to become both locally relevant and globally competitive. It is essential to be amenable to change and pivot in response to prevailing economic situations. However, scaling of these initiatives still requires government support and therefore, public funds should be availed towards these programmes.

Entrepreneurial skills—Possessing great ideas does not equate to knowing how to build a business case around it. Incubation programs bridge the gap for early stage start-ups, taking them through business development, value creation and investor preparation. Most innovators with a STEM background struggle with understanding and articulating financials for their start-ups. Although it is not necessary to be skilled in every area, a basic appreciation of finances is critical for entrepreneurs. A good starting point would be making business studies mandatory in schools at an earlier stage, fostering creativity and risk taking attributes.

Soft skills: Problem solving, negotiation, creativity, team play, cross cultural management and presentation skills are vital for career and business success. Experimentation, iteration and ubuntu are critical elements embedded in our training programmes. The beneficiaries are equipped with skills to manage both success and failure, organise community outreaches in less privileged areas and do advocacy work.

Policy priorities: Some quarters postulate that digital skills are not a priority for Africa and are therefore, a waste of resources. They believe focus should be on fixing basic needs such as food, health and clean water. There is, therefore, a need to clearly articulate the link between science and humanity and the role that science and technology play in day to day life to get buy-in from policy makers. This requires a multi-stakeholder approach which includes media for improved STI communication, cognizant of the fact that STEM is not a silver bullet. Policy makers should also be equipped with digital skills to so that they can debate on digital issues from an informed perspective. There are fundamental structural and governance issues that need addressing first, more research is required to provide demonstrable proof that STEM and ICT for development (ICT4D) skills are crucial in solving the several challenges faced by the continent.

Data paucity: Published evidence on the importance of girls' education in STEM in Africa is not readily available, forcing researchers and practitioners to infer trends from global surveys. External researchers may fail to articulate the cultural nuances that local researchers are able to pick on. Public funds are vital for research aligned to local needs and agendas and governments should ensure that policies that support the production and open sharing of relevant data are put in place to facilitate access to important data by researchers.

Mismatch in approach: There is a huge mismatch in approach, selection of participants and focus areas between interventions at grassroots level and what is offered in mainstream education. STEM advocates are then misconstrued as driving foreign agendas or failing to appreciate local contexts and priorities. STEM advocates should, therefore, deliberately increase interaction with and involvement of government officials in programme delivery to dispel any misunderstanding and build mutually beneficial relationships.

4.3 Intellectual Property Protection

Intellectual Property (IP) issues are a serious concern for innovators to the extent that potential innovators shy away from sharing their ideas fearing IP theft. The major concern is around predatory corporates whom they accuse of using or stealing their ideas leveraging on their vast resources. IP protection is not a clearly understood area, and is beyond the scope of most STEM advocates and hub managers. IP experts are, therefore, essential for consultancy and advice. Some of the pain points around IP shared by innovators include questions on how to protect their ideas and at which stage they can do that. Teece (1986) states that "If there are innovators who lose there must be followers/imitators who win" rightly pointing out that innovators, in most cases, are not the ones who derive the most benefit from their innovations (Teece 1986). Unfortunately, bigger firms have stronger and more established complimentary assets and will likely prevail over start-ups.

4.4 Impact Measurement

Challenges exist on how impact can be attributed solely to our interventions in an uncontrolled environment and how to find mechanisms to measure and differentiate cases of good and bad impact. Another example is that an entrepreneur (beneficiary) connected to a potential investor can disclose the intricacies of the ensuing deal at their sole discretion. If they choose not to, this critical information will be missing in impact reports. We also make use of impact stories to show intangible impact such as motivation and inspiration, but, it is a challenge to present such stories as evidence before policy makers who demand hard facts and concrete evidence.

4.5 Access to Early Stage Capital

Support to early stage innovators is limited. Venture capital is limited and angel investors are still very few in Zimbabwe, if any, and generally quite nascent in sub-Saharan Africa. Public funds are vital during this delicate level of the entrepreneurial growth phases. Donor dependence severely limits creativity and innovation; donors are mostly driven by their own agendas which may not fit in well with local needs and priorities. Stirling (2014) stresses that innovation democracy encompasses the ability to determine the values, priorities and direction of innovation processes and outputs. Innovators should be empowered to make these choices, particularly female innovators who have to contend with other additional structural issues.

4.6 Access and Affordability

Limited access to the internet and digital devices affects mostly women who may not possess or control their own finances. For instance, Zimbabwe is ranked second for the most expensive mobile data in sub-Saharan Africa (Ecobank Research 2018), faring poorly both in real and income relative measurements. Thus, data charges are exorbitant and beyond the reach of many. This lack of access, severely limits practice time and skills development outside of training sessions.

4.7 The Role of the Media

The media plays an important role in giving STEM the face that students can relate to and see within their reach. The media can be instrumental in doing away with labor concealment, highlighting instead, the achievements made by women as researchers, inventors and entrepreneurs. The Next Einstein Forum[9] has already started showcasing extraordinary African scientists and technologists doing phenomenal work around the world.

5 Conclusion and Recommendations

Promoting innovation and entrepreneurship in Sub Saharan Africa requires building the right STEM and ICT skills set that enable the development and deployment of solutions which address relevant societal problems. Inclusion is a critical component in development—thus the need to improve the computational thinking and entrepreneurial skills of women and girls using digital technologies. Context, space, delivery, positive reinforcement, increased and varied interaction with digital technologies are all critical factors in increasing the participation of women and girls in STEM supported by the right and accessible infrastructure and policy environment. There is need for boldness to challenge and redefine, in the right time, existing educational systems which carry a colonial legacy—systems entrenched for ages require time to distill and dismantle. Multi-pronged policy responses make it difficult to determine what works, what does not and what to drop off completely, therefore it is incumbent upon each community to determine their area of intervention focus. We suggest research on the assessment of the direct impact of the initiatives and programs in women and girls in STEM run over the past ten years at country and continental level, to build a local database for ease of reference and also to inform policy. Comparative research for Women and Girls in STEM has been conducted across countries and regions, but, research focused on internal diffusion and impact Vis a vis the needs of that community needs to be explored. Additional dimensions to deal with include fixing regulatory hurdles and ensuring that potential high growth innovations from the grassroots are not shut out by the system before their potential is fully realised. Another dimension is the establishment of relationships between

[9]The Next Einstein Forum is an organisation working to make Africa a global hub for science and technology and hosts the largest biennial science and innovation gatherings in Africa. Available at www.nef.org.

innovation centers in universities and entrepreneurial hub ecosystems so that the conventional innovation centers can offer guidance and expertise to innovators at the grassroots and in turn receive the innovative edge and agility embedded in these communities. Development partners can use their convening power to create platforms of engagement to bring together relevant stakeholders to co-learn and co-create a way forward.

5.1 Recommendations

5.1.1 Governments and Policy Makers

- Release public funding to support innovation and include support for innovation at grassroots. Run open challenges to solve specific issues in society and encourage young women to participate by setting aside specific funding for them. Support women and girls in STEM programs and allocate a portion of universal service funds towards these programs.
- Introduce subjects that are in line with the demands of the digital economy to prepare student for the future of work. Encourage experiential and hands-on learning activities, for example, introducing robotics as a practical subject. Online safety should be embedded in curriculum from a human rights and security perspective for student to appreciate data and privacy issues online.
- Incorporate ethics and gender components in science curriculum from primary school to raise awareness and equip both boys and girls with the skills to correctly respond to gender dynamics in STEM early on.
- Give schools a level of autonomy in determining additional activities they may want to engage in. Build systems that work, continuously review and do not be afraid to change what does not work.
- Incentivise the participation of role models and mentors through, for example, tax cuts to individuals and companies that run formal mentorship programs to motivate and retain more women and enhance girls' interest in STEM and ICT.
- Train and appraise legislators on current digital trends and give them skills to properly adjudicate on digital matters from a well-informed position.
- Fund research on the state of women and girls in STEM including civic society initiatives and grassroots innovation to understand the state of affairs and make decisions based on evidence.

5.1.2 Girls and Women in STEM/ICTs and Innovation Communities

- Coalesce and build a unified voice for advocacy and become credible access points for policy.
- Identify and train male champions. Some girls testify that their role models are men who have inspired, encouraged and supported them to pursue STEM.

- Promote Afro centric traditional modes of financing that offer solutions which can be adapted to suit the times as an avenue for community support of innovation.
- Engage with government as allies with a common goal not as antagonists.

5.1.3 Private Sector

- Establish formal mentoring programmes specifically targeting girls and young women;
- Support women and girls in STEM and ICT by offering facilities for training and networking, identifying areas of shared value.
- Fund locally grown initiatives as a long term investment towards human capital development.
- Tap into the entrepreneurial capacity of young women by organising innovation challenges in collaboration with Women in STEM communities through, for example hackathons, for specific product or service innovations.

Notes

a. TechWomen empowers, connects and supports the next generation of women leaders in STEM from Africa, Central and South Asia, and the Middle East by providing them the access and opportunity needed to advance their careers, pursue their dreams, and inspire women and girls in their communities. Through mentorship and exchange, TechWomen strengthens participants' professional capacity, increases mutual understanding between key networks of professionals, and expands girls' interest in STEM careers by exposing them to female role models (TechWomen 2019a).

b. #eSkills4Girls initiative tackles the existing gender digital divide in particular in low income and developing countries to globally increase the access of women and girls in the digital world and to boost relevant education and employment opportunities. It is an initiative of G20 members in partnership with UNESCO, UN Women, ITU and OECD (eSkills4Girls 2019b).

c. i4Policy is an initiative by African Innovation Communities through participation and gathering of insights from young entrepreneurs and innovation communities such as hubs to develop a policy vision to support digital and economic transformation in Africa (i4policy 2019c).

d. A4Ai aims to stimulate the adoption of exponential technologies across Africa by empowering a fully inclusive and up-skilled labor force for the jobs of the future, aligning public–private decision makers on best practices for accelerated growth of the ecosystem and celebrating our collective success to ensure proper reporting and increased engagement from the people (Alliance for Africa's Intelligence 2019).

References

African Union (2018) AU strategy for gender equality & women's empowerment 2018–2028. www.au.int/. Accessed 6 Aug 2019

Alliance for Africa's Intelligence (2019) In: A4Ai. https://www.alliance4ai.org/about.html. Accessed 23 Aug 2019d

Atkinson RD, Mayo M (2010) Refueling the U.S. innovation economy : fresh approaches to science. Technology, Engineering and Mathematics (STEM) Education. Washington, DC

AU (African Union) (2014) Agenda 2063 the Africa we want. In: African Union. https://au.int/sites/default/files/documents/36204-docagenda2063_popular_version_en.pdf%0Ahttp://www.un.org/en/africa/osaa/pdf/au/agenda2063.pdf. Accessed 5 Aug 2019

AUC (African Union Commission) (2014) STISA-2024 science, technology and innovation strategy for Africa 2024. https://au.int/sites/default/files/newsevents/workingdocuments/33178-wd-stisa-english_-_final.pdf. Accessed 6 Aug 2019

AUC (2015) Agenda 2063 overview. https://au.int/sites/default/files/documents/33126-doc-11_an_overview_of_agenda.pdf. Accessed 6 Aug 2019

Beer J De, Armstrong C, Ellis M, Kraemer-mbula E (2017) A scan of South Africa 's maker movement

Benhabib J, Spiegel MM (2005) Human capital and technology diffusion. In: Aghion P, Durlauf SN (eds) Handbook of economic growth. pp 935–966

Carlone HB, Johnson A (2007) Understanding the science experiences of successful women of color: Science identity as an analytic lens. J Res Sci Teach 44:1187–1218. https://doi.org/10.1002/tea.20237

Chaparadza A (2019) First phase of constructing 6 innovation hubs finished- minister of higher and tertiary education. https://www.techzim.co.zw/2019/02/first-phase-of-constructing-6-government-sponsored-innovated-hubs-finished-minister-of-higher-and-tertiary-education/. Accessed 18 Aug 2019

Chataway J, Smith J, Wield D (2005) Partnerships and building capabilities for science, technology, innovation and development in Africa. Milton Keynes

Daniels CU (2014) Policy support for innovation at grassroots in developing countries: perspectives from Nigeria. J Sci Technol Soc

Daniels C (2017) Science, technology, and innovation in Africa: conceptualizations, relevance, and policy directions. In: Mavhunga CC (ed) What do science, technology, and innovation mean from Africa? The MIT Press, Cambridge, Massachusetts, pp 169–184

Daniels C, Ustyuzhantseva O, Yao W (2017) Innovation for inclusive development, public policy support and triple helix: perspectives from BRICS. Afri J Sci Technol Innovation Dev 9(5):513–527

Ecobank Research (2018) Digital | The high cost of mobile data in Sub-Saharan Africa

eSkills4Girls (2019b). In: eSkills4Girls. eskills4girls.org. Accessed 23 Aug 2019b

Government of Zimbabwe (2012) Second science. Technology and InnovationPolicy of Zimbabwe, Harare

Government of Zimbabwe (2018) Towards an upper-middle economy by 2030. Harare

Government of Zimbabwe (2019a) Industrial Parks in Zimbabwe: towards achieving vision 2030. Harare

Government of Zimbabwe (2019b) Education 5.0: Doctrine for the Modernisation and Industrialisation of Zimbabwe through education, science and technology development to achieve vision 2030. Government of Zimbabwe, Harare

GSMA (2019) The mobile economy: Sub-Saharan Africa

Gupta AK (2013) Tapping the entrepreneurial potential of grassroots innovation. Stanford Soc Innov Rev 11:18–20

Harwood SA (2011) The domestication of online technologies by smaller businesses and the 'busy day.' Inf Organ 21:84–106. https://doi.org/10.1016/j.infoandorg.2011.03.002

Hayes E (2008) Girls, gaming, and trajectories of IT expertise. In: Beyond Barbie and Mortal Kombat. The MIT Press, pp 183–194

Hooker M (2017) A study on the implementation of the strengthening innovation and practice in secondary education initiative for the preparation of science, Technology, English and Mathematics (STEM) Teachers in Kenya to integrate Information and Communication Technology. Queen's University Belfast

i4Policy (2019c). In: i4Policy. www.i4policy.org. Accessed 10 Jul 2019c

Ismail Z (2018) Benefits of STEM education. International Development Department, Birmingham, UK

Johnson M (2018) Leveraging the opportunities of the digital economy. In: Concluding meeting of the 26th OSCE economic and environmental forum. ITU, Prague https://news.itu.int/digital-economy-opportunities/. Accessed 25 Aug 2019

Knowledge @Wharton (2019) Why female innovators need a new deal. In: World economic forum. https://www.weforum.org/agenda/2019/05/finding-stem-s-gone-girls-why-women-innovators-need-a-new-deal/. Accessed 11 Aug 2019

Madzwamuse M, Kouakou K (2018) The future of work for women in Africa: Crises and opportunities with. African Women's Exp 5–9

Mosatche HS, Matloff-Nieves S, Kekelis L, Lawner EK (2013) Effective STEM programs for adolescent girls—three approaches and many lessons learned. Afterschool Matter Spring, pp 17–25

Nancy L, David W, de la Torre J, Wong G (2018) A global framework of reference on digital literacy skills for indicator 4.4.2

Petray T, Doyle T, Harrison R, et al (2019) Re- Engineering the "Leaky Pipeline" Metaphor : Diversifying the Pool by Teaching STEM "by Stealth .". Int J Gender, Sci Technol 11

Potraz (2018) Abridged postal and telecommunications sector performance report. Harare

Rajahonka M, Villman K (2019) Women managers and entrepreneurs and digitalization: on the verge of a new era or a nervous Breakdown? Technol Innov Manag Rev 9. https://doi.org/10.22215/timreview/1243

Reserve Bank of Zimbabwe (2018) Circular to banking institutions no. 2/2018: Virtual currencies. https://www.rbz.co.zw/documents/publications/circulars/circular-to-banking-institutions----operations-of-cryptocurrency-exchanges-----11-may-2019.pdf Accessed 15 Aug 2019

Rosenberg N (2004) Innovation and economic growth

Rosenberg N (2013) Sources of Innovation in developing economies: reflections on the Asian experience. Seoul J Econ 26:283–309

Sibanda V, Makwata R (2017) Zimbabwe post independence economic policies : a critical review. Lambert Academic Publishing

Stirling A (2014) Towards innovation democracy? Participation, responsibility and precaution in innovation governance. SSRN Electron J. https://doi.org/10.2139/ssrn.2743136

Tait J, Banda G (2016) Proportionate and adaptive governance of innovative technologies: the role of regulations. Guidelines and Standards, London

TechWomen. In: TechWomen. techwomen.org. Accessed 23 Aug 2019a

Teece DJ (1986) Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. Res Policy 15:285–305. https://doi.org/10.1016/0048-7333(86)90027-2

The World Bank (1998) World development report 1998/1999: knowledge for development. Oxford University Press, New York

The World Bank (2008) Technology and technological diffusion in developing countries. Glob Econ Prospect, pp 51–104

The World Bank (2018) Doing business 2018 reforming to create jobs: comparing business regulation for domestic firms in 190 economies. Washington DC

Thygesen T (2019) The state of venture capital—female-founded companies secure only 3% of investments. In: Forbes. https://www.forbes.com/sites/tinethygesen/2019/08/23/the-state-of-venture-capital-female-founded-companies-secure-only-3-of-investments/#74b2ea551d46. Accessed 10 Sep 2019

UNECA (2017) Economic report on Africa 2017—An overview of urbanization and structural transformation in Africa

UNESCO (2015) UNESCO science report: towards 2030. UNESCO, Paris

UNESCO (2017) Cracking the code: Girls' and women's education in science, technology, engineering and mathematics (STEM). Paris. UNESCO

United Nations Statistics Division (UNSD) (2015) The world's women 2015 : trends and statistics. In:Education

West M, Kraul R, Ei Chew H (2019) I'd blush if I could: closing gender divides in digital skills through education

Yu L (2017) Stimulating STEM related skills development and women's entrepreneurship through ICT: experience from SE Asia. In: STEM gender equality congress. The Sasakawa Peace Foundation

Zimbabwe National Statistical Agency (ZimStat) (2016) The zimbabwe population census 2012: Women and men profile summary report. Harare

Mapping Entrepreneurial Ecosystem for Technology Start-ups in Developing Economies: An Empirical Analysis of Twitter Networks Between Start-ups and Support Organizations of Nairobi's Digital Economy

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1 Introduction

Since entrepreneurship as an important driving force for economic growth has been emphasized by Schumpeter (1969), dedicated research on entrepreneurship has served as a foundation for formulating policies to encourage entrepreneurship. During the last two decades, the rise of Silicon Valley has fuelled special interest of policymakers in creating favourable environment for venture creation with its extraordinary achievement in fostering start-ups based on new emerging ICT technologies. The success story of Silicon Valley became an eye-opener for many policymakers in developed economies with stagnating growth and eventually used as benchmark for facilitating new venture creation in many cities and regions all over the world (Bresnahan et al. 2001).

Especially, the increasing focus on technology-based entrepreneurship coincided with the recent empirical findings showing that not all new businesses contribute to economic growth (Wong et al. 2005; Stam et al. 2009). Studies in entrepreneurship

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research started to distinguish necessity-driven entrepreneurship and opportunity-driven entrepreneurship in assessing their economic impact and found that only opportunity entrepreneurship contributes positively to economic development (Acs and Varga 2005). In line with this, traditional view on entrepreneurship as 'self-employment' and 'small businesses' has lost its value in drawing implication for policy, while more emphasis has been placed on 'high-growth firms' and 'ambitious entrepreneurs' (Stam et al. 2012). As technology-based ventures are mainly founded by detecting market opportunities originating from new technologies, they are also likely to be associated with high growth potential or high ambition level of entrepreneurs.

The emphasis on technology-based entrepreneurship has also been detected in the context of developing economies. The emergence of technology entrepreneurship in Africa, mainly based on new ICT technologies, is gaining attention with its potential to achieve leapfrogging and economic catch-up (Osiakwan 2017). The new technologies with short life cycle allow entrepreneurs to quickly acquire emerging technological competences to compete with global players, which deviates from the traditional industrial development path preceded by developed countries (Lee 2013). Not only do the new ventures show the potential to achieve economic growth, but a fair number of them also address basic social issues in the society based on new technologies (Hain and Jurowetzki 2018). For these economies, supporting technology entrepreneurship could be an efficient way to achieve both 'social' and 'economic' development simultaneously.

How to effectively support entrepreneurship has been a major consideration of many policymakers and researchers. While earlier focus has been placed on entrepreneurs as individuals with special characters and behaviors, there has also been increasing attention towards understanding contextual factors for entrepreneurial activities with a holistic view (Audretsch and Belitski 2017). The recently emerged concept of entrepreneurial ecosystem (EE) seems to serve this need as it balances focus on entrepreneurs as individual actors and the system-level conditions as contextual factors, with the recognition that individual entrepreneurial actions are largely influenced by the local business environment (Isenberg 2011; Mason and Brown 2014; Stam 2015). Similar to the systemic approach to innovation as in the innovation system framework (Lundvall 1992; Freeman 1995), this framework suggests that entrepreneurship happens in a system that consists of various actors involved in entrepreneurial activities and their interaction within local environment, which is typically demarcated with the boundaries of cities and regions.

Despite its advantage to provide a holistic assessment of the ecosystem for policymakers, this approach has rarely been applied in the context of developing economies. We argue that the ecosystem framework can be a useful tool in pointing out weak and strong elements in the local business environment, which will then guide the developing economies in leveraging relatively strong resources for facilitation of entrepreneurial activities. In this study, we apply the framework to identify ecosystem around technology start-ups in Nairobi, Kenya, one of the leading entrepreneurial hubs in African continent. More specifically, we analyze networks of Twitter mentions between technology start-ups and support organizations to identify entrepreneurial communities that constitute an important part of Kenyan entrepreneurial ecosystem. We assume that in resource-scarce developing economies with weak institutions and knowledge base, entrepreneurial communities serve as a major driving force in nurturing entrepreneurship.

This study contributes to the literature in the following ways. First of all, we draw our attention to connection and interaction between the elements of the ecosystem, which has received relatively little attention in previous empirical studies (Motoyama et al. 2014). Secondly, we address one important shortcoming of the previous studies—focus on the ecosystems in developed economies—in order to draw implications on some peculiarities of the development of an entrepreneurial ecosystem in developing economies. Third, and related, most indicators of the structure of as well as interaction within ecosystems proposed so far draw from data sources typically available in developed economies, but less so in the data-sparse context associated with most developing economies. Our research aims at jointly addressing these issues by deploying a novel combination of methods and data sources to map the structure and interaction within dynamic emerging ecosystems.

The structure of the chapter is as follows. The next section discusses the theoretical background for entrepreneurial ecosystem. Then, the empirical context of Nairobi and the methodology will be explained in the following sections. We proceed to presentation of the results from the empirical analysis on networks, which is followed by a discussion and conclusion of the paper.

2 Theoretical Background

The analysis presented in this chapter utilizes the entrepreneurial ecosystem approach in identifying the networks in the supportive environment for tech-based start-ups. The following section provides an account of the approach in general and the application of it in the developing economy context.

2.1 Entrepreneurial Ecosystem and the Importance of Networks in the Ecosystem

The recent trend in entrepreneurship research shows that the focus has shifted from entrepreneurs as individuals with certain characteristics and behaviors towards a holistic understanding of how entrepreneurial actions are taking place in certain territories (Feld 2012; Acs et al. 2014; Audretsch and Belitski 2017). Considering that entrepreneurship plays an important role in economic growth (Audretsch and Lehmann 2005), understanding the systemic nature of entrepreneurial success seems like a due objective of research in this domain. The increasing attention to the local context in which individual entrepreneurs pursue their opportunities contributes to establishing a more balanced view in recognizing that both ‘individual entrepreneurial action’ and ‘contextual factors’ matter for entrepreneurship (Audretsch and Belitski 2017).

One of the early conceptualization of systemic nature of entrepreneurship was suggested by Spilling (1996) who defined an entrepreneurial system as a system consisting of “a complexity and diversity of actors, roles, and environmental factors that interact to determine the entrepreneurial performance of a region or locality (p. 91).” The systemic thinking recognizes the importance of various actors/factors that exist within a system and their interaction in creating the environment for venture creation. During the last decade or so, the concept of *entrepreneurial ecosystem* has emerged as a framework to illustrate the systemic nature of entrepreneurial activities anchored within certain geographical boundary (Isenberg 2011; Napier and Hansen 2011; Stam 2015; Spigel 2017). While there is no one universal definition, the general understanding of the concept seems to be “a set of interdependent actors and factors coordinated in such a way that they enable productive entrepreneurship (Stam 2015, p. 1765).” The actors involved in the ecosystem could be, for example, (1) potential and existing entrepreneurial actors, (2) entrepreneurial organizations such as firms, venture capitalists, business angels and banks, and (3) institutions like universities, public sector agencies, and financial bodies (Mason and Brown 2014). The other interconnected factors may include social, political, economic, and cultural elements within a certain regional boundary, as Spigel (2017) specifies. In other words, the ecosystem can be understood as a community and network of various actors and the system-level institutional and socioeconomic contextual factors (Audretsch and Belitski 2017).

In most studies within this literature,[1] entrepreneurship is conceptualized as new venture creation by ‘individual’ entrepreneurs (Isenberg 2011; Audretsch and Belitski 2017; Spigel 2017). Central actors in focus in the ecosystem, therefore, are most often start-ups and entrepreneurs behind the start-ups. Stam (2015) pointed out that there is a tendency to focus on “high-growth start-ups” rather than more traditional definition of entrepreneurship as “self-employment” or “small businesses” in previous studies on the ecosystems with the argument that it is rather this type of entrepreneurship that contributes to innovation, productivity, and employment (Napier and Hansen 2011; Mason and Brown 2014).

There have been attempts to identify various elements and pillars of the entrepreneurial ecosystem in developing the holistic view of the system. Isenberg (2011) pinpointed 12 elements (further consolidated in 6 domains) that need to be present in order for the system to be self-sustainable: policy (government initiatives and leadership), markets (early customers and networks), finance (capital), human capital (Labor and educational institutions), culture (success stories and societal norms), and supports (infrastructure, support professions, and non-government institutions). Similarly, World Economic Forum (2013) lists 8 pillars (accessible markets, human capital/workforce, funding and finance, support systems, government and

[1] Stam (2014) include activities by ‘entrepreneurial’ employees in established firms as a form of entrepreneurship in the analysis of Dutch entrepreneurial ecosystem.

regulatory system, Education and training, universities, and cultural support) that overlap with the elements identified by Isenberg (2011).

The initial identification of elements and pillars led to more structured models of an entrepreneurial ecosystem following the recognition that there is a lack of relational configuration between the elements. Stam (2015) suggested a model with four ontological layers connected with causal relations. Each of the four layers consists of framework conditions (formal institution, culture, physical infrastructure, and demand), system conditions (networks, leadership, finance, talent, knowledge, and support services/intermediaries), outputs (entrepreneurial activity), and outcomes (aggregate value creation). Elements in the framework conditions represent social and physical conditions for human interaction, which forms the fundamental causes leading to entrepreneurial activity, but what determines the success of the entrepreneurial activity is how well elements in the system conditions work together. These elements together induce entrepreneurial activities as outputs that further lead to aggregate value creation in society as the outcome. In this model, entrepreneurial activities can be manifested in different forms such as innovative start-ups, high-growth start-ups, and entrepreneurial employees, but what is considered most critical is that these activities create aggregate welfare increases in the end.

Spigel (2017) categorized some elements of an ecosystem into three groups and illustrated how they are related to each other. The first group represents cultural attributes including cultural attitudes towards entrepreneurship and success stories as histories of entrepreneurship. The second group of elements, social attributes, are resources from social networks existing in the system and include network themselves, investment capital, mentor/dealmakers, and worker talents. Lastly, material attributes are tangible elements such as universities, policy and governance, physical infrastructure, support services, and open markets. These three categories of attributes influence and reinforce each other in a system and thereby work in tandem to support entrepreneurship. For example, cultural beliefs and values facilitate formation of social network of various actors and interaction among them. The dense connection between the actors, on the other hand, reinforces and strengthens the creation of common values and norms in the system. Furthermore, social attributes like active communities of entrepreneurs and mentors could support development of material attributes like policies and support services. Spigel (2017) asserts that some elements can be missing even in a thriving ecosystem and the attributes should merely be understood as the factors that create supportive environment for entrepreneurship.

The structural models of EE point to the importance of interaction among the elements in the system. While having the necessary elements and condition in place is desired, what can also be critical for the well-functioning of EE is how well the elements are connected in networks. The networks in the ecosystem connect the actors and channel resources like knowledge, financing, and human capital (Spigel and Harrison 2018). The creation of communities of entrepreneurs and other relevant actors through a social network can, therefore, have a lasting effect on facilitating a suitable environment for entrepreneurship. Spigel and Harrison (2018) use ‘network strength' together with 'resource availability' to assess the overall strength and functionality of the EE. The authors show that various configurations of ecosystem can exist depending on the strength of the two aspects and explain that some ecosystems in developing economies such as Accra and Lagos have dense networks despite sparse resources they possess. The dense networks then allow local entrepreneurs to create new resources in collaboration or to get access to resources from abroad through the social ties of diaspora.

Although the previous literature generally defines the ecosystems at a regional (sub-national) level, it is still not completely clear at what level entrepreneurial ecosystems can be or should be applied in terms of their geographical boundaries (Stam 2015). The previous empirical studies on the ecosystem show that the concept has been applied in various local contexts such as cities, counties, regions, and nations (Neck et al. 2004; Napier and Hansen 2011; World Economic Forum 2013; Audretsch and Belitski 2017; Spigel and Harrison 2018). As Stam (2015) pointed out, some elements like human labor pool and social networks can be better defined at a regional level, while other elements like government policy and regulations can be applied in a broader national context. What could be more important in determining the geographical scope can be interaction among the actors through which the entrepreneurial activities are taking place and resources needed for the activities are sourced. In certain cases, one may also detect strong connections beyond regional and national borders through the activities of global entrepreneurs, investors, or support organizations (Malecki 2011).

2.2 Application of Entrepreneurial Ecosystem Approach in Developing Economies

The literature on entrepreneurial ecosystems is mostly based on investigation in the regions and cities in advanced economies.[2] Silicon Valley, Boston, Boulder county, and Edinburgh are some of the examples of typical reference cases mentioned in the studies of both empirical and theoretical character. Even the studies comparing various ecosystems from different countries have focused on regions and countries in the developed part of the world (Napier and Hansen 2011; Audretsch and Belitski 2017). As the literature was largely driven by policy-oriented research that naturally stems from the need and the capacity of developed economies, the application of the ecosystem approach has been characterized with a benchmark of few success stories from developed economies, without much consideration of local context. However, the recent consent in the literature is that further development of the ecosystem approach should incorporate the heterogeneity of ecosystems and the evolutionary force behind the emergence of the ecosystems in the local context (Busenitz et al. 2013; Motoyama et al. 2014; Spigel 2017). Along this line, we acknowledge the need

[2]Few studies applied the ecosystem approach in the context of Latin America (Kantis and Federico 2012) and Africa (Sheriff and Muffatto 2015; Bramann 2017).

to explore the applicability and relevance of the approach for emerging economies to accommodate diverse local settings.

As it was pointed out by Acs et al. (2008), countries have different dynamics of entrepreneurship depending on the institutional context and the level of economic development. For example, the rate of new firm creation and the ratio of necessity entrepreneurship and opportunity entrepreneurship vary in different national contexts. Some developing economies have a higher level of new firm creation than developed economies, but with a significantly higher share of necessity-driven entrepreneurship due to limited employment opportunities in the labor market (Acs et al. 2008). This signals that there will be a different contextual background for the entrepreneurial ecosystem, depending on the level of economic development.

The most immediate influence of the level of economic development on entrepreneurial ecosystem originates from resource scarcity, which makes it hard to create the optimal environments for new business creation (Bramann 2017). The typical challenges of local entrepreneurs in emerging economies suffering from resource scarcity are a low level of consumer demand, weak financial markets, weak enforcement of formal institution and regulation, general lack of trust in the society, inefficient administrative systems, and underdeveloped infrastructure (Webb et al. 2009; Bramann 2017; de la Chaux and Okune 2017; Atiase et al. 2018). These challenges are present in most of the fundamental elements of the ecosystem models typically discussed in the literature such as finance, institution, market, and government and regulatory system (e.g. Isenberg 2011; Stam 2015). The changes and improvements in each of the elements will require long-term effort and investment, meaning that significant effort will be required to improve multiple elements in the system. Under these circumstances, it would be beneficial to direct attention to the networks within and across the local ecosystem, through which the actors can generate and channel resources in need. For developing economies, critical assessment and improvement of the networks can be more effective for creating the best possible environment for entrepreneurship.

3 Empirical Context: Technology Entrepreneurship in Kenya

Kenya has achieved steady economic growth with an average growth rate of 5.5% for the period of 2004–2016 and received attention as one of the KINGS countries (Kenya, Ivory Coast, Nigeria, Ghana, and South Africa) leading the current economic growth in the African continent (Osiakwan 2017). What has gained more interest among scholars is the rise of the ICT sector in Kenya in the recent years (Gathigi and Waititu 2012; Drouillard et al. 2014; Hain and Jurowetzki 2018). The capital Nairobi witnessed a surge of technology entrepreneurship that has also attracted local and international impact, angel and fund investors (Hussey 2015; de la Chaux and Okune

2017). Economist (The Economist 2012) even named it "Silicon Savannah" with the analogy to Silicon Valley.

There has been cautious[3] anticipation that technology entrepreneurship may have the potential to lift the social and economic burden that the region has been carrying around for decades (Ndemo and Weiss 2017). A positive prospect could be made on the account that many of the recent technology start-ups deal with social problems such as absence of physical addresses and reliable postal services (Hain and Jurowetzki 2018), indicating that new ventures are aiming at making social impact. Furthermore, recent technology-based entrepreneurial activities in Nairobi are characterized by being opportunity-driven than necessity-driven. It is observed that many technology ventures have a clear goal of addressing local market needs with newly available technologies and some non-local technology entrepreneurs even moved to Nairobi to pursue venture creation based on specific local needs they detected (Park et al. 2016). As entrepreneurship literature emphasizes the particular importance of 'opportunity-driven' entrepreneurship on economic development (e.g. Acs and Varga 2005), we could also expect the new ventures to create positive economic impact. All in all, these observations speak for the importance of technology entrepreneurship as potential driving force for economic and social development in the region.

There seem to be three main factors that led to the emergence of high-tech entrepreneurship in Nairobi. The first factor is the rapid dissemination of the mobile technologies following the introduction of mobile phone subscriptions, the arrival of the smartphone to the country, and the privatization of the telecommunication sector (cf. Zavatta 2008). In a GSMA report, 31% of people living in Kenya have at least one mobile subscription (Drouillard et al. 2014), while other studies suggest that 60% of Kenyans living on less than $2.50 a day have access to mobile phones. The second factor is the arrival of the submarine Fiber-Optic Cable to Mombasa in 2009, allowing the country to access a reliable internet connection. Finally, the introduction of revolutionary innovations by pioneers of tech start-up based on the growing consumer markets for technology. M-Pesa within mobile banking and the worldwide renowned Ushahidi crowdsourcing platform are a couple of examples of early start-ups that initiated the entrepreneurial scene in Kenya.

Utilizing the entrepreneurial ecosystem approach on qualitative data from case studies and interviews, Bramann (2017) identified several barriers and enablers of entrepreneurship in the Kenyan context. The first main barrier is the lack of qualified human capital. The absence of knowledge-intensive industries and research institution lead to few individuals with management, entrepreneurial, and technological competences. The second barrier is the Kenyan culture that associates entrepreneurship with low prestige. The entrepreneurial career path is not recognized as an attractive employment option compared to more stable corporate jobs. The next obstacle is the financial landscape. Even though there are records of venture capital deals into several Kenyan Start-ups (Hain and Jurowetzki 2018), these kinds of investments

[3]Ndemo and Weiss (Ndemo and Weiss 2017) noted that, although new ICT technologies may seem to democratize distribution of information, one need to be aware that few players take control over how seemly abundant information is being created and disseminated.

most often take place later in the finance funnel. Early Stage funding, in particular, is hard to find. Start-ups end up seeking for other types of non-marketed finance such as grant funding (Bramann 2017), which often fails to identify and support competent ventures. Lastly, the quality of market is still low, meaning that limited source of income hampers the implementation of business-to-customer monetization models in introducing new innovation and leads to utilization of social impact models through government, NGOs, and international development agencies. On the other hand, strong support infrastructure is identified as an important enabler of entrepreneurial activities in Kenya. Nairobi hosts multiple support organizations such as hubs, accelerators, and incubators that nurtures entrepreneurial spirit, provides managerial and entrepreneurial training, and, most importantly, builds an active community of entrepreneurs.

In similar vein, Marchant (2015) in the analysis of ICT environment in Kenya also pointed out that local actors such as universities and government bodies lack involvement with and connection to the industry, especially entrepreneurs. This is also shown in weak formal networks in terms of partnership among various actors in the ecosystem such as universities, public organizations, multinationals, and entrepreneurs. On the other hand, informal networks mostly formed around incubators are identified to have critical importance to the entrepreneurial scene in Kenya, providing social proximity among entrepreneurs, which is critical for innovation and interactive learning (Boschma 2005).

4 Method

Based on previous observations and analyses discussed in the previous section, we focus on informal networks around start-ups and support organizations in Nairobi in our empirical analysis as we consider it a critical driving force in the local entrepreneurial ecosystem. We draw on the methodology of social network analysis (SNA) and use data from the CrunchBase database and social media platform Twitter to construct the social networks.

4.1 Identifying Start-ups and Supporting Organizations

To identify the central actors in the ecosystem, we first extracted data from CrunchBase (CB). CB is the open, community-curated database of TechCrunch with profiles of 650,000 companies, investors, and people. It provides information on technology-based ventures with a detailed account of activities including investment rounds and technology descriptions. The dataset was constructed by crawling the graph structure of CB, starting with all listed tech start-up companies in Kenya as well as their listed investors. Then, we identified 49 start-ups, of whom a majority have documented investment rounds in CB. We argue that the ventures that received investment show better prospect in terms of contributing to economic development in the region and see these ventures as central entrepreneurial actors in the ecosystem.

To identify the main supporting organizations, we used the Twitter REST API to extract all the tweets of 49 start-ups that possess a Twitter account. We identified 66,072 unique Twitter users. However, as it is typically expected from a social media network, the data contains irrelevant stakeholders for the study, such as stars (actors, musicians, and athletes) and politicians. Nevertheless, we also expect the Kenyan start-ups to follow relevant accounts of support organizations on Twitter. Therefore, we decided to filter the nodes according to the total degree centrality and keep actors who have the most overall interest in the ecosystem. We then re-used the Twitter REST API to collect the tweets of the selected accounts. The final network graph is hence composed of 241 unique users including the start-ups and other relevant accounts. These 241 have initially exchanged over 300,000 mentions. We decided to limit to tweets that have a least one retweet as a measure of quality. That allows us to reduce the number of mentions to 152,861 for an exact number of 82,616 individual tweets.

We then utilized a typology of actors in an entrepreneurial ecosystem suggested by Motoyama et al. (2014) to classify the accounts. We refer to the authors' definition of "Entrepreneurship Support Program" as organizations such as accelerators, chambers of commerce, tech-related conferences, and non-profits that support entrepreneurs. We scanned Twitter timelines, CrunchBase profile, and official webpage of the different accounts to identify supporting organizations.[4] Furthermore, we classified the different feeds in terms of geography. The local accounts refer to feeds in Kenya, where most are based in Nairobi. Global accounts include both regional (Kenya neighboring countries) and overseas feeds (United States, Europe).

4.2 Social Network Analysis and Twitter

The structure of Twitter data makes it a natural fit for network analysis. Twitter data produce networks between users based on their public interactions such as replies, mentions, or re-tweets (Conover et al. 2011; Jürgens et al. 2011). In this paper, we focus on the interactions through mentions, where the author of the tweet mentions another or several other accounts. We argue that mention denotes direct communication between the two users.

In social network analysis, the ties—or edges—may represent different kinds of relationships. According to Borgatti et al. (2009), a significant proportion of social network research studies how four basic types of relations—similarities, social relations, interactions, and flows—affect each other. Twitter mentions can represent the notion of interactions, conceptualized as discrete events which can be counted over time and hence provide both direction and weight to the edge. Whereas the Twitter mention itself does not offer a meaningful flow, it may correspond to a past or future

[4] Table 2 in the analysis section reports a description of these supporting organizations.

off-line interaction between the two actors. For instance, congratulation to other actor's success story through Twitter mention can imply that there already exists a form of 'personal relation.' It could be interpreted that the involved actors may have had a collaboration on projects before or participated together in an event organized by a supporting organization.

We use the following metrics to analyze the networks in our data. To get a grasp of the network and its interconnectedness, we utilize the measures of density and community detection. To understand the role of a specific actor (node) in the network, we use two centrality measures: Total degree centrality and Betweenness centrality.

- Community detection: We clustered the actors by applying the Louvain algorithm (cf. Blondel et al. 2008) which aim is to optimize modularity, defined as a value that measures the density of links inside communities compared to links between communities. Through an iterative process, the algorithm builds communities that have a higher density of links. In this paper, we compute the Louvain modularity algorithm.
- Degree centrality: It accounts for all the ties a node has, in a directed network. There are three types of degree centrality: (1) In-degree denoting ties directed to a specific node, (2) out-degree denoting ties originating from a specific node, and (3) total degree centrality as the sum of the previous two, including all interactions a node has with the network. In this paper, we consider total degree centrality as we are interested in both actors, those who initiate interaction, and those who are subject to interaction.
- Betweenness centrality: It quantifies the number of times a node acts as a bridge along the shortest path between two other nodes. It then denotes the crucial elements in the network that allow a faster flow of information and interaction. It is a relevant measure for identifying the presence of hubs.

4.3 Limitation of Twitter Data

The use of Twitter data in the analysis comes with certain limitations. Representativeness and accuracy of the data are main issues as the dataset extracted from social media represents a particular subset of people of interest (Mislove et al. 2011; Boyd and Crawford 2012). For instance, a Twitter account may be managed by multiple users and vice-versa, a single person may have several accounts (Boyd and Crawford 2012). Another issue could be that the data might exclude users who are active 'listeners,' meaning that they are part of the network, but do not actively post information on the network (Crawford 2009; TwitterInc. 2011). In other words, Twitter users represent a small proportion of internet users, and within those users, the usage of Twitter varies from account to account. There is, therefore, a disparity between accounts in terms of issued tweets (mentions).

Furthermore, the data on Twitter represents a static state of online activity. Therefore, the data gathered for this analysis cannot be used to study the evolution of the ecosystem. It only illustrates the current state based on recent past or future close interaction.

Notwithstanding, Twitter popularity among entrepreneurs has increased in the past few years as a necessary tool to communicate activities and successes as well as convey news on the on-going activities within the ecosystem. It is, nowadays, in the interest of start-ups and support organizations to develop their business online to increase their visibility and follow success stories and news on the ecosystem. Even with its shortcomings, Twitter data has evident strength as it is naturally fitted for conducting social network analysis, which, we argue, complements previous studies by highlighting connections of specific set actors of the ecosystem. Finally, the investigation of informal ties is deemed relevant in the particular case of Kenya, where most relationships within the ecosystem are perceived to be informal (Marchant 2015).

4.4 Natural Language Processing Approach to Strengthen the Interpretation of the Network Analysis

To understand the thematic focal points of the discourse on Twitter in the studied population, we utilize a Natural Language Processing approach. We identify latent themes or topics in the discourse and contrast them with the detected communities. This allows us to understand who is talking about what and thereby gain a deeper understanding of communities and their constituent actors.

The process involves tokenizing all tweets using a tokenization strategy that considers the specificity of language on Twitter. We identify common phrases—bi-and trigrams—and remove common stop-words. Then we filter out all words that are not a noun/noun phrase, adjective or adverb and lemmatize the remaining tokens in the corpus. After these steps, the dataset contains 31,527 unique features (words).

There is a variety of approaches to identifying themes in a given text-corpus. Here, we decided to use a topic modelling strategy that requires minimal inputs from the researcher and produces results that can easily complement a qualitative exploration of the focal context. The approach requires no predefined vocabulary, identifies a set number of topics from a collection of documents (tweets) and provides a score for each topic in a document, which simplifies the labelling of topics to documents.

We utilize the Correlation Explanation (CorEx) algorithm proposed by Gallagher et al. (2017) that relies on an information-theoretic approach to identify n combinations of features in the data that maximally describe correlations in the inputs. The algorithm takes a simplified one-hot-encoded bag-of-words representation of the documents as input and gives the desired number of identified topics, returning a document-topic matrix. For easy interpretation, topics are described as sequences of words which are sorted by their contribution of each feature to total correlation.

5 Empirical Analysis

Based on the latest 3200 tweets of each start-up and supporting organization account,[5] we extracted available mentions from tweets. We then identified relevant mentioned accounts recurring to standard measures as degree centrality. We then built three directed and weighted networks; one network among start-ups, one with all the accounts based in Kenya and another with all the accounts including international accounts. In this section, the start-ups' local support organizations and other local accounts in the data will be presented along with the two first networks. Then, we analyse the network with interactions with international actors, including international supporting organizations. After an overview of the network is complete, a section will be dedicated to examining the topics in the tweets containing mentions.[6]

5.1 Network of Start-ups

Having CrunchBase as our data source, the start-ups in our sample are mostly technology-based firms. Most companies in our sample work with ICT-related technologies such as mobile communication, mobile payments, apps, and online services, with few exceptions of firms involved with green technologies (cf. Table 1). While companies pursue different types of business models (for-profit, social businesses, and mixed), a common feature of these companies is that the provided products and services rely on modern technology to overcome inefficiencies in necessary infrastructure. The mobile phone became a universal platform for developing and delivering services in areas as different as public transportation and agriculture pricing. Over a third of the companies are developing software, mostly mobile apps, and another roughly 20% rely on Internet platforms, which today are not much different from the former. Other than ICT-related business firms, several companies work with clean-tech and renewable energy technology, addressing the need to provide access to basic sanitation and sustainable electricity for the general public.

The network below (cf. Fig. 1) illustrates the interactions among the start-ups through mentions and the communities of start-ups identified with the Louvain method. The identified communities are presented in different colors in the network. The algorithm identified 5 different communities, although only 4 have more than 3 members.

The first community, with the most members, encompasses start-ups within the Energy and solar sectors (e.g. PayGo_Energy, mkopasolar, PowerGen_RE, steamco), payment and financial services (e.g. Cellullant, BitPesa, DPOGroup), financial services (e.g. KeEquityBank, BritamEA, ModeGlobal) and ecosystem supporters (e.g. umaticapital, africamanager, Ajua_Africa). Start-ups in the second community,

[5]The tweets were fetched in January 2017, and 3200 is the maximum number of tweets made available by Twitter.

[6]Data collection, treatment and visualization required the use of Python, R and Gephi.

Table 1 Core start-up information

Twitter handle	Start-up	Founding date	Desctiption	Sector I	Sector II
Lynk_Kenya	Lynk jobs	2017	Lynk solves the problems faced by informal workers and the households and businesses seeking their services	App/Computer software	
Sematime	Sematime	2016	Sematime is Kenya's number one bulk SMS service for schools, churches, SMEs and utility companies	App/Computer software	
mDaktariKE	ConnectMed	2016	ConnectMed builds digital therapeutics platform that allows patients to manage their primary and chronic care needs	Healthcare	Internet
djuaji	Djuaji	2015	Djuaji is an accounting platform that allows businesses to conduct survey-based research by paying respondents with mobile money	Accounting	
AirKlip	AirKlip	2015	Interactive study management app providing collaborative environment for students and administrators	App/Computer software	Education
Ongair_	Ongair	2015	Customer support through Whatsapp and other instant messaging services for Business	Internet	Professional/Diversified services
OjayGreene	Ojay greene	2014	Working to up-scale smallholder farmers and linking them to profitable urban markets	Agribusiness	Professional/Diversified services
Farmdriveke	Farmdrive	2014	FarmDrive is a Kenyan-based social enterprise that connects unbanked and underserved smallholder farmers to credit, while helping financial institutions cost effectively increase their agricultural loan portfolios	Agribusiness	App/Computer software
PayGo_Energy	PayGo energy	2014	PayGo Energy is a distribution service that harnesses the power of pay-as-you-go-technology	Clean technology	
Totohealth	Totohealth	2014	Detecting development abnormalities and improving access to healthcare information for the remote and vulnerable populations	Healthcare	App/Computer software
Letsokhi	OkHi	2014	OkHi is building the next generation address system in Kenya to overcome the lack of addressing infrastructure	Internet	App/Computer software
HiviSasa	HiviSasa.com	2014	At Hivisasa, we believe that societies function best when information flows freely among people. This is why we've created Africa's first crowdsourced news site	Internet	
SendyMobile	Sendy	2014	On-demand door-to-door last mile package delivery services	Transportation	App/Computer software

(continued)

Table 1 (continued)

Twitter handle	Start-up	Founding date	Desctiption	Sector I	Sector II
EleniLLC	Eleni	2013	Exchange builder for frontier markets in Africa	Agribusiness	Financial services
GreenhouseKenya	Llluminum greenhouses	2013	Illuminum Greenhouses are an Agri-Tech greenhouse and drip installation company in Kenya working with smallholder farmers to improve increase efficiency through the use of new modern technologies	Agribusiness	
m_changa	M-Changa	2013	Mobile phone based fund-raising management service	App/Computer software	Financial services
AnganiLTD	Angani	2013	Angani is a Kenyan public cloud computing provider located in Nairobi, Kenya, offering services to the entire East African region	App/Computer software	Internet
GreenCharKenya	GreenChar	2013	Clean household energy social enterprise producing charcoal briquettes and clean cookstoves	Clean technology	Renewable energy
Brcknet	BRCK	2013	Rugged, self-powered, mobile WiFi device which connects people and things to the interner in areas of the world with poor infrastructure	Computer hardware	Internet
BitPesa	BitPesa	2013	Payment platform connecting digital currencies with mobile payment systems	Financial services	Internet
Lipisha	Lipisha	2013	Micro- and Mobile-payment processing for businesses	Financial services	App/Computer software
BigSquareKE	Big square	2013	A casual dining restaurant serving locally sourced, SQUAREMADE burgers, fried chicken, BBQ ribs, beer, wine, delicious desserts and hand-spun shakes	Food and beverages	Retail
TwigaFoods	Twiga foods	2013	Twiga Foods is a business-to-business marketplace platform that sources produce directly from farmers and delivers it to urban retailers	Food and beverages	
HaltonsCares	Haltons pharmacy	2013	Haltons Pharmacy is a brand created by Haltons Limited. It is a collection of pharmacists, investors and leaders passionate about delivering accessible and affordable pharmacy care of the highest quality to Kenyans in a dignified manner wherever they are	Healthcare	
Ajua_Africa	Ajua	2012	Mobile survey platform	App/Computer software	Internet

(continued)

Table 1 (continued)

Twitter handle	Start-up	Founding date	Desctiption	Sector I	Sector II
Safaridesk	Safari desk	2012	Hotel management software	App/Computer software	Leisure
Umaticapital	Umati capital	2012	Innovative financial services to SMEs and their suppliers particularly in the agro-sector	Financial services	Agribusiness
Buyrentkenya	BuyRentKenya.com	2012	Property portal	Internet	Real estate
Mdundomusic	Mdundo	2012	Provide Africa with easy and affordable access to music	Music	Internet
Futurepump	Futurepump	2011	Low-cost, low-maintenance solar powered irrigation pump	Agribusiness	Renewable energy
mfarm_ke	M-Farm limited	2011	Connect farmers and Farm produce consumers and give price Information of Kenyan markets	Agribusiness	App/Computer software
BookNowKenya	Book now	2011	Bus booking app	App/Computer software	Transportation
Africamanager	The African management initiative	2011	Social enterprise offering online and offline learning tools and development initiatives for managers, entrepreneurs and professionals	Education	Internet
EnezaEducation	Eneza education	2011	Eneza Education, a.k.a. MPrep, was founded in 2011 by Kenyan teachers and educators serious about making technology useful for their students	Education	Internet
Mkopasolar	M-KOPA	2011	"Pay-as-you-go" energy services for off-grid customers	Renewable energy	App/Computer software
PowerGen_RE	WindGen power products	2011	Small wind turbines for the East-African off-grid energy market	Renewable energy	Clean technology
Sanergy	Sanergy	2010	Sustainable small-scale hygienic sanitation and waste recycling affordable and accessible in urban slums for everyone	Clean technology	Health services
MobiusMotors	Mobius motors	2010	Building vehicles suited to local demand	Manufacturing	Transportation
Steamaco	SteamaCo	2010	Off-grid energy systems management	Renewable energy	App/Computer software
Africastalking	Africa's talking	2010	Mobile phone software infrastructure integrator across mobile providers in Africa	Telecommunication	Internet

(continued)

Table 1 (continued)

Twitter handle	Start-up	Founding date	Desctiption	Sector I	Sector II
BridgeIntlAcads	Bridge international academies	2007	Bridge partners with governments, communities, teachers, and families to deliver great schools and high-quality affordable education to underserved families and children	Education	Education
DPOGroup	Direct pay online group	2006	Direct pay online provides a real time, cloud based processing platform, with state of the art technology that supports multiple transaction types with online and offline capabilities	App/Computer software	Payments
Sanivation	Sanivation	2006	Delivering household sanitation services to peri-urban communities and refugee camps in Kenya	Clean technology	Health services
MODEGLOBAL	DT One	2005	DT One operates a global network for mobile top-up solutions and innovative mobile rewards for emerging economies	App/Computer software	Payments
Forexcoke	Forex	2005	Forex.co.ke enables foreign exchange consumers to compare quotes from currency dealers, transact online, and settle payments electronically	Financial services	
Cellulant	Cellulant	2004	Cellulant is a leading multinational payments company in Africa on a mission to digitise payments for Africa's largest economies	Financial services	Payments
VirtualCityLtd	Virtual City Ltd	2002	Innovative mobility and distribution solutions along the Supply Chain for distributors and retailers of Fast Moving Consumer Goods in emerging markets	Transportation	Retail
KeEquityBank	Equity group holdings	1984	Equity Bank Kenya is a financial services provider headquartered in Nairobi, Kenya. It is licensed as a commercial bank by the central bank of Kenya, the Equity Group Holdings central bank, and national banking regulator	Financial services	
ShelterAfrique	shelter Afrique	1982	Shelter Afrique is the only pan-African finance institution that exclusively supports the development of the housing and real estate sector in Africa	Financial services	
BritamEA	Britam	1956	Britam is a diversified financial services group, listed on the Nairobi Securities Exchange	Financial services	

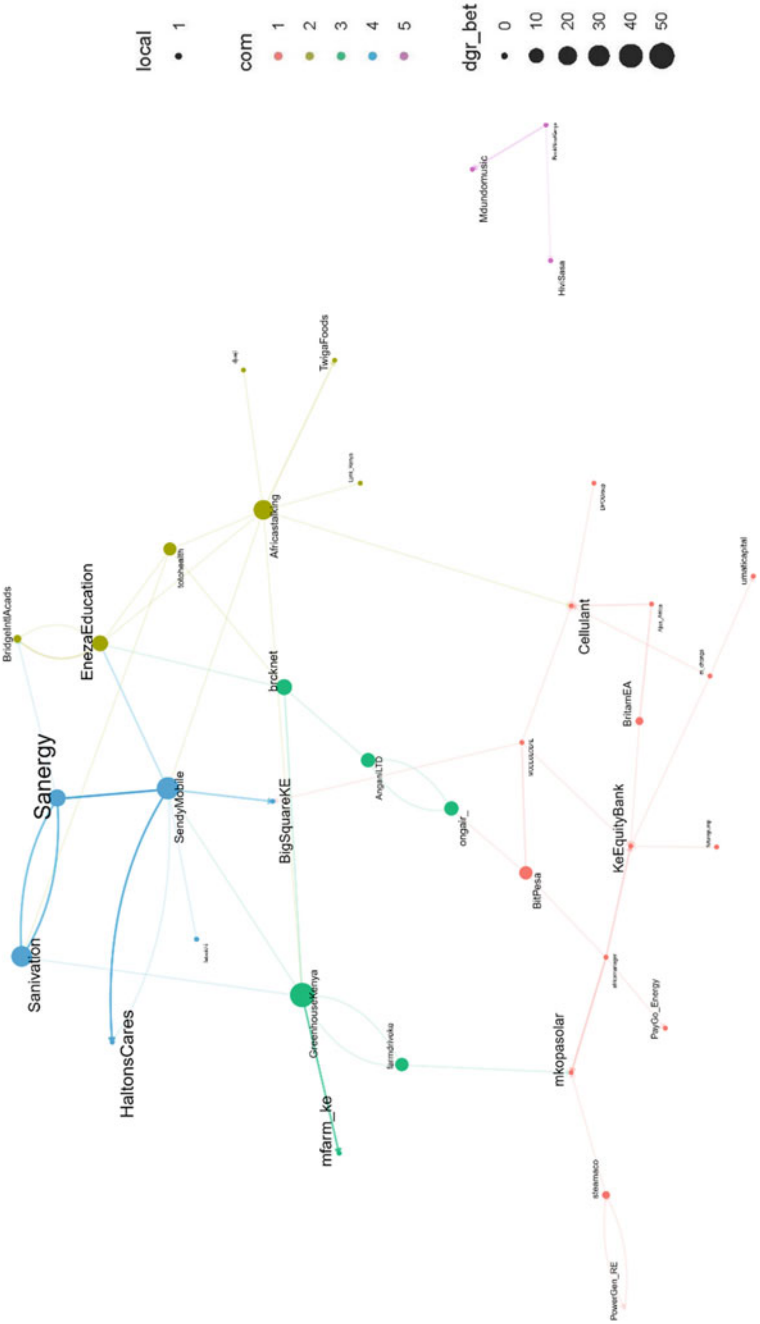

Fig. 1 Core start-up network

with only 7 members, focus mainly on promoting access to services such as education, knowledge development, and hiring (e.g., EnezaEducation, Africastalking, BridgeIntlAcads, Lynk_Kenya).

The third community is composed of two main sets of start-ups. The first, within farming and agriculture (e.g., GreenhouseKenya, mfarm_ke, farmdriveke); and the second start-ups offering internet services or enabling access to it (e.g., brcknet, AnganiLTD, ongair_). The fourth community comprises on the one hand sanitation and healthcare services (e.g. Sanivation, HaltonsCares, Sanergy) and on the other hand start-ups improving transportation and addressing system (e.g. SendyMobile, letokhi).

We tend to notice that in communities with more than one focus (i.e., all except the second), the different start-ups seem to provide complementary service. For instance, in the first community, 5 start-ups focus on Energy and interact with several enablers (financing, accelerators, etc.). The third community depicts interactions between agricultural start-ups and its enablers (access to internet, Cloud payment, and B2B internet communication). Indeed, farmers in Kenya need remote access to the internet to enable payment and communication with partners and suppliers. Similarly, in the fourth community, sanitation and healthcare services benefit from the access to a more reliable addressing system and transportation.

The fact that start-ups mention another on Twitter does not necessarily show, within the above analysis, that they communicate and cooperate offline. It demonstrates, however, that the user mentioning recognizes the existence and attempts to convey a message through an online social network. In the network, we can also depict different node sizes which display the betweenness centrality which helps to identify actors who act as a bridge. Important actors within the network seem to be GreenhouseKenya, SendyMobile, Africastalking, and Sanivation. These accounts either contribute to the network as hubs around which their community gathers or as actors that nurture interactions across different communities.

5.2 *The Network of All Kenyan Accounts*

This network (cf. Fig. 2) comprises the start-ups mentioned in the previous network, and the rest of the accounts based in Kenya, including other company accounts, support organizations and individuals who engage within the community. In this graph, the algorithm identified 10 separate communities. It seems much more significant, now accommodating 177 different nodes. Of those, 48 of the identified start-ups in the graph figure in the network with only 3 failing to be allocated in a community with more than 3 members. There are also 20 accounts identified as supporting organizations. When comparing overall changes in the network with the previous one, it is noticeable that the inclusion of other Kenyan actors reinforces interactions across communities. The graph displays a higher level of interconnected; indeed most communities seem to have at least one link to all or most of the other communities, whereas, in the first network communities had only interactions neighbouring ones.

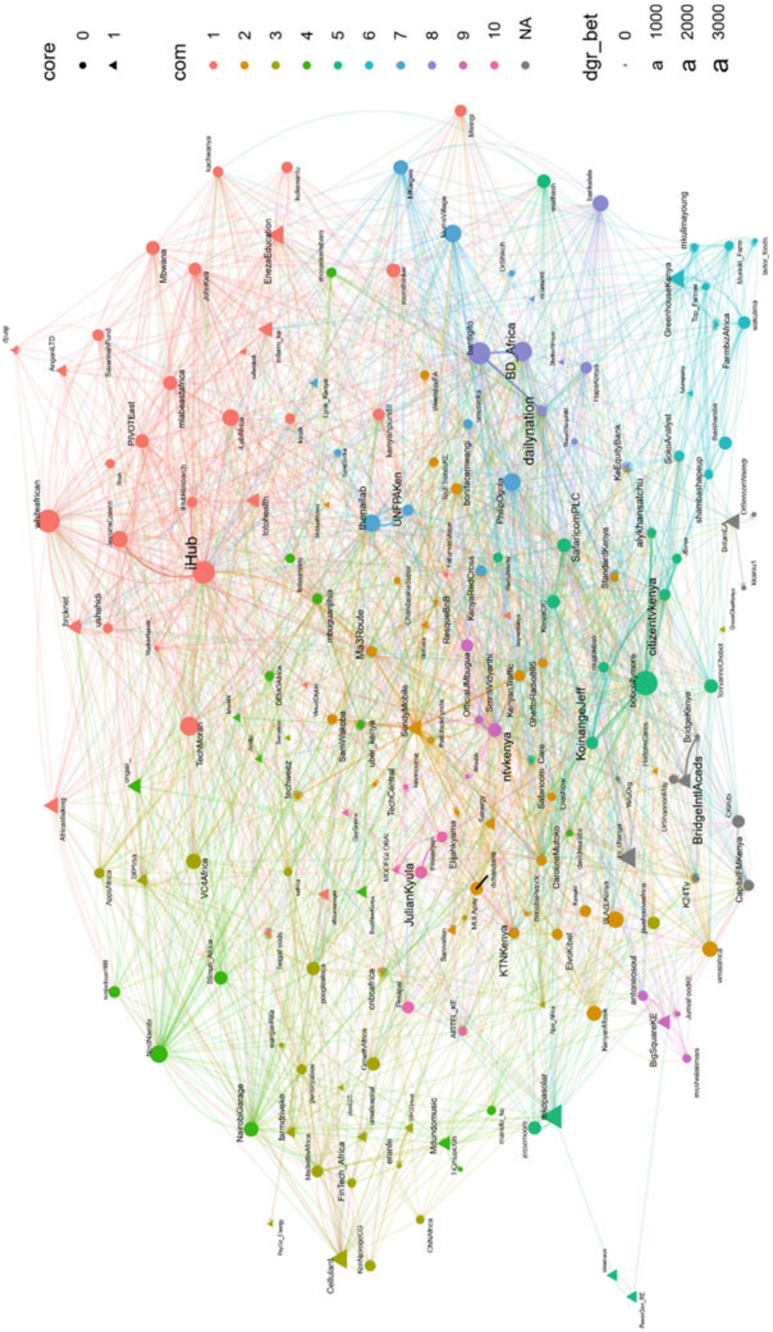

Fig. 2 Kenya network: Directed and weighted graph

This can be explained by the presence of supporting organizations that act as hubs, and although they have been allocated to a specific community, they can very well interact with other actors in other communities within the ecosystem.

This network displays two types of communities, some communities are well grouped forming a distinct cluster (e.g., communities 1 and 6), and others with nodes spread between the center and the extremities of the graph (e.g. communities 3 and 7). Community 1 is the largest with 33 accounts of which 12 are core start-ups. It suggests that these start-ups interact tightly together on Twitter. This community also features 5 supporting organizations, one of them being iHub which, together with whiteafrican account, has among the highest betweenness degrees in the whole network. Therefore, the presence of influential accounts helps to consolidate interactions, especially since they interact closely with each other. Accounts in community 6, although having only 2 original start-ups and 1 supporting organization, are tightly grouped. The cohesion seems to come from the fact that the additional accounts in this community are mostly within the same sector activity (i.e. farming). Community 3 is rather spread compared to communities 1 and 6 discussed above. However, it shares similarities with community 1. There are 25 accounts in the community, 10 core start-ups, and 5 supporting organizations. The main difference lies in the fact that, as in the first community, there are also two main accounts with high betweenness centrality (i.e. Cellulant and VC4Africa). However, the two accounts do not share many interactions, and the community is, therefore, pulled into two different positions.

Comparing this network with the previous one, with the inclusion of support organizations and other Kenyan accounts, start-ups started to detach themselves from the others that don't share the same area of activity. For instance, in the first network, start-ups within the Energy and solar sectors shared the community with start-ups within the payment and financial services sectors. In this new network, these two portions are separated (i.e. BitPesa and Cellulant are in community 3, whereas mkopasolar, PowerGen_RE and steamco are in community 5). We can also denote the cleat appearance of a farming community (cf. Community 6) detached from the others.

The table below (Table 2) presents a sample of such Support Organizations. It also includes some global accounts perceived as Supporting Organizations that will be shown in the following network.

5.3 The Network of National and International Accounts

This network (cf. Fig. 3) comprises the start-ups mentioned in the previous network, and the rest of the accounts in Kenya and foreign countries. It includes other company accounts, support organizations, and individuals who engage with the Kenyan ecosystem. In this network, the algorithm identified 12 separate communities. The graph displays 215 different nodes.

Table 2 Information on a selection of Supporting Organizations in the network

Twitter handle	Supporting organization	Founding date	Description	Geography
Echoinggreen	Echoing green	1987	Global nonprofit organization that provides fellowships, seed-stage funding, and strategic support to social entrepreneurs globally	Global
Info Dev	info Dev	1995	A program ofthe World Bank supporting entrepreneurs in developing countries through research and innovation hubs for climate tech, agribusiness and digital	Global
Acumen	Acumen	2001	Non-profit global venture fund that uses entrepreneurial approaches to solve the problems of poverty	Global
NextBillion	NextBillion	2005	NextBillion is a community of business leaders, social entrepreneurs, NGO managers, policy makers, academics and others exploring the connection between development and enterprise through analysis, news, jobs and events	Global
VC4Affica	VC4Affica	2008	Platform for start-up funding. Fast growing community of business professionals dedicated to building game changing companies on the African continent	Global

(continued)

Table 2 (continued)

Twitter handle	Supporting organization	Founding date	Description	Geography
Villagecapital	Village capital	2009	Non-profit organization that finds, trains, and fluids eariy-stage ventures solving major global problems in agriculture, education, energy, financial inclusion, and health	Global
WorldBankAffica	World Bank Africa	2010	International financial institution that provides loans to developing countries for capital programs focusing on the African region	Global
VC4AfricaMentor	VC4Africa mentorship	2012	VC4Africa exists to support entrepreneurs. We know that starting a business is hard & having access to the right network, knowledge & expertise is essential	Global
GreenAfficaDir	GreenAlficaDirectory	2012	Online pan-African network that aims to connect and promote sustainability organisations across Africa and is a green hub for news and information	Global
DEMOAffica	DEMO Africa	2012	Flagship initiative of LIONS'ft trica that amis to connect African startups to the global ecosystem	Global
GrowtiiAfrica	GrowtiiAfrica	2002	Accelerator for African entrepreneurs and impact enterprises providing advisory support, local netwoik and access to impact investment	

(continued)

Table 2 (continued)

Twitter handle	Supporting organization	Founding date	Description	Geography
Thenailab	Nailab	2010	Business incubator focused on providing the right ingredients to turn business ideas into viable startups	Local
iHub	iHub	2010	Nairobi’s Innovation Hub for the technology community is an open space for the technologists, investors, tech companies and hackers in the area	Local
PITVOTEast	PIVOT east	2011	PIVOT East is East Africa’s premier mobile startups pitching competition and conference showcasing region’s 25 top startups!	Local
Mlabeastafrica	m:lab East Africa	2011	Identifying, nurturing, and helping to build sustainable East Afi’ican enterprises with a mobile technology focus	Local
KenyaCIC	Kenya CIC	2012	Providing incubation, business advisory and financing seivices to Kenyan entrepreneurs developing innovative solutions that address climatechange	Local
NairobiGarage	NaiiobiGarage	2013	Nairobi’s largest co-working tech space	Local
MadeinNairobi_	Made in Nairobi	2015	Brings a comprehensive listing of companies established and operated from Nairobi	Local

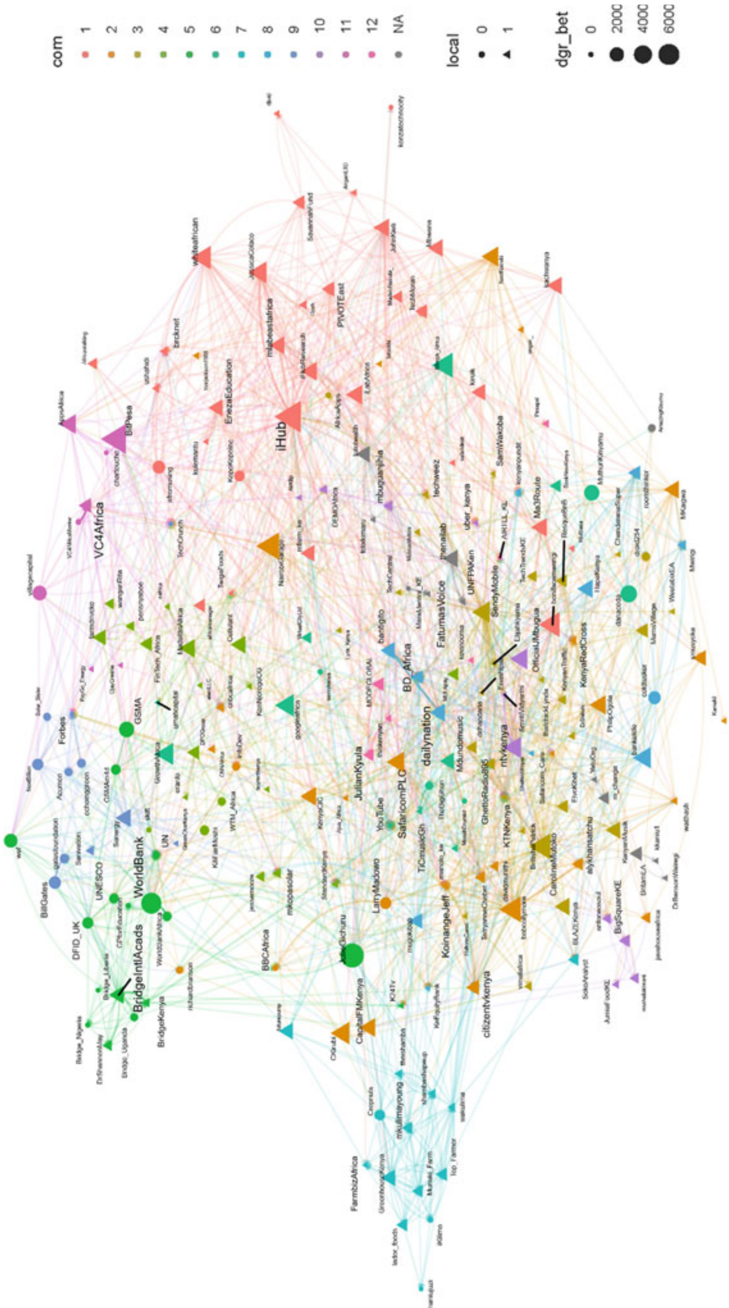

Fig. 3 Full network: Directed and weighted graph

The inclusion of international accounts constitutes an attempt to determine how outside actors decide to interact with the Kenyan ecosystem. There are 48 accounts located outside Kenya. From the analysis of the nodes, it quickly shows that international accounts tend to cluster together. Community 5 displays 13 foreign accounts out of 17. The accounts within the community constitute a network of Bridge, UN, Unesco, and WorldBank. This community seems to focus on education and development. Community 9 also contains 8 foreign accounts out of 11. The only 3 Kenyan accounts are Sanergy, Sanivation, and GreenCharKenya which concentrate on sanitation and clean energy solutions. They are joined by several foreign accounts mostly related to foundations and foreign aid (i.e. GatesFoundation, Acumen, NextBillion, echoingreen, etc.). Sanergy and Sanivation have shared, together with other accounts the same community at the internal level. However, with the inclusion of international foreign aid, both these accounts have changed community.

It is also worth noticing that the two communities with a high number of foreign accounts mentioned above share direct mentions between them and are displayed next to each other on the graph. Furthermore, the communities which revealed a high concentration in the network restricted to national accounts (cf. 5.2. Communities 1 and 6 in Network of all Kenyan accounts) have not been affected by the inclusion of foreign accounts. Indeed, the opposite is observed for communities which previously were somewhat scattered in comparison. For instance, Cellulant and VC4Africa both belonged to the same community, although they were pulling apart the community. With the inclusion of foreign accounts, Cellulant and VC4Africa have split into separate communities.

These observations go in line with the analysis of the previous graph. There, we have noticed that Sanitation services start-ups started isolating themselves from the other more tech-related firms. With the inclusion of Foreign Supporting organizations, this has been accentuated.

The community comprising farming and agribusiness start-ups, which became well grouped in the previous network, remained even better clustered with the inclusion of other foreign farming accounts.

It leads to suggest that two different ecosystems co-exist together: (a) one with start-up in the farming, sanitation, and education sectors, highly connected with foreign aid and supporting organizations—except for the farming community—and with clear development views; (b) another with more tech-related start-ups which interact more with local supporting organizations.

5.4 Analysing Mentions Texts

Depicting the patterns in the networks provides insights into how national and international accounts may affect the network structure and cohesion. However, as the network is based upon mentions, it is essential to understand what type of tweets the users write when they mention another account. There are two main types of interactions that may happen. On the one hand, users may mention other accounts in tweets regarding everyday social life, lifestyle and regular news. On the other hand, they may mention others to announce a new service, to communicate events happening soon or congratulate an achievement by sharing an article or the success in question.

To understand the thematic focal points of the discourse on Twitter in the studied population, we utilize a Natural Language Processing approach. The aim is to contrast the themes and topics with the communities in the different graphs ultimately providing a deeper understanding of the communities and their respective actors.

From the tweets gathered, the procedure identified 20 themes (cf. Appendix 1). The topics were then contrasted against the different communities through propensity tables.[7] In the first network, community 1 focuses mostly on communicating messages related to their services (i.e., providing customer service and marketing). However, having more accounts than any other community, they also write about technology and innovation, entrepreneurship and mobile services. The second community share tweets regarding education and share messages regarding women and children issues. Community 3 seems to use the account to share marketing and entrepreneurship related tweets as well as other topics (e.g. women/children and market). The fourth community tweets correspond to marketing, customer service, entrepreneurship, and transport.

From the analysis of the tweet texts, there is a mix between topics related to the offline activity of actors managing the twitter account and other topics more prevalent in social media. A clear pattern can be found in communities with actors focusing on education solutions (e.g. community 2 in the core start-up graph, community 1 in the Kenyan national graph), climate and energy (e.g. community 5 in the Kenyan national graph) and technology and innovation (e.g. community 1 in start-up network, community 3 in Kenyan national graph and community 11 in the international network). These accounts tend to interact on Twitter around themes similar to their start-up or professional activity.

Similarly, in the international network, the two communities with most foreign actors tend to be assimilated with tweets close to their offline activities. For instance, accounts in community 5 interact with topics related to education, climate, and energy as well as women and children. Topics extracted from community 9 have similar focus (i.e., climate, energy and women/children) with additional tweets on entrepreneurship and innovation.

Finally, most users seem to use twitter to communicate and update both partners and clients on the status of their services and on-going marketing. They also utilize Twitter as a platform to share, read, and stay up to date on the latest news in the country and outside.

[7] A table with a summary of the different networks, communities and their respective topics can be found in Appendix 2.

6 Discussion

Nairobi's entrepreneurial environment shows a clear deficiency in major domains of the ecosystem such as human capital, governmental leadership, regulation, financial markets, and university and research institutions as it is typically the case in many emerging economies (Bramann 2017; de la Chaux and Okune 2017). We posit that, by utilizing an entrepreneurial ecosystem approach, developing economies can identify relatively strong elements in the system that they can leverage to overcome other weaknesses in the system. We, therefore, direct our attention to the strongest element in the system, namely, the relations between start-ups and support system, and analyze the ecosystem based on these connections. Although we focus on certain elements of the ecosystem in our empirical analysis, we aim to shed light on how these specific elements can be used to strengthen the current entrepreneurial ecosystem as a whole in Nairobi.

Through the analysis of the Twitter mention networks of start-ups and support organizations, we identified several distinctive communities of actors based on entrepreneurial dynamics. The communities detected throughout the three networks differ in the following areas: interaction pattern among entrepreneurs and support organizations, the geographical scope of interaction, technology orientation. Some of the differences will be discussed in detail with the implications for the literature and policymaking.

To begin with, the existence of distinctive communities based in Nairobi raises the issue of how one defines an 'entrepreneurial ecosystem' with geographic and relational scope. If we place more emphasis on the impact of interaction pattern and technological focus on entrepreneurial processes and outcome, we could argue that there exist two different ecosystems in Nairobi. One could contend that the feedback and reinforcement among various elements of the system (Spigel 2017) could eventually lead to the emergence of two distinctive ecosystems. For example, the different interaction patterns may lead to development of different entrepreneurial culture within the two communities, and the entrepreneurs can be influenced by different norms and behavioral expectation in each community. Moreover, different technology fields associated with each community means that they are likely to face different market needs with various levels of consumer expectation and price sensitivity, which has rather direct influence on entrepreneurial outcome. The type of support organization involved in each community also suggests that there may be different funding and financing possibilities for the two communities. We detected communities with a focus on development related activities and have shown that, when the network displays international actors, development-oriented global support organizations with clear social goals (such as NextBillion, EchoingGreen and Gates-Foundation), could grant easier access to financial resources with development aid character. However, this may not necessarily lead to 'productive entrepreneurship' (Stam 2015), as funding of this nature does not have efficient mechanisms for supporting ventures with high potential (Bramann 2017).

Defining 'entrepreneurial ecosystem' in practice also has a geographical aspect to consider. The current conceptualization of entrepreneurial ecosystem does not provide clear indication on which geographic level the ecosystem can best be defined and utilized (Mason and Brown 2014; Stam 2015). The general discussion is characterized with an orientation towards the regional (sub-national) aspects as it typically is compared to clusters and regional innovation systems (Spigel 2017), but the current application of the concept does not confine to specific geographical scale or size of the involved territories (Napier and Hansen 2011). The consensus seems to be that, no matter which level they are defined at, the 'local' contextual factors that influence entrepreneurial endeavors matter. In our empirical case, the starting point of geographical boundary of the ecosystem is Nairobi as a city. However, based on the discussion above, one may identify two different ecosystems in one city or region.

Another essential geographical aspect to mention about Nairobi's ecosystem is that one of the communities has a strong connection to global support organizations. Although our analysis is based on the networks of local start-ups based in Nairobi, the geographical scope of critical interaction of these start-ups spans beyond the local context of Nairobi. As it is the case in Nairobi, when the network and interaction between the start-up and support organization constitutes a significant share of the entrepreneurial dynamics, this could raise the question of how 'locally-oriented' certain ecosystems are. What can then advocate for the 'localness' of entrepreneurial ecosystem is that the start-ups are still under the conditions such as physical infrastructure, formal institutions, policies and culture with strong regional and a national foundation.

The relational construct between various elements in the system as suggested by Spigel (2017) points to the possibility of nurturing relatively weak elements through the function of strong elements as well. Based on the strong connection and interaction among 'social purpose' technology start-ups, one could start building a more positive view on entrepreneurship in general in the society by highlighting the social impact of these ventures. With a high level of embeddedness of support organizations in start-up networks, one can also expect these organizations to take over the roles of other actors in the system such as universities and investors. Support organizations can expand their activities to training/education and investment to compensate for the lack of support to these areas in the system. With regards to this, connection to global actors can be critical as this can function as 'global pipelines' to source additional knowledge and financial resources from abroad (Maskell et al. 2006).

In the analysis of the networks, we noted several supporting organizations that aim at tackling certain critical societal issues such as climate change and clean energy—e.g. InfoDev, Kenya CIC—, a group of technology start-ups with a clear social purpose—Sanivation, Futurepump, Sanergy—, and other start-ups that could be considered as social-driven with less pronounced emphasis—GreenCharKenya, mkopasolar and steamaco. Even the start-ups with explicit for-profit business models, intendedly or not, address social issues as the market and customer needs in developing economies often originate from the lack of necessary infrastructure and public services. As an example, BRCK, which is pursuing for-profit business model, offers solutions to deal with unfavourable electricity infrastructure in Kenya. This speaks for the importance of strengthening the entrepreneurial ecosystem in Nairobi, which can serve as fertile ground for nurturing ventures driving both social and economic development. Social and economic development will be the concrete outcome of aggregate value creation in an entrepreneurial ecosystem model, which can be seen as the final goal of the ecosystem as conceptualized by Stam (2015).

The co-existence of for-profit and social purpose start-ups in Nairobi is a unique feature of the ecosystem that requires more attention. Social innovation communities in other parts of the world tend to develop a strong community spirit that marks clear distinction from typical for-profit businesses. Accordingly, there is no active interaction among for-profit businesses and social enterprises. However, in Nairobi, we observe some connection and interaction between actors in the community of for-profit start-ups and the community of social purpose start-ups. They are mostly connected through support organizations, which may signal that they participate in the same support programs or events organized by the support organizations. This setting provides opportunities for developing unique business models combining approaches from the two communities, but this may require more dedicated facilitation through concrete initiatives.

Lastly, it seems as though the lack of strong government leadership in facilitating the ecosystem is compensated by bottom-up forces driven by individual entrepreneurs and the communities around the support organizations. Without clear direction with policy initiatives, entrepreneurial activities were initiated by highly motivated individuals and yielded outcome as can be witnessed with the emergence of technology ventures. Certain vital individuals and support organizations (e.g. iHub) worked as catalysts in creating an active community of IT-based ventures, following the installation and dissemination of mobile and internet technologies. The other community in the ecosystem has gained force in the local context based on long-term presence of development agencies. This shows that there exist historical events and background behind the evolution of the ecosystem in Nairobi, which is critical to account for in understanding the current construct of the ecosystem.

7 Conclusion

In this chapter, we analysed the Twitter network of start-ups, local actors and support organizations in Nairobi as well as foreign influence on these networks. The network analysis led to the identification of two different patterns in a local ecosystem, social innovation community, and ICT community, based on various qualitative features such as technological focus, business models, and interaction pattern among the actors. The local technology start-ups are connected to different types of support organizations depending on the technology profile and the business model, which further leads to different geographical span in their interaction.

The social innovation community ventures aim to solve social issues within agriculture, energy, education, and general infrastructure based on new technologies.

These start-ups have active direct connection among themselves and are mostly connected to global support organizations with specific development goals. On the other hand, ICT community has stronger profit orientation with businesses based on new ICT technologies such as apps and other mobile and online platforms. Without active direct interaction among themselves, these ventures are connected in the network through a few local hubs such as co-working spaces, incubator, and accelerators.

Our findings have the following main implications in enhancing the understanding of entrepreneurial ecosystems. Firstly, we find that there may be issues regarding the level of analysis both in terms of the interaction of the involved actors and geographical scale when utilizing the ecosystem approach. In Nairobi, we observe two different entrepreneurial dynamics with distinctive characters based on interaction patterns of main actors. If we assume that the relations between ventures and support organizations constitute a critical focal point of the ecosystem as it can be the case in many developing economies with weak institutions, we may also need to consider them as different ecosystems co-existing in the same locality and support them in different ways. Regarding the geographical scale, we show that some ecosystems around local start-ups may have a strong connection to global actors, which often serve as critical channels for sourcing resources that are not easily accessible in the local context. Without a clear definition of the geographical boundary of the concept, this may suggest, on the one hand, the possible extension of the concept across different levels of geographical scale, but on the other hand, it may also indicate difficulties in maintaining consistency in the level of analysis in the literature.

Secondly, we demonstrate that the ecosystem framework is as relevant and useful in the context of developing economies as in developed economies. This is also in line with the advantage of the ecosystem construct that, apart from providing the holistic view, it also allows dissecting the system in elements and directing focus on certain critical elements in studying the ecosystem. We argue that, for emerging economies, focusing on existing and thriving elements in creating a productive supporting environment is of great importance, and the ecosystem approach can be used to point out these elements. We showed, furthermore, that the focused analysis on certain elements can be discussed in relation to other elements in the ecosystem, thereby enhancing the understanding of the ecosystem as a whole in the end.

The analysis of the interaction in the ecosystem in Nairobi also points to some policy implications. As mentioned before, interaction with global actors could function as mechanism for sourcing relevant resources and increasing local knowledge and competences related to entrepreneurial activities. Actively supporting these relations would induce productive entrepreneurial outcome in a relatively short time span, compared to the effort and investments to strengthen other elements in the ecosystem such as informal institution, education, and market, which typically requires longer time to establish. Also, the unique setting of co-existence of for-profit and social enterprises could be more actively utilized in facilitating innovative solutions for social and economic challenges that Kenya faces. Encouraging more interaction between the two communities with different business models can inspire entrepreneurs and support organizations from both sides, which could lead to creative innovation. As this construct is rarely found in developed economies, it would also be a great opportunity to create a successful model that originates from a developing economy and benchmarks in the rest of the world.

The use of social network analysis is compatible with the network dimension of the entrepreneurial ecosystem approach. We also argue that the sample extracted from CrunchBase reflects important actors who have potential to scale-up or considerably impact the local development. Twitter mention network utilized in this study provides an approximation to informal offline connections that seem to be important in the context of Kenya. However, we acknowledge that there may be disparity in online activity between two actors and their real-life interaction in the community. We have attempted to mitigate the issue by analysing the themes within the tweets. It has indeed indicated that those local actors who interact with foreign supporting organizations tend to write tweets more focused to their sector or area. It has also shown that discussions around entrepreneurship are often nurtured at the local level. However, we recognize that such a small selection of firms included in the analysis raises issues regarding the representativeness of the sample. It would be, therefore, interesting for further research to expand the twitter sample, to merge twitter data with CrunchBase and qualitatively gather data on the ecosystem.

Furthermore, to draw more in-depth insights into the ecosystem, it is crucial to complement social network analysis with empirical findings from qualitative studies or combine network metrics with socio-economic datasets to perform quantitative studies on the ecosystem. Other than improving the methodology, further studies could incrementally include other actors (government, education, etc.) in the ecosystem to understand the dynamics of the whole network. Furthermore, relevant social media data extracted regularly may be used to construct dynamic networks and explore the evolutionary aspect of the entrepreneurial ecosystem. Finally, the analysis of the evolution of communities can be compared to historical data on ecosystem events, government policies and programs as well as on global stakeholder's activities (e.g. NGO's projects in the region, etc.) and give intuitions on causality of the ecosystem development.

Appendix 1: Table of Topics

Topic	Theme words	Topic name
0	Number, kindly, account, apology, sorry, transaction, inconvenience, dm, phone, assistance	Customer service
1	Road, traffic, thika, police, mombasa, jam, accident, county, sexual, rd	News
2	Expo, livestock, kicc, agri, conf, nairobi, agriprenuership, investment, africa, jobseeker	Agri/Business

(continued)

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Topic	Theme words	Topic name
3	Climate, change, city, energy, impact, socent, globalgoal, sector, sustainability, impinv	Climate/Energy
4	Technology, news, development, ict, story, late, startup, tech, innovation, finalist	Technology/Innovation
5	Chat, twitter, sast, african, p.m. , nov, april, enviroed, future, august	Social media
6	Woman, girl, health, icpd, young, adolescent, violence, iwd, female, pregnancy	Women/children
7	Cnbcafrica, ceo, sub, journeysofar, air, dstv, saharan, director, archive, commerce	Tv/News
8	%, country, low, high, government, quality, president, datum, cost, access	Economy
9	School, teacher, student, bridge, pupil, primary, parent, bridgetosuccess, chain, o	Education
10	Year, people, child, life, old, family, ago, safe, non	Demographics
11	New, entrepreneur, business, opportunity, mentor, world, company, founder, solar, kenya	Entrepreneur
12	Driver, trip, asap, partner, date, specific, close, trouble, rider, pickup	Transport
13	Education, valley, eneza, ukaid, silicon, liberia, daily, edchat, cycloneidai, century	Education2
14	Mobile, app, service, money, payment, bank, m, available, option, user	Mobile service
15	Happy, birthday, mumsvillage, valentine, mum, love, bob, day, christmas	Lifestyle
16	Tv, pm, event, live, session, press, application, open, episode, release	Tv/Leisure
17	Market, customer, product, transforminglive, hotel, travel, food, care, constantly, huaweiy	Market
18	Egfellow, chief, justice, deep, speech, right, staff, important, action, freedom	Legal
19	Free, online, update, ticket, website, page, course, feature, note, apple	Marketing

Appendix 2: Summary of Communities and Their Respective Topics

Network brief statistics										
Core start-up accounts					Core start-up accounts					
Communities	Number of accounts	Number of core accounts	Number of local accounts	Number of support organizations accounts	A sample of users	Topics	N	Core	Local	Support
1	15	15	15	1	BitPesa, BritamEA, steamaco, KeEquityBank, CelIulant, mkopasolar	0, 4, 7, 11, 19	15	15	15	1
2	7	7	7	0	Africastal king, Eneza Education, totohealth, BridgelntlAcads	6, 9, 11, 13, 19	7	7	7	0
3	6	6	6	1	GreenhouseKenya, brcknet, AnganiLTD, ongair_,farmdriveke, mfarm_ke	6, 11, 16, 17, 19	6	6	6	1
4	6	6	6	0	SendyMobile, Sanivation, Sanergy, HaltonsCares, BigSquareKE, letsokhi	0, 3, 11, 12, 19	6	6	6	0
5	3	3	3	0	Mdundomusic, HiviSasa, BookNowKenya	1, 2, 15, 19	3	3	3	0
Total	37	37	37	2			37	37	37	2
Kenyan based accounts					*Kenyan based accounts*					

(continued)

(continued)

Network brief statistics										
Core start-up accounts					Core start-up accounts					
Communities	Number of accounts	Number of core accounts	Number of local accounts	Number of support organizations accounts	A sample of users	Topics	N	Core	Local	Support
1	33	12	33	5	whiteafrican, iHub, iLabAfrica, JessicaColaco, EnezaEducation, mlabeastafrica, PIVOTEast, Afri castalking, mfarm_ ke, kenyanpundit, brcknet	9, 11, 13, 16, 19	33	12	33	5
2	30	6	30	0	SendyMobile, KenyanTraffic, Sanergy, KTNKenya, TechTrendsKE, Sanivation	1, 2, 11, 17, 19	30	6	30	0
3	25	10	25	5	VC4Africa, Cellulant, GrowthAfrica,BitPesa, farmdriveke, GreenCharKenya	0, 4, 5, 7, 11, 19	25	10	25	5
4	17	5	17	3	NestNairobi, NairobiGarage, 88mph_Africa, ongair_, DEMOAfrica, letsokhi	0, 4, 12, 15, 19	17	5	17	3

(continued)

(continued)

Network brief statistics										
Core start-up accounts					Core start-up accounts					
Communities	Number of accounts	Number of core accounts	Number of local accounts	Number of support organizations accounts	A sample of users	Topics	N	Core	Local	Support
5	16	3	16	0	mkopasolar, Safa ricomPLC, KenyaCIC, PowerGen_ RE, steamaco, Safaricom_Care	0, 3, 8, 11, 19	16	3	16	0
6	11	2	11	1	GreenhouseKenya, Muriuki_Farm, Top_ Farmer, futurepump, FarmbizAfrica	5, 6, 11, 16, 17	11	2	11	1
7	10	1	10	2	thenailab, MumsViIlage, MKaigwa, UNFPAKen, KenyaRedCross	1, 6, 10, 15, 19	10	1	10	2
8	9	3	9	1	bantigito, BD_Africa, dailynation, ShelterAfrique, KeEquityBank, mDaktariKE	0, 3, 8, 11, 14, 19	9	3	9	1
9	8	1	8	0	ntvkenya, OfficialJMbugua, BigSquareKE, antoneosoul, mssheilakimani	0, 2, 15, 18, 19	8	1	8	0

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Network brief statistics										
Core start-up accounts					Core start-up accounts					
Communities	Number of accounts	Number of core accounts	Number of local accounts	Number of support organizations accounts	A sample of users	Topics	N	Core	Local	Support
10	7	2	7	0	JuIianKyula, PesapaI, thiskenyan, AIRTEL_KE, MODEGLOBAL, OjayGreene	0, 1, 11, 114, 19	7	2	7	0
NA	11	3	11	3			11	3	11	3
Total	177	48	177	20			177	48	177	20
All accounts including international					*All accounts including international*					
1	32	10	29	5	iHub, brcknet, whiteafrican, PIVOTEast, EnezaEducation, mlabeastafrica, JessicaColaco, mfarm_ke, africamanager	1, 4, 11, 16, 19	32	10	29	5
2	30	3	26	3	NairobiGarage, bobcollymore, CKirubi, SafaricomPLC, NestNairobi, KenyaCIC	0, 7, 11, 15, 19	30	3	26	3

(continued)

(continued)

Network brief statistics										
Core start-up accounts					Core start-up accounts					
Communities	Number of accounts	Number of core accounts	Number of local accounts	Number of support organizations accounts	A sample of users	Topics	N	Core	Local	Support
3	28	4	26	0	CarolineMutoko, SendyMobile, MumsVillage, KTNKenya, TechTrendsKE	0, 1, 15, 17, 19	28	4	26	0
4	19	6	16	2	Cellulant, farmdriveke, DPOGroup, Fintech_Africa, mkopasolar, MadeItInAfrica	0, 5, 7, 11, 17, 19	19	6	16	2
5	17	1	4	1	WorldBank, GSMA, wef, DFID_ UK, UNESCO, UN, BridgeKenya, BridgeIntlAcads	3, 6, 9, 10, 13	17	1	4	1
6	15	4	9	2	88mph_Africa, googleafrica, GrowthAfrica, BookNowKenya, VirtualCityLtd	2, 4, 11, 15, 19	15	4	9	2

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Network brief statistics										
Core start-up accounts					Core start-up accounts					
Communities	Number of accounts	Number of core accounts	Number of local accounts	Number of support organizations accounts	A sample of users	Topics	N	Core	Local	Support
7	14	2	11	1	GreenhouseKenya, futurepump, Cropnuts, Top_Farmer, lador_foods	5, 6, 11, 17, 19	14	2	11	1
8	12	2	11	1	bankelele, HapaKenya, roomthinker, kenyanpundit, KeEquityBank, ShelterAfrique	0, 8, 11, 14, 19	12	2	11	1
9	11	3	3	2	Sanergy, NextBillion, gatesfoundation, echoinggreen, Sanivation, GreenCharKeny	3, 4, 6, 11, 18, 19	11	3	3	2
10	11	2	11	1	ntvkenya, BigSquareKE, DEMOAfrica, JumiaFoodKE, AirKlip	0, 1, 2, 12, 19	11	2	11	1
11	8	3	5	2	BitPesa, villagecapital, AppsAfrica, VC4Africa, PayGo_Energy, OjayGreene	4, 5, 11, 16, 19	8	3	5	2

(continued)

(continued)

Network brief statistics										
Core start-up accounts					Core start-up accounts					
Communities	Number of accounts	Number of core accounts	Number of local accounts	Number of support organizations accounts	A sample of users	Topics	N	Core	Local	Support
12	6	1	6	0	MODEGLOBAL, JulianKyula, Pesapal, thiskenyan, kevinouma, AIRTEL_ KE	0, 1 , 7, 11, 14, 19	6	1	6	0
NA	12	3	10	3			12	3	10	3
Total	215	44	167	23			215	44	167	23

References

Acs ZJ, Varga A (2005) Entrepreneurship, agglomeration and technological change. Small Bus Econ 24:323–334. https://doi.org/10.1007/s11187-005-1998-4

Acs ZJ, Autio E, Szerb L (2014) National systems of entrepreneurship: measurement issues and policy implications. Res Policy 43:476–494. https://doi.org/10.1016/j.respol.2013.08.016

Acs ZJ, Desai S, Hessels J (2008) Entrepreneurship, economic development and institutions. Small Bus Econ 31:219–234. https://doi.org/10.1007/s11187-008-9135-9

Atiase VY, Mahmood S, Wang Y, Botchie D (2018) Developing entrepreneurship in Africa: investigating critical resource challenges. J Small Bus Enterp Dev 25:644–666. https://doi.org/10.1108/JSBED-03-2017-0084

Audretsch DB, Belitski M (2017) Entrepreneurial ecosystems in cities: establishing the framework conditions. J Technol Transf 42:1030–1051. https://doi.org/10.1007/s10961-016-9473-8

Audretsch DB, Lehmann EE (2005) Does the knowledge spillover theory of entrepreneurship hold for regions? Res Policy 34:1191–1202. https://doi.org/10.1016/j.respol.2005.03.012

Blondel VD, Guillaume JL, Lambiotte R, Lefebvre E (2008) Fast unfolding of communities in large networks. J Stat Mech Theory Exp. https://doi.org/10.1088/1742-5468/2008/10/P10008

Borgatti SP, Mehra A, Brass DJ, Labianca G (2009) Network analysis in the social sciences. Science (80-) 323:892–895. https://doi.org/10.1126/science.1165821

Boschma RA (2005) Proximity and innovation: a critical assessment. Reg Stud 39:61–74. https://doi.org/10.1080/0034340052000320887

Boyd D, Crawford K (2012) Critical questions for big data: provocations for a cultural, technological, and scholarly phenomenon. Inf Commun Soc 15:662–679. https://doi.org/10.1080/1369118X.2012.678878

Bramann JU (2017) Building ICT entrepreneurship ecosystems in resource-scarce contexts: learnings from Kenya's "Silicon Savannah." In: Ndemo B, Weiss T (eds) Digital Kenya. Palgrave Macmillan, London, pp 227–264

Bresnahan T, Gambardella A, Saxenian A (2001) "Old economy" inputs for "new economy" outcomes: cluster formation in the new silicon valleys. Ind Corp Chang 10:835–860. https://doi.org/10.1093/icc/10.4.835

Busenitz LW, West GP, Sheperd D, et al (2013) Economic imperialism author (s): Edward P. Lazear Published by : Oxford University Press ECONOMIC IMPERIALISM *. J Evol Econ 115:99–146. https://doi.org/10.1016/S0149-2063(03)00013-8

Conover M, Ratkiewicz J, Francisco M (2011) Political polarization on twitter. In: Icwsm. pp 89–96

Crawford K (2009) Following you: Disciplines of listening in social media. Continuum (N Y) 23:525–535. https://doi.org/10.1080/10304310903003270

de la Chaux M, Okune A (2017) The challenges of technology entrepreneurship in emerging markets: a case study in Nairobi. In: Ndemo B, Weiss T (eds) Digital Kenya. Palgrave Macmillan, London, pp 265–301

Drouillard M, Taverner D, Williamson C (2014) Digital entrepreneurship in Kenya. GSMA, London

Feld B (2012) Startup communities: building an entrepreneurial ecosystem in your city. Wiley, New York

Freeman C (1995) The 'national system of Innovation' in historical perspective. Camb J Econ 19:5–24. https://doi.org/10.1093/oxfordjournals.cje.a035309

Gallagher RJ, Reing K, Kale D, Ver Steeg G (2017) Anchored correlation explanation: topic modeling with minimal domain knowledge. Trans Assoc Comput Linguist 5:529–542. https://doi.org/10.1162/tacl_a_00078

Gathigi G, Waititu E (2012) Coding for development in the Silicon Savannah: the emerging role of digital technology in Kenya. In: Onwumechili C, Ndolo I (eds) Re-imagining development communication in Africa. Rowman & Littlefield, pp 201–224

Hain DS, Jurowetzki R (2018) Local competence building and international venture capital in low-income countries: exploring foreign high-tech investments in Kenya's silicon savanna. J Small Bus Enterp Dev 25:447–482. https://doi.org/10.1108/JSBED-03-2017-0092

Hussey M (2015) Silicon savannah: how start-ups in Africa are taking on some of humanity's biggest challenges. Huffington Post. https://www.huffingtonpost.co.uk/matthew-hussey/african-startups-take-on-challenges_b_6416676.html?guccounter=1. Accessed 13 Jan 2017

Isenberg DJ (2011) The entrepreneurship ecosystem strategy as a new paradigm for economic policy. Inst Int Eur Aff 1:1–13

Jürgens P, Jungherr A, Schoen H (2011) Small worlds with a difference: new gatekeepers and the filtering of political information on twitter. In: 3rd international web science conference, WebSci 2011

Kantis HD, Federico JS (2012) Entrepreneurship ecosystems dynamics and tipologies View project Corporate venturing in Latam: main trends, challenges and lessons View project Entrepreneurial Ecosystems in Latin America: the role of policies

Lee K (2013) Schumpeterian analysis of economic catch-up: knowledge, path-creation, and the middle-income trap. Cambridge University Press, Cambridge

Lundvall B-Å (1992) National systems of innovation: towards a theory of innovation and interactive learning. Pinter Publishers

Malecki EJ (2011) Connecting local entrepreneurial ecosystems to global innovation networks: open innovation, double networks and knowledge integration. Int J Entrep Innov Manag 14:36–59. https://doi.org/10.1504/IJEIM.2011.040821

Marchant E (2015) Who is ICT innovation for challenges to existing theories of innovation, a Kenyan Case Study. Cent Glob Commun Stud

Maskell P, Bathelt H, Malmberg A (2006) Building global knowledge pipelines: the role of temporary clusters. Eur Plan Stud 14:997–1013. https://doi.org/10.1080/09654310600852332

Mason C, Brown R (2014) Entrepreneurial ecosystems and growth oriented entrepreneurship. In: Oecd. pp 1–38

Mislove A, Lehmann S, Ahn Y-Y, et al (2011) Understanding the demographics of Twitter users. In: International AAAI conference on weblogs and social media (ICWSM)

Motoyama Y, Konczal J, Bell-Masterson J, Morelix A (2014) Think locally, act locally: building a robust entrepreneurial ecosystem. SSRN Electron J. https://doi.org/10.2139/ssrn.2425675

Napier G, Hansen C (2011) Ecosystems for young scalable firms. Fora Gr

Ndemo B, Weiss T (2017) Digital Kenya. Palgrave Macmillan, London

Neck HM, Meyer GD, Cohen B, Corbett AC (2004) An entrepreneurial system view of new venture creation. J Small Bus Manag 42:190–208. https://doi.org/10.1111/j.1540-627x.2004.00105.x

Osiakwan EM (2017) The KINGS of Africa's digital economy. In: Ndemo B, Weiss T (eds) Digital Kenya. Palgrave Macmillan, London, pp 55–92

Park EK, Hain D, Jurowetzki R (2016) Entrepreneurial upgrading: evidence from high-tech venture creation in Nairobi, Kenya

Schumpeter J (1969) The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle. Oxford University Press, London and Oxford, Translated by Redvers Opie

Sheriff M, Muffatto M (2015) The present state of entrepreneurship ecosystems in selected countries in Africa. Afr J Econ Manag Stud 6:17–54. https://doi.org/10.1108/AJEMS-10-2012-0064

Spigel B (2017) The relational organization of entrepreneurial ecosystems. Entrep Theory Pract 41:49–72. https://doi.org/10.1111/etap.12167

Spigel B, Harrison R (2018) Toward a process theory of entrepreneurial ecosystems. Strateg Entrep J 12:151–168. https://doi.org/10.1002/sej.1268

Spilling OR (1996) of a Mega-Event. 103:91–103

Stam E (2014) The Dutch entrepreneurial ecosystem. Available at SSRN: https://doi.org/10.2139/ssrn.2473475

Stam E (2015) Entrepreneurial ecosystems and regional policy: a sympathetic critique. Eur Plan Stud 23:1759–1769. https://doi.org/10.1080/09654313.2015.1061484

Stam E, Bosma N, van Witteloostuijn A, et al (2012) Ambitious entrepreneurship

Stam E, Suddle K, Hessels J, Stel A van (2009) High-growth entrepreneurs, public policies, and economic growth. Public Policies Foster Entrep 91–110. https://doi.org/10.1007/978-1-4419-0249-8_5

The Economist (2012) Upwardly mobile—innovation in Africa. https://www.economist.com/business/2012/08/25/upwardly-mobile. Accessed 20 Jan 2017

TwitterInc. (2011) One hundred million voices. https://blog.twitter.com/en_us/a/2011/one-hundred-million-voices.html. Accessed 13 Jan 2017

Webb JW, Tihanyi L, Ireland RD, Sirmon DG (2009) You say illegal, i say legitimate: Entrepreneurship in the informal economy. Acad Manag Rev 34:492–510. https://doi.org/10.5465/AMR.2009.40632826

Wong PK, Ho YP, Autio E (2005) Entrepreneurship, innovation and economic growth: evidence from GEM data. Small Bus Econ 24:335–350. https://doi.org/10.1007/s11187-005-2000-1

World Economic Forum (2013) Entrepreneurial ecosystems around the globe and company growth dynamics. Rep Summ Annu Meet New Champions 2013:36

Zavatta R (2008) Financing technology entrepreneurs and SMEs in developing countries. Washington, DC. Available at https://www.infodev.org/publications. Accessed 17 Jan 2019

What Do We Know About Nascent and Young Innovative Entrepreneurship in Africa? Insights and Perspectives from Morocco

Ilyas Azzioui and Serena Sandri

1 Introduction

This chapter uncovers and describes the factors that initiate, hinder and facilitate the process of emergence, survival and success of knowledge-intensive innovative startups in Morocco. For this purpose, the following definition of a knowledge intensive innovative startup applies:

i. To be no older than 5 years and to have some interaction with the entrepreneurial and innovation ecosystem
ii. To have an innovative/disruptive business model or technology and/or
iii. To aim at a significant growth in revenue and number of employees.

Within this definition we made a distinction between young knowledge intensive innovative startups (had a 12 months period where revenues where superior to expenses at least half the time), the rest of interviewed startups that have not yet reached that threshold were called nascent knowledge-intensive innovative startups. Data was collected through a structured questionnaire that was used to guide face to face interviews of 45–60 min with 41 non-random sample of knowledge-intensive innovative generated via contacts with incubators, accelerators, venture capitalists (VCs) and relevant entrepreneurship events and programs.

In this investigation, the founder(s) are viewed as spokesman of the startup, their characteristics such as their gender, age, education level or entrepreneurial experience are considered as part of the human and social capital resources at the disposal of the startup just like financial resources, advice resources, and other resources

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captured by the questionnaire. A special attention was given in the questionnaire to the characteristics of the startup business idea including the motives that prompted the founders to engage in entrepreneurship, the targeted sector and last but not least the perceived innovativeness and competitiveness of the startup and its expected outcomes and growth aspirations. The startup creation process was approached through to the measurement of the gestation activities (Reynolds and Miller 1992; Davidsson 2006; Davidsson et al. 2011). Indeed, individual characteristics matter, because they are likely to be associated with differences in individual behaviors. But, it is the behaviors, themselves, that produce organizations. So, entrepreneurs do no create instantaneously to exploit venture ideas. Instead, it is a process that includes many behavioural steps that can be undertaken in many different sequences, as related research has demonstrated (Reynolds and Miller 1992; Sarasvathy 2001).

So far, Moroccan research on entrepreneurship has been focusing only on existing organizations and/or individuals who succeeded in setting up their businesses no information on startup activities has been provided on those individuals who attempted and/or failed in their entrepreneurial venture. As Gartner argues: "It is the knowledge gained from studying the—failures—that provides reasonable contrasts for making sense of the success. Information gleaned from the individuals who successfully started new businesses cannot be used to infer whether the unsuccessful nascent entrepreneurs behaved differently" (Gartner et al. 2010). While venture formation occurs within a context—political, social, cultural, economic, community—it is clear that ventures are not created by their context. Entrepreneurs are necessary for entrepreneurial behavior, and it is through them that organizations come into existence. Hence, this study tries to shed some light on innovative entrepreneurial behavior and bridge this gap in literature in developing countries like Morocco where innovation and entrepreneurship contexts are very different from those of fully developed countries. This will lay the foundations for a deeper and more comprehensive research project about the pace by which progress is made in the process in terms of the total number of activities that are completed at different points in time, and how this differs by venture type, country, available resources and amounts of entrepreneurial ability in terms of human and social capital.

2 Relevant Literature and Approaches

As mentioned earlier in the introduction there is almost a consensus among relevant that Innovation and entrepreneurship are the engines of economic growth, job creation and social welfare—the underpinning of a prosperous and stable civil society. However, there has been little agreement to date on how this works and what kind of innovation and entrepreneurship we should be talking about. In this section we will first explain why it is important to study startups as they emerge and underline key relevant literature that have inspired our research work. Second, we will address issues related to the meaning and importance of innovation in a developing country context. Third, we will discuss the concept of knowledge-intensive and innovative entrepreneurship and how it contributes to economic development and prosperity and at the end we will outline our focus and interest in that respect.

2.1 Why Studying Entrepreneurial Behavior and Entrepreneurial Emergence?

The word “emergence” suggests that we need to catch startups early in the entrepreneurial process (Davidsson 2003a, b). evidence from literature has shown that retrospective studies of successful startups and entrepreneurs were subject to significant hindsight and selection biases and that it is important to study the entrepreneurial behavior as it happens or as close to that ideal as possible (Davidsson 2004).

Hindsight bias (also known as knew-it-all-along or I knew it would happen) refers to a well-established fact in cognitive psychology that memory is constructive in nature (Fischhoff and Beyth 1975). It describes the tendency for individuals to see past events as being more predictable, or to believe after an event, that their prediction of the outcome was more accurate than it actually was (Roese and Olson 1996; Cassar and Craig 2009). This means that even the most honest and careful respondents will inevitably distort the image of what happened during the startup emergence process. Selection Bias is probably more dangerous than the hindsight bias and it underlines the necessity of studying also “unsuccessful or prematurely terminated processes” (Davidsson 2004) when trying to research issues related to the creation of new organizations. Because, knowledge gained from studying successful startups cannot be used to infer whether failed nascent entrepreneurs behaved differently.

The most important and influential development in the study of ‘nascent entrepreneurs’ and ‘firms in gestation’ was the Panel Study of Entrepreneurial Dynamics (PSED) (Gartner et al. 2004) and its extensions in Argentina, Canada, Australia, Greece, Netherlands, Norway and Sweden. PSED I started in 1988 and followed by PSED II in 2005 were an important first step towards systematically studying new venture emergence while addressing selection and hindsight biases issues. It represented just the beginning of a stream of nascent venture studies.

A representative cohort of 830 nascent entrepreneurs actively involved in the creation of their business were selected and interviewed regarding 75 factors that could affect adults’ decision to start a business and 130 factors that could be associated with ability to complete the emergence of the startup. Then, there were three additional follow-ups (Reynolds 2000; Gartner et al. 2004). It was the first longitudinal research studying a representative sample of emerging businesses and suitable for statistical generalizations. However, with random sampling it was not possible to generate a sufficiently large group of nascent knowledge-intensive, high-growth and/or or high-potential innovative startups and was largely dominated by imitative businesses with modest aspirations and potential for growth and socio-economic impact (Davidsson et al. 2011). But, according to evidences from literature, although considered an epiphenomenon of entrepreneurship, it is the first kind of innovative businesses that generate almost all the effect of start-ups on job creation and economic development although it is (Birch et al. 1995; Wong et al. 2005).

To address this issue, The Comprehensive Australian Study of Entrepreneurial Emergence (CAUSEE) obtained theoretically valid representative but non-random sample generated through contacts with many organizations that are likely to be in contacts with such startups.

2.2 What Is Innovation?

Most recent studies of innovation adopt the third edition of the Oslo Manual's definition of innovation (OECD 2005: 46): "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations". It stems from this definition that there are several types of innovation (product, processes, marketing, managerial and organizational). Another important concept is that Innovation can only be appreciated and understood in its context, it is a relative and not an absolute concept (Tether 2003). Based on its degree of novelty and innovativeness, innovation might be new to the world, new to the market [to the country(ies)], new to a sector, new to the firm or new to an individual. These distinctions are crucial particularly in the developing countries context (OECD 2005).

Although it is new to the world innovation that captures more often the focus of policy discussions, this type of innovation usually requires a powerful R&D base and fits more with the context of developed countries operating at the frontier of science and technology. However, in developing countries context (such as MPCs), there is a tremendous amount of valuable foreign knowledge and technology that is already there waiting to be adopted, disseminated and absorbed by their relevant economic agents and actors. Literature is replete with examples of developing countries or firms that have devised deliberate strategies for acquiring and exploiting already exiting knowledge and improved greatly their growth and welfare (Sauter and Watson 2008). Incremental and adaptive innovations that are usually underpinned by new to the market, new to a sector, new to the firm or new to the individual are often of more relevance and importance (World Bank 2010). Incremental innovations are usually driven by the process of economic agents striving to improve the quality, the performance and the design of their products and services which involves a lot of learning by using, doing and interacting between suppliers and users of technology (Lundvall 1988; Freeman 1992). This type of innovation has played a vital role in the technological "leapfrogging" whereby several developing countries managed to jump over several stages in short period of time from Importing and absorbing highly modern existing technology to replicating, producing and improving the imported technology to innovating new to the world technologies of their own (Sauter and Watson 2008). For instance, Korean steel industry became an international technology leader by first adopting internationally established technology followed by a continuing process of incremental improvements, Gallagher (2006). Similarly, successful latecomers in wind energy such as Spain and China started developing their industry through joint partnerships technology transfer via licensing agreements with manufacturers from Denmark and Germany, Gallagher (2006).

For brevity, *innovation* means "technologies or practices that are new to a given society. They are not necessarily new in absolute terms" (World Bank 2010). As long as they have a considerable impact as the origin of new industries, jobs, and income, all potential sources of innovation are considered not only science and research driven innovation. For example, cultural and creative industries might make use of technologies, sometimes sophisticated, however, their novelty lies in offering a new service, better design, and the like. Likewise, many innovations in banking, logistics, and supply chains make an intensive use of information technology (IT) but are fundamentally managerial or procedural in nature. These innovations also have considerable importance for economic growth and welfare improvement. Last but, not least, we might also add to that list some innovations that are entirely social in nature (like the concept of microcredit pioneered by Muhammad Yunus the founder of Grameen Bank which was introduced in Bangladesh and) have since successfully spread throughout the world. Finally, it is important to understand that what is not used and disseminated in the market is not innovation. In addition, bringing new technologies and practices to the users in the market as well as the development of any new industry would require a complex set of activities and competencies that go far beyond technology or R&D and the key agent that will do it is the entrepreneur.

2.3 What Is Knowledge-Intensive Innovative Entrepreneurship?

The meaning of entrepreneurship requires clarification, as does the distinction between self-employment (or small- and medium-sized enterprises, SMEs) and entrepreneurship. In the Global Entrepreneurship Index Report of 2017 Acs and his co-authors define the entrepreneur as "a person with a vision to see an innovation and the ability to bring it to market". It follows from this definition that entrepreneurs actively renew and reshape the economy and that most of small business owners are not entrepreneurs because there is nothing new about them (Acs et al. 2017). In this regard, literature distinguishes between opportunity entrepreneurship (starting a business to take an advantage of a Market opportunity) and necessity entrepreneurship (starting a business because no other option is available). Most of the self-employed fall into the second category and are not regarded as entrepreneurs in this study, although they might evolve into opportunity entrepreneurs at later stages (Iversen et al. 2008; Henrekson 2007).

Empirical evidences from literature show that economies that foster (a few) high-impact and growth oriented entrepreneurial firms are better off than those that try to maximize the rate of self-employement or the number of SMEs (Audretsch et al. 2002; Shane 2008). This partially explains why one of the major indicators captured by the Global Entrepreneurship Monitor (GEM) called total early-stage entrepreneurial activity (TEA) is negatively correlated with economic freedom, global competitiveness and economic growth, the greater the TEA the worse is the economy (Acs et al. 2017; El Ouazzani et al. 2017; Singer et al. 2018). Because TEA focuses more on the quantity rather than on the quality of entrepreneurship it measures mainly self-employment and necessity driven entrepreneurship. While Uganda enjoys the highest TEA in the world, few would dare to support that Uganda is more entrepreneurial than USA (Acs et al. 2017). So, in this study we are more concerned with entrepreneurship that is innovative, opportunity driven with high potential for growth, scalability and job creation. This perspective on entrepreneurship is not new and was advocated by prominent scholars as the growth engine of western economies decades ago (Schumpeter 1934, 1942; Drucker 1985).

Although we have adopted a rather narrow definition of the entrepreneur as someone who innovates and gets thing done, we remain very inclusive when it comes to the type of innovation and its technological sophistication level. As mentioned in the previous section on innovation we address entrepreneurs that are introducing new technologies and practices in a given society or a market. They could be in high tech but also in mid tech, low tech or even non tech sectors as long as they are introducing innovative/disruptive processes and business models. A business model describes how a company creates, delivers and captures value. Emblematic examples of non-tech or low tech but very innovative entrepreneurs are the founders of MacDonald's, Starbucks, Zipcar and last but not least Uber. They respectively did not invent hamburgers, coffee, cars rental or taxi services but they introduced very innovative processes and highly innovative, repeatable and scalable business models that have created thousands of jobs around the world and disrupted their respective markets by increasing efficiency (how quickly you can serve a hamburger, a coffee or find a taxi) (Acs et al. 2017).

In his attempt to capture the essence of knowledge-intensive innovative entrepreneurship (KIE) Malerba and McKelvey (2018) suggest the extension of the Schumpeterian tradition by integrating insights from evolutionary economics and innovation systems approach (Table 1). They contend that this novel conceptualization through the integration of three theoretical frameworks would be very useful to conceptually understand, define, and measure knowledge-intensive innovative entrepreneurship (Malerba and McKelvey 2018).

Hence, based on the insights from this three theoretical building blocks (Table 1) and the empirical findings of AEGIS research project (2013), Malerba and McKelvey (2018) derived the following definitions:

- "knowledge-intensive innovative entrepreneurs are involved in the creation, diffusion, and use of knowledge; introduce new products and technologies; draw resources and ideas from their innovation system; and introduce change and dynamism into the economy".
- "knowledge-intensive innovative entrepreneurship is about new firms that are innovative, have significant knowledge intensity in their activity, are embedded

Table 1 A summary of insights on entrepreneurs and entrepreneurship drawn from three theoretical frameworks: Schumpeterian perspective, evolutionary economics and innovation systems approach

	Schumpeterian entrepreneurship	Evolutionary economics	Innovation systems
The entrepreneur	– Takes risks and reaps profits – Turns technology and ideas into innovations in the market – Enables new combinations – Faces uncertainty about current choices in relation to future outcomes – Creates opportunities, by both driving and adapting to change in the external environment	– Are involved with others in the diffusion, use and creation of knowledge – Engage in learning and problem-solving activities – Use knowledge into new combinations for innovation – Are affected by education, knowledge and experience in their innovative activities	– Are highly dependent upon the knowledge infrastructure, the supporting actors and the institutional context – Create opportunities but are also bounded by the geographical and sectoral dimensions in which they operate and innovate
Entrepreneurship function	– Acting as a disruptive, disequilibrium force, which arises endogenously in the economy – Driving wider processes of economic dynamism, which in turn lead to economic growth and societal well-being	– Is a process with emergent properties – Involves actors searching for opportunities and generating new knowledge – Is affected by of the learning, technological and knowledge context – Involves the co-evolution of knowledge, firms, industrial structure and institutions	– Is affected by the complementarities in knowledge and capabilities of actors linked within innovation systems – Relies upon existing and new networks and channels through which knowledge is communicated, shared or generated

in innovation systems and exploit innovative opportunities in diverse evolving sectors and contexts".

According to this view, the success of entrepreneurs during the whole entrepreneurial process from the identification of opportunities to the creation of the business and the exploitation in the market is conditioned, among others, by the quality of the linkages and networks related to the national innovation system and the availability of complementary agents such as skilled labor, venture capitalists, intermediary organizations and other relevant supportive institutions (Henrekson and Stenkula 2010; Malerba and McKelvey 2018). Without these complementary assets innovative entrepreneurs cannot succeed. Conversely, the lack of productive and ambitious entrepreneurs cannot be fully offset by the provision of supportive measures and environment such as an extensive supply of skilled labor or venture capital (Henrekson and Stenkula 2010). This makes an elusive and a qualitative concept like knowledge intensive innovative entrepreneurship difficult to handle and approaching it only from a quantitative perspective could be misleading.

Probably the most used definition of a startup is “a temporary organization used to search for a repeatable and scalable business model”. In that sense, it should not be confused with a new organization or an SME that have established operations and validated business model (Blank 2013). But for the purpose of this study, taking into consideration what has been said above, we adopted a modified version of the European Startup Monitor’s definition (ESM) (Kollmann et al. 2016):

iv. To be no older than 5 years and to have some interaction with the entrepreneurial and innovation ecosystem (for ESM it was 10 years)
v. To have an innovative/disruptive business model or technology and/or
vi. To aim at a significant growth in revenue and number of employees.

Within this context, investigated knowledge-intensive innovative startups need to fulfil the first criterion and at least one of the other two criteria (innovative and/or aiming at significant growth) and thereby differing from general SMEs.

3 Method and Sample Description

3.1 Data Collection

Traditionally, finding nascent firms in sufficient quantities has been a daunting challenge. To identify “high potential” businesses at an early stage for the purpose of comparing their characteristics with “regular” start-ups is a very challenging task Aldrich (1999). As previously mentioned, there is no agreed-upon definition of “high potential” businesses (Crick and Spence 2005). Second, by any meaningful definition they are rare, so obtaining a sizeable sample of them is even more difficult than is sampling “regular” start-ups at an early stage (before they appear in any registers) (Reynolds 1997; Wong et al. 2005). A random sample of start-ups will, of course, include a proportion of HP startups; however, when a sufficiently demanding HP definition is employed that proportion is likely to be small Reynolds and Miller (1992). Obtaining a large enough random sample of such entities may therefore be impossible or prohibitive in terms of costs. On the other hand, if they are identified through a single type of source (e.g., business incubators; business angel networks) the sample would almost certainly be biased compared to the theoretical category the study intends to investigate. Third, no single criterion (e.g., founders’ track record; booming industry; being highly innovative) can with satisfactory accuracy determine whether a start-up has “high potential” or not (Gundry and Welsch 2001).

Although inspired from the Panel Study of Entrepreneurial Dynamics (PSED) (Reynolds and Curtin 2007), generating randomly a representative sample of emerging knowledge-intensive innovative startups was not possible in our case. Even in technologically developed countries, where the economies are driven by innovation, obtaining a sizeable sample of nascent innovative startups has been a daunting challenge (Aldrich 1999). They are rare by any meaningful definition, of course, a very large random sample of "regular" startups at an early stage might include a proportion of knowledge-intensive and innovative startups but this proportion is likely to be very tiny. Therefore, getting a large enough random sample of such startups may be prohibitive in terms of cost or even impossible, especially, in the context of a developing country like Morocco where innovation is not really high in the agenda of policymakers as well as the private sector (Reynolds 1997; Aldrich 1999; Wong et al. 2005; Senyard et al. 2009).

As a second-best alternative we followed the approach of the Comprehensive Australian Study of Entrepreneurial Emergence (CAUSEE) research team who managed to obtain a theoretically valid representative but non-random sample of high potential innovative startups generated through contacts with many organizations that are likely to be in contacts with such startups (Senyard et al. 2009). Inspired from CAUSEE data was collected through a structured questionnaire that was used to guide face to face interviews of 45–60 min with 41 non-random sample of knowledge-intensive innovative generated via contacts with incubators, accelerators, VCs and relevant entrepreneurship events and programmes.

Within our definition of knowledge-intensive innovative startups we made the distinction between nascent knowledge- intensive innovative startups/**entrepreneurs** and young knowledge intensive innovative satrtups/entrepreneurs (Reynolds and Curtin 2008).

Definition of a <u>nascent knowledge- intensive innovative entrepreneur</u>:

a. considered themselves in the firm creation process;
b. had been engaged in some behavior to implement a new firm—such as having sought a bank loan, prepared a business plan, looked for a business location, or taken other similar actions;
c. expected to own part of the new venture;
d. the new venture had not yet become an operating business (that is, did not have a positive monthly cash flow that covers expenses and the owner-manager salaries for more than 6 months).

Definition of a <u>young knowledge-intensive innovative entrepreneur</u>:

The young entrepreneur's fits with the same criteria of a nascent entrepreneur with one exception: If his knowledge-intensive innovative startup had a 12 months period where revenues where superior to expenses half the time we are talking about a young <u>knowledge-intensive innovative entrepreneur</u> and not a <u>nascent knowledge-intensive innovative entrepreneur</u>.

The Key question we used to tell apart a nascent innovative startup from a young innovative startup is the following question:

Has your monthly revenue been more than monthly expenses for more than 6 of the past 12 months?

- Yes (young knowledge intensive innovative startup)
- No (nascent startup).

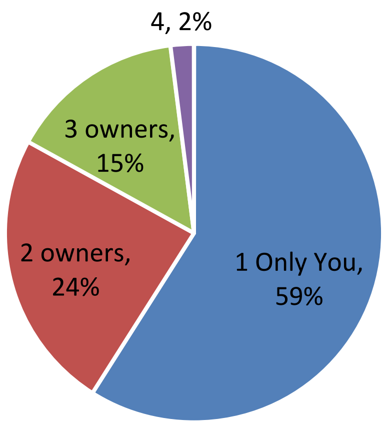
All the interviewed startups had less than 5 years old. Almost two thirds (66%) had sales revenues for more than 6 months of the past 12 months. However, only 37% could be considered as young knowledge-intensive innovative startups which means that their monthly revenue had been more than monthly expenses for more than 6 of the past 12 months while 63% are still in the emergence stage and are classified as nascent knowledge-intensive innovative startups (monthly revenue not covering expenses for more than 6 months the past 12 months).

3.2 Research Design

The major aim of EMNES project is to explore and understand, for the first time in the southern Mediterranean context, the interactions and the relationships between the knowledge-intensive innovative startup creation process, resources, the innovative startup Idea (the opportunity), the environment and resulting startup outcomes.

Although Data was collected from (one of) the founder(s) of the innovative startup they are not mentioned in the Fig. 1 above because this research approaches gathered data from the startup perspective. In this investigation, the founder(s) are viewed as spokesman of the startup, their characteristics such as their education level or entrepreneurial experience are considered as part of the human and social capital resources at the disposal of the startup just like financial resources, advice resources and other resources captured by the questionnaire. The major theoretical building blocks of this section are the resources base view (RBV) of the firm (Barney and

Fig. 1 Number of owners



Arikan 2001) and recent theorizing about balanced skill set of the entrepreneur known as Lazear's jack-of-all-trades theory (Lazear 2005). The resources base view assesses the firm as a bundle of tangible and intangible resources, possessed internally, which can be deployed toward competitive advantage (Barney and Arikan 2001). In jack-of-all-trades theory, Lazear (2005) proposed a theoretical model highlighting the importance of the combination of different aspects of human capital in a balanced skill set for entrepreneurs. Lazear's basic assumption is that entrepreneurs must be competent in many skills because they have to combine different resources such as physical and financial capital, people and ideas in order to successfully run a business.

Traditionally entrepreneurship has paid a little attention to the startup idea also referred to as "the opportunity" (Davidsson et al. 2011). This paper tries to fill the gap in the context of a developing country by investigating from various angels the newness of startup ideas as well as the nature and reasons of their changes during the startup creation process.

As far as the environment is concerned it did not receive much attention in the questionnaire but it will be dealt with using available secondary data.

The startup creation process was approached through to the measurement of the gestation activities (Reynolds and Miller 1992; Davidsson 2006; Davidsson et al. 2011). Katz and Gartner (1988) grouped the behaviours or gestation activities undertaken in the process conceptually into the categories *intentionality; boundaries; resources,* and *exchange.* Delmar and Shane (2004) suggest the categories *legitimacy building activities; relationship building activities,* and *resource-acquisition activities.* The interviewees were asked whether they had started or accomplished each of more than twenty-five such as gathering information on the market, preparation of the business plan, starting fundraising, patents applications, talking to customers, and the like (see Appendix).

The assessment of the outcomes of nascent and young knowledge-intensive innovative startups is always a tricky question. Traditional established business performance indicators are either irrelevant or simply not available (Davidsson et al. 2011). For instance, CAUSEE used a range of indicators such as the pace of progress in the gestation activities, first sales, levels of sales, employment and profitability; growth, etc.

Basically all the components described above were mirrored in the different sections of the questionnaire as shown in the following Table 2.

4 Who Start Knowledge-Intensive Innovative Startups?

Forty-one startup founders were interviewed, the table below illustrates some of their main characteristics (Table 3).

As expected, the above table shows that the founders of knowledge intensive and innovative startups in Morocco are predominantly highly-educated male phenomenon. Women represented 20% of the founders which is a little better than

Table 2 Different sections of the questionnaire and their main focus

	Sections of the questionnaire	Main focus of each section
A	Individual demographic background	Name, gender, level of education, age, current employment status
B	Startup screening questions	Level of commitment to the startup, ownership of the startup, sales revenues, state of emergence nascent Vs young startup, less than 5 years, etc.
C	Classifying the venture	Ownership, opportunity Vs necessity, industrial domain, Products versus services, R&D spending, online sales, growth aspirations, etc.
D	Business idea newness	technology level of the sector, newness of the product/service, newness of technologies used, newness of production/process, promotion/selling etc.
E	Business idea change	Different types of changes of in terms of products, customers, method for promoting or selling, method for producing or sourcing, revenue model
F	Reasons for business idea change	Was it requested by customers, suppliers, investors or market research? failure or success with customers, lack of funds, change in the management, etc.
G	Gestation activities	See Appendix
I	Resources, experiences (jack of all trades)	agreement between the partners, gender, family ties between the founder(s), age, etc.
I-1	Team resources general description	
I-2	Team resources: Education of founder(s)	Usefulness of the founder(s) education in 5 functional areas: (1) Marketing/sales; (2) Finances accounting; (3) R&D; (4) production; (5) HR/administration
I-3	Team resources: Contributions of the founder(s)	Number of years of experience, technical and managerial experience, experience in the same industry, entrepreneurial experience. The usefulness of the founder(s) experience-based knowledge in 5 functional areas: (1) Marketing/sales; (2) Finances accounting; (3) R&D; (4) production; (5) HR/administration, etc. Financial and time contributions of the founder(s) Social capital contributions
J	Resources advantages	Perceived advantages and disadvantages in comparison with established competition in the same sector

(continued)

Table 2 (continued)

	Sections of the questionnaire	Main focus of each section
K	Sources of funding	Major and minor sources of funding used by the startup
L	Sources of advice	Major and minor sources of advice used by the startup Perceived needs for advice
M	Future expectations	Employees in 5 years, revenues from abroad in 5 years, personal wealth

Table 3 Some characteristics of the interviewed founders

Gender	80% males, 20% females
Age of the founders during the interview	Average 27,22: the youngest had 16 years old and the oldest 39 years
Age at foundation	About 25 years old
Education	(93%) have a university degree: 63% have an engineer or master level degree, 22% have a bachelor degree and 5% have a Ph.D.
Employment status	65% describe themselves as self-employed, 15% employed and 20% students
Business ownership	17% are involved in another entrepreneurial experience and own more than one business

the European average (14.8%) according to the European Startup Monitor (Kollmann et al. 2016). The average age of the interviewed founders is 27 years old, which is significantly younger than the average age of Australian high potential startups founders whose average age is around 40 years old (Davidsson et al. 2008) and the average age of the founders of the top 0.1% fastest growing tech ventures in the USA which is 45 years old according to Azoulay et al. (2018). Contrary to Media hype, research has shown that founding a successful business need skills, a sound experience in the field of the business and strong human, social and financial capital that are not available to younger entrepreneurs (Azoulay et al. 2018). The majority namely 65% of the founders are fully dedicated to their business while 35% are following more prudent and hybrid strategy.

As regards the founding team, Fig. 1 shows the proportion of solo, partner (any two owners) and team (three or more owners) startups. 59% of the founders are lone wolf, 24% of the startups have two partners and 17% are started by teams of 3 and more.

Almost two thirds of the interviewees (69%) qualified their partners as friends and acquaintances from previous work, (22%) of the partners are just friends without any previous work experience together and only 12% of the partners are family members either relatives by blood or spouses (Fig. 2).

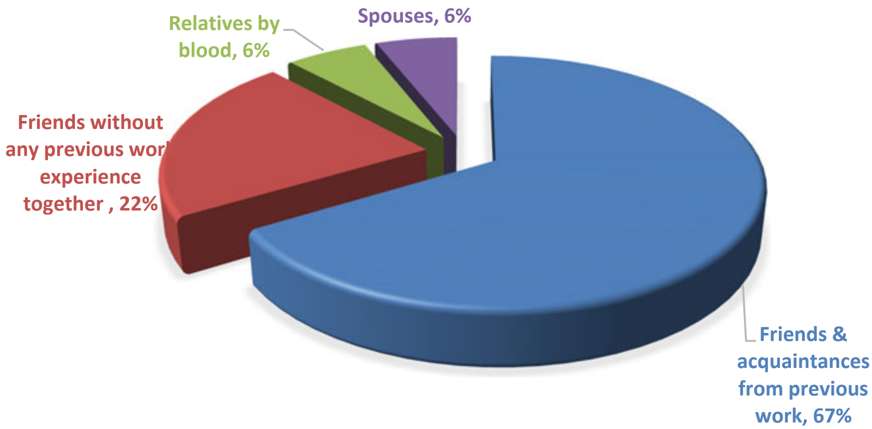


Fig. 2 Relationships between owners

5 What Types of Firms Are Started and How They Are Initiated?

The issue of what comes first the business idea or the decision to start a business has been a controversial and much disputed subject within the field of entrepreneurship (Bhave 1994). Some believe that business founders first decide that they want to start a business. Then, they start searching and evaluating alternative opportunities to exploit before they settle for one. However, empirical evidences show that alternative process, where the business idea triggers the entrepreneurial process around it, is also very common (Bhave 1994). In our case the majority of the founders (56%) highlighted the role of the business idea in triggering the entrepreneurial process which is consistent with the findings of Davidsson et al. (2008) in Australia where 67% of the founders of high potential startups even more emphasized the idea rather than the wish to start a business as the trigger (Fig. 3). Further investigation into the profile of founders that are driven by the wish to start a business and those that are triggered by the business idea will be carried out to shed more light on this issue.

The vast majority of interviewed startups (85%) are legally registered with the appropriate government agency. The almost exclusive legal form is Limited Liability Company most known under the French acronym SARL. Practically 61% of the startups are selling or expected to be selling mainly services followed by 22% selling mainly products and 17% selling a combination of services and products (Fig. 4). A possible interpretation of the dominance of services-oriented startups is that product-oriented startups are more complex to set up and require more resources.

Regarding the physical location of the business only 29% have a separate physical location while 32% are using the site of an existing business, 22% are managing their business from their residence or personal property. 17% declared that they have not reached yet the stage where they will need a specific location (Fig. 5).

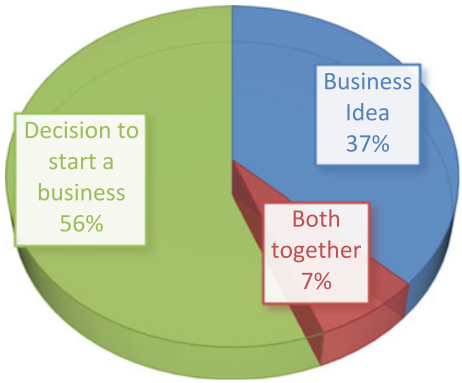


Fig. 3 The trigger of the entrepreneurial process. Business idea or the decision to start

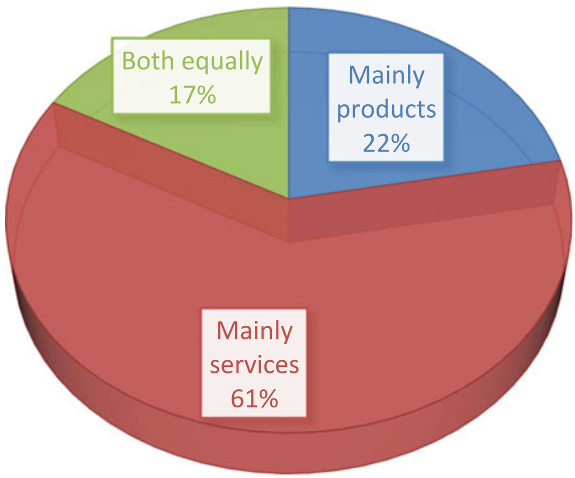


Fig. 4 Startups offer product versus service

Concerning the level of maturity of the product/service of the startups, 63% declared that their product/service is ready for sale, 20% had tested it on their potential customers and 17% were still in initial stages of its development (Fig. 6).

Figure 7 displays the profile of the industries in which innovative Moroccan firms are being started. The industries that comprise more than 10% of knowledge-intensive innovative startups regardless their level of maturity are respectively: health education and social services (24%), hospitality and tourism (17%), business consulting/services (12%), consumer services (10%) and construction (10%). Manufacturing and agriculture accounts for 7% and 2% respectively although their contribution to Moroccan GDP is much higher. One possible explanation of this situation is because these two sectors are more resource intensive and subsequently are more challenging for startups.

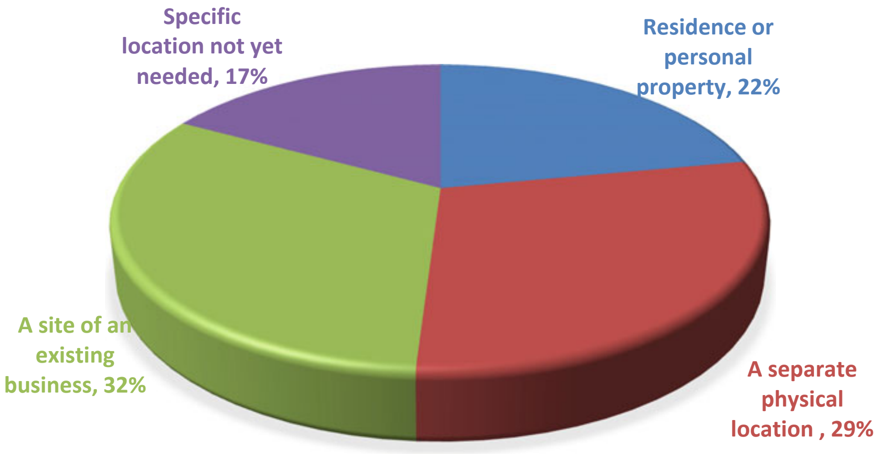


Fig. 5 Startups locations

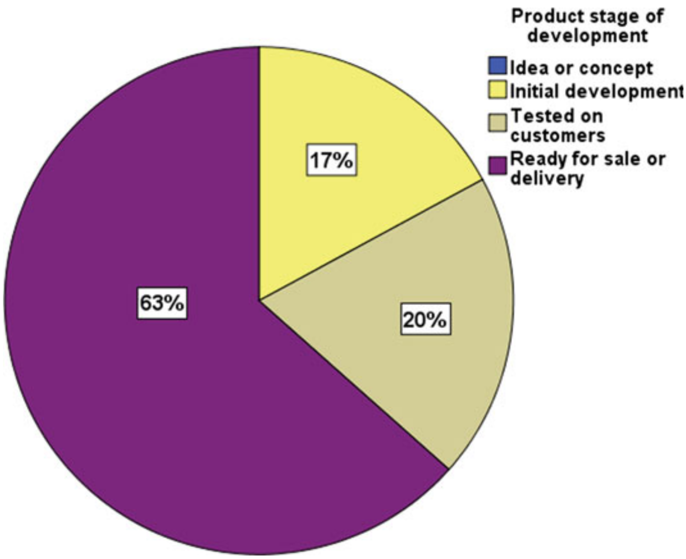


Fig. 6 Maturity level of the product/service offer of startups

6 Self-Perceptions of Innovativeness and Competitiveness

As displayed in Table 4, almost half of the respondents in Morocco consider their business as a high tech (49%) and 56% reported that the technologies or procedures required for their main product or service were not available 5 years ago. 54% of the Moroccan knowledge-intensive innovative startups indicated that R&D spending will

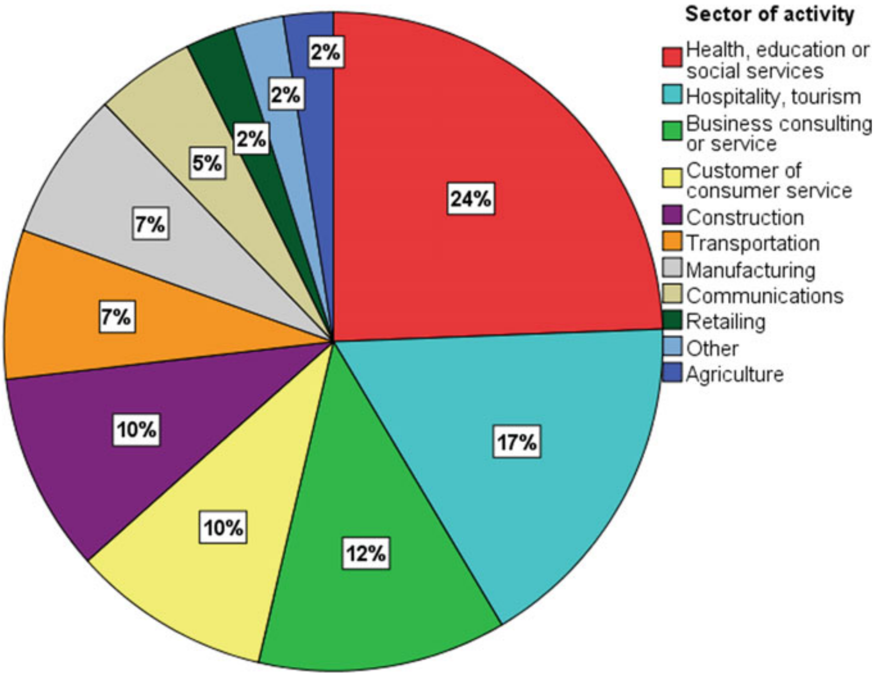


Fig. 7 Startups industry affiliation

be a major priority for their business. 61% of the founders have some entrepreneurial experience and 93% hold a university degree. 22% of the startups have applied for IP protection. The expected median number of employees in 5 years is 9.

The comparison between Moroccan knowledge-intensive innovative startups and Australian nascent startups (high potential and regular ones) shows the following:

- Moroccan knowledge-intensive innovative startups are in a median position they are less sophisticated than high potential Australian nascent startups but more innovative than regular and normal Australian startups
- Except for the level of education of the owners, Australian high potential nascent startups scored better than the Moroccan nascent startups in all indicators, the most marked differences are in terms of IP application (48 vs. 22%), R&D spending as major priority (54 vs. 77%), Entrepreneurial experience of the founders (82 vs. 61%), the number of startups in manufacturing sector (23 vs. 7%) and last but not least the expected number of employees in 5 years (20 vs. 9).

Although our sampling methods of knowledge-intensive innovative startups were largely similar and inspired from the Australian study (CAUSEE), the differences highlighted above could be partially explained by the difference of the level development between the two countries. In fact, in developing countries context (such as MPCs), where rapid adoption and diffusion is a central concern, incremental and

Table 4 Comparison between Moroccan knowledge-intensive innovative startups and Australian startups in terms of innovation and sophistication of the business

	Morocco knowledge-intensive innovative startups	Australian nascent high potential startups	Australian (regular) Nascent startups
Perceives the business to be ‘high-tech	49%	66%	26%
Claims R&D spending as major priority, %	54%	77%	40%
Wants maximum growth rather than manageable size	88%	90%	15%
Claims required technology was not available 5 years ago	56%	n.a	30%
Has applied for IP protection	22%	48%	6%
Entrepreneurial experience of the founder	61%	82%	53%
Manufacturing, %	7%	23%	7%
University education (1 or more of owners have), %	93%	65%	44%
Expected number of employees in 5 yrs (median.)	9	20	2

Source Senyard et al. (2009)

adaptive innovations that are usually underpinned by new to the market, new to a sector, new to the firm or new to the individual are often of more relevance and importance. In this regard, many Moroccan knowledge-intensive innovative startups claimed that they were innovative in terms of:

- Offering a product or service which is entirely new for the targeted industry/sector of activity (37%)
- The method for promotion or selling, which is entirely new for the targeted industry/sector of activity 45%
- Focusing on serving customers or target markets that NO other businesses focus on (20%) or those that most of other businesses fail to serve (73%).

One of theoretical frameworks mobilized in this study is the Resource Base View (RBV) of Barney and Arikan (2001). This theory assesses the firm as a bundle of resources, possessed internally, which can be deployed toward competitive advantage (Barney and Arikan 2001). Resources are inputs to the production process, and include tangible and intangible assets such as equipment, intellectual assets, and patents (Barney and Arikan 2001). Given the level of sophistication and innovativeness of the startups described earlier it is not surprising that the startups reported more advantage in terms of product development expertise and its uniqueness and the knowledge of the latest technological trends (Fig. 14). Also, flexibility is an inherent characteristic of small companies. The fact that knowledge-intensive innovative startups do not rely heavily on cost as a competitive advantage is not surprising as well. Although, some evidences from literature suggest that innovative first movers need to develop cost advantages if they are to keep their success (Durand and Coeurderoy 2001).

Paradoxically, the interviewed startups mentioned as a competitive advantage that they know what leading customers are asking for but globally they perceive their marketing expertise as a disadvantage (Fig. 8). They also highlighted their lack of networking capabilities. This could have a significant negative impact on their social capital and subsequently their ability to access and leverage required resources and might threaten the survival of the startup in a low trust market like Morocco.

7 Education, Experiences and Contributions

In this section we investigated the education of the founders, their work and entrepreneurial experience as well as their commitment and contribution to the startup. In addition to the resources-based view theory mentioned above this section mobilized the Lazear's jack-of-all-trades theory (balanced skill set). Lazear (2005) proposed a theoretical model highlighting the importance of the combination of different aspects of human capital in a balanced skill set for entrepreneurs. Lazear's basic assumption is that entrepreneurs must be competent in many skills because they have to combine different resources such as physical and financial capital, people and ideas in order to successfully run a business.

In this respect, balanced skills were measured as the number of distinct functional areas in which the founders of the nascent innovative startup and their partners had education and/or work experience prior to the first gestation activities. The five possible categories include (1) marketing, sales, promotion; (2) accounting, controlling, financing; (3) engineering, R&D; (4) production; and (5) administration and HR management (Lazear 2005; Wagner 2006). While education provide the entrepreneurs with explicit and declarative knowledge, previous entrepreneurial and work experiences are useful in equipping the entrepreneur with tacit, procedural knowledge on what to do and how to succeed in the entrepreneurial process (Bandura 1982).

As regards education, it appears that the founders feel that the knowledge they got from their formal education was more useful to master the technical aspects of the project like engineering, R&D and the production process and their partners have quite similar profile except for the sales and marketing where they seem to have stronger educational background than the founders. Skills in finances, accounting,

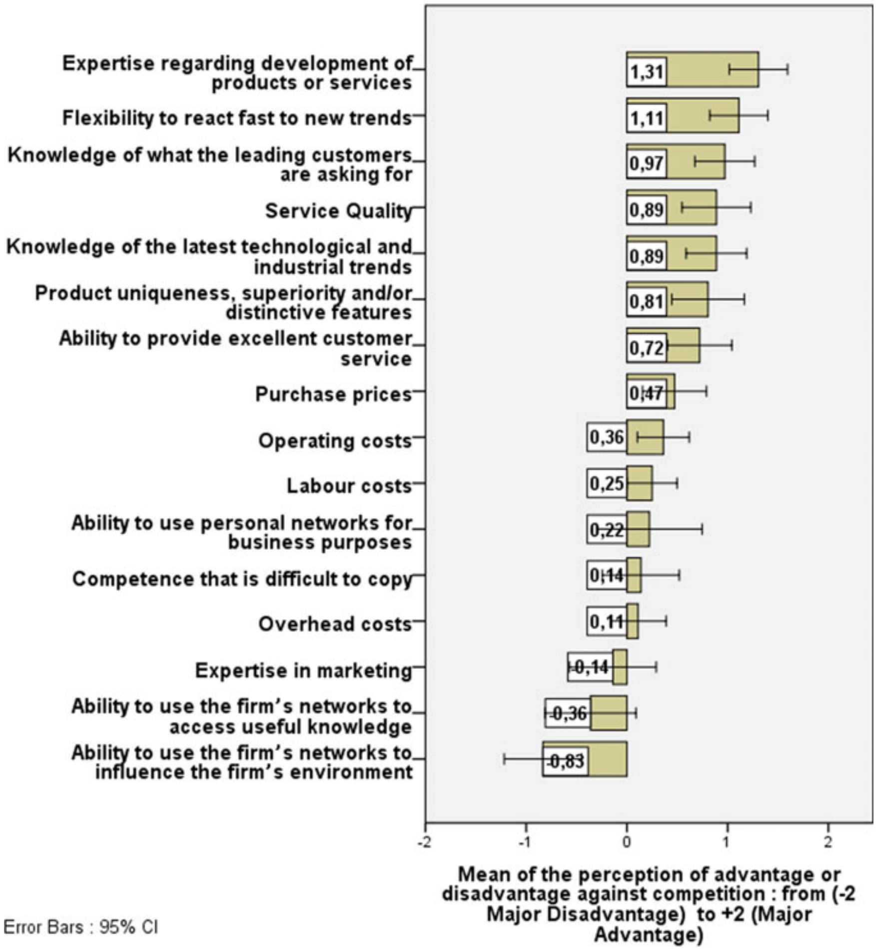


Fig. 8 Perceived competitive advantages and disadvantages of the entrepreneurs

administration and human resources management are the weakest in both groups Figs. 9 and 10.

For the founders, in addition to the needed technical skills, the experience-based knowledge coming from work and entrepreneurial experience was more useful in balancing their skills set in terms of sales, marketing and promotion. This trend is further confirmed with the partners whose experience-based knowledge is perceived complementary and more useful in the areas of marketing and sales and accounting and finances (Figs. 11 and 12).

Working for small companies or having previous entrepreneurial experience is regarded as the best route to acquire purposely a balanced skill set (Stuetzer et al. 2013). The lack of complex and specialized hierarchical structures exposes the

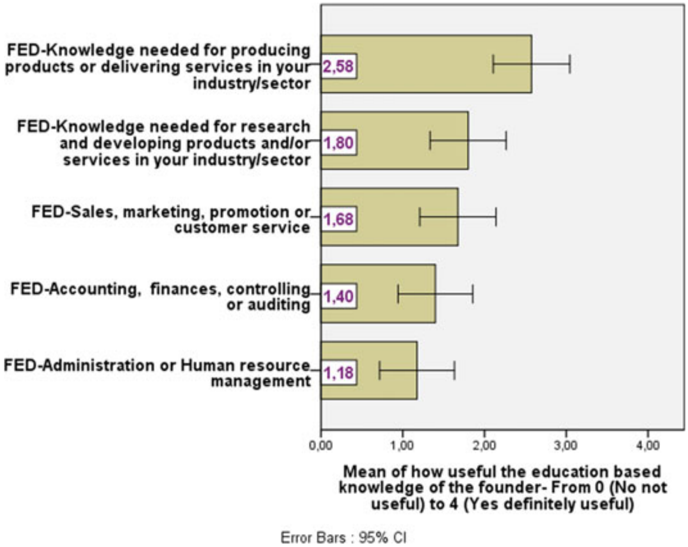


Fig. 9 Usefulness of the education of the founder

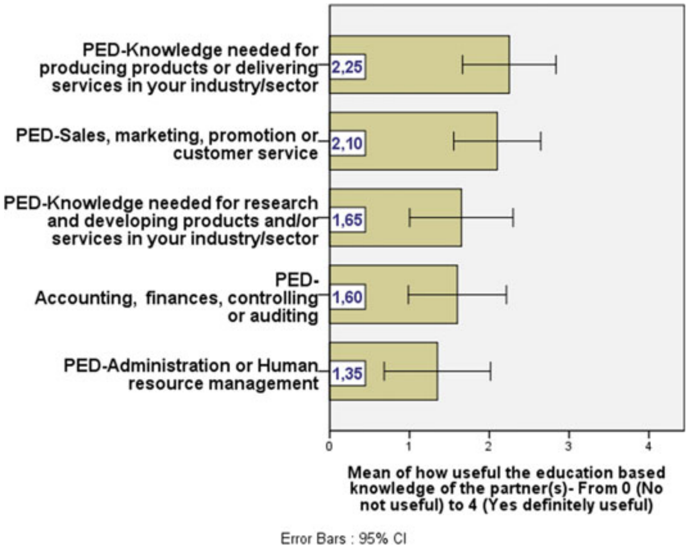


Fig. 10 Usefulness of the education of the partners

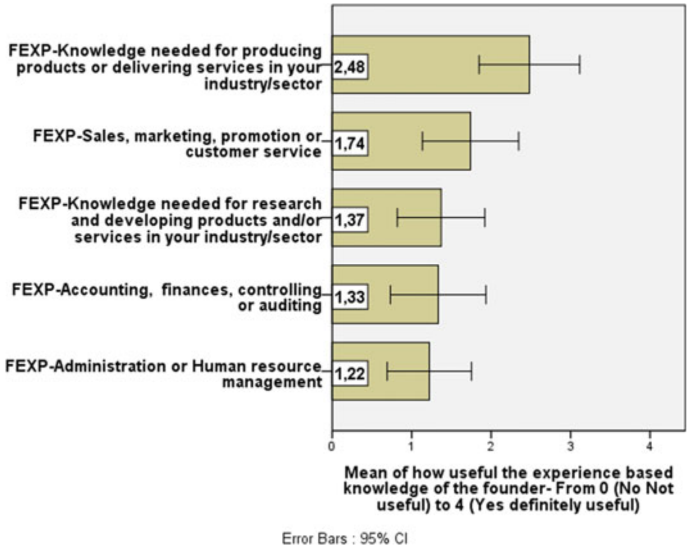


Fig. 11 Usefulness of the founder's experience-based knowledge to the startup

Fig. 12 Usefulness of the partner(s)' experience-based knowledge to the startup

entrepreneur or the employee to a variety of tasks and provides a lot of opportunities of learning by doing which leads to balanced skills. In this respect, 61% of the founders reported that they have at least one entrepreneurial experience and 32% of the partners helped to start at least one business as owner or part-owner (Figs. 13 and 14). In addition, 39% of the founders reported that they have less than 5 years of work and 10% have between 5- and 10-years work experiences in small companies (less than 20 employees).

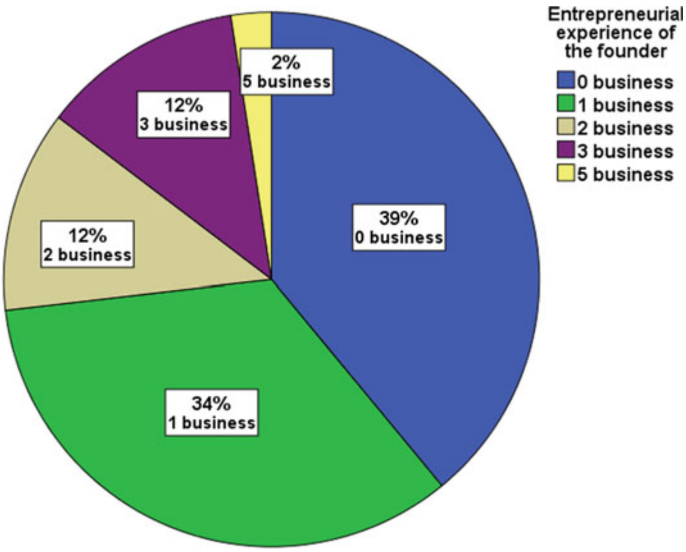
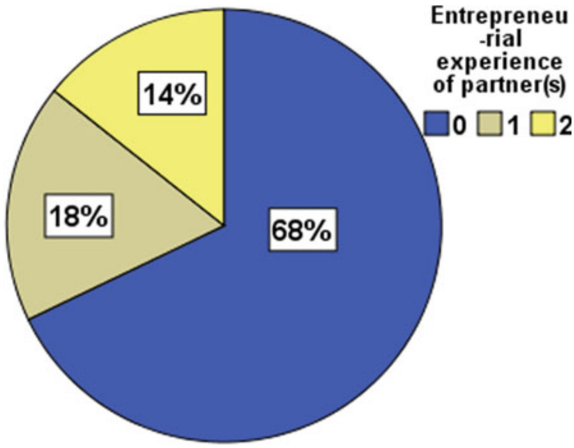


Fig. 13 Number of businesses the founder helped to start as an owner or part owner

Fig. 14 Number of businesses partner(s) helped to start as an owner or part-owner



8 Startup Gestation Activities

As demonstrated by Davidsson et al. (2009), high potential startups take longer, are harder to get up and running. They had stayed in the startup process for 35.5 months while non-high potential startups had been attempting the startup for less than 22 months which is a very significant difference. They also had accomplished more activities, probably because some activities are more relevant to their case (like IP protection for example).

Figure 15 displays the number of startups that have accomplished the startup process. Activities such as discussion of product or service with potential customers, gathering information to estimate potential sales or revenues, Discussion of product or service with potential customers, own email address, saving money for the business or the preparation of the business plan are carried out by most of the startups at an early stage. Although important, these activities are not good predicators of the gestation progress score in terms of the number of activities accomplished.

The gestation activities that are better in predicting the global gestation progress score and probably the most challenging are related to time invested in the startups either by the founders or new recruits and credibility building activities (having a

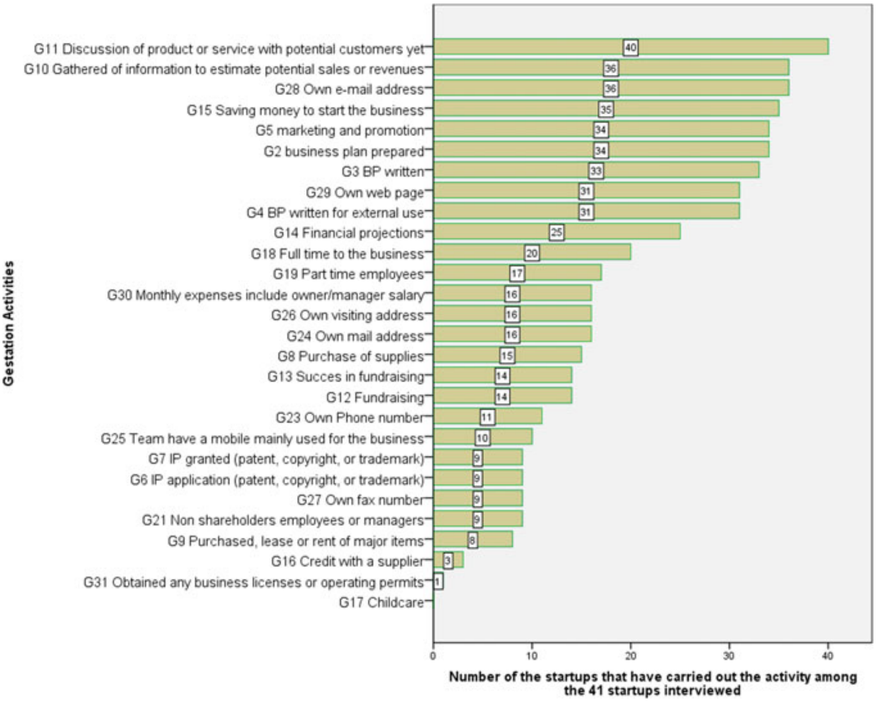


Fig. 15 Number of startups that have accomplished each gestation activity among the 41 interviewed

physical presence) as shown in Table 4. Therefore, the most significant activities in this respect are as follows respectively:

– Recruitment of full-time employees
– Recruitment of part time employees
– Having its own visiting address
– First financial projections are done
– Being full time dedicated to the business
– Business Plan is written
– Business Plan is written for external use (Table 5).

As mentioned earlier, knowledge-intensive innovative startups are hard to launch and require more dedication and time investment. In this respect, the results of this investigation shows that 37% of the founding teams dedicate more than 50 h per week followed by 22% devoting between 35 and 49 h per week to their startups, 27% work between 20 and 34 h and 15% work less than 19 h.

9 Funds and Sources of Funding

The most striking fact is the poor diversity of funding sources. Most of the funds are coming from personal savings or businesses that are owned by the founders, followed by loans that are mostly provided by a network called Réseau Maroc Entreprendre which is a network of high profile businessman that supports entrepreneurship through mentoring programs and provides free interest loans to selected entrepreneurs. Banks, business angels, private equity funds, government grants for example are almost absent as a source of funding for startups in Morocco which shows how challenging to raise funds for innovative startups in Morocco. In fact, As can be seen in Fig. 16, 57% of the knowledge-Intensive innovative Moroccan startups have invested less than €5000.00 and only 7% have invested more than €50,000.00 while in Australia, for example, 46% of nascent high potential startups and 52% of high potential young startups have invested €60,000 or more (Davidsson 2008).

10 Sources of Advice and Needs for Advice

Although knowledge-intensive innovative startups are in average better endowed with human capital compared to imitative businesses, the complexity and uncertainty characterizing the innovative startup process require external use of talents that are not available within the startup team.

Fortunately, we enjoy here more diversity compared to the financial sources described above. Surprisingly, internet and websites communities are on top of the major source of advice used by Moroccan startups followed by potential or actual

Table 5 Correlation between each gestation activity and the gestation progress score

Gestation activities	Correlation to the gestation progress score
G20 Full time employees	**.819****
G19 Part time employees	**.767****
G26 Own visiting address	**.725****
G14 Financial projections	**.695****
G18 Full time to the business	**.691****
G24 Own mail address	**.673****
G3 BP written	**.659****
G4 BP written for external use	**.643****
G1 Product stage of development	**.631****
G13 Success in fundraising	**.624****
G2 business plan prepared	**.611****
G5 marketing and promotion	**.592****
G30 Monthly expenses include owner/manager salary	**.584****
G23 Own Phone number	**.559****
G27 Own fax number	**.543****
G7 IP granted (patent, copyright, or trademark)	**.474****
G6 IP application (patent, copyright, or trademark)	**.473****
G21 Non shareholders employees or managers	**.446****
G9 Purchased, lease or rent of major items	**.442****
G28 Own e-mail address	**.418****
G25 Team have a mobile mainly used for the business	**.368***
G8 Purchase of supplies	**.361***
G29 Own web page	**.358***
G33Number of entrepreneurship classes or workshops	**.337***
G10 Gathered of information to estimate potential sales or revenues	.263
G12 Fundraising	.246
G15 Saving money to start the business	.144
G16 Credit with a supplier	.139
G31 Obtained any business licenses or operating permits	**.015**
G11 Discussion of product or service with potential customers yet	−.015

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

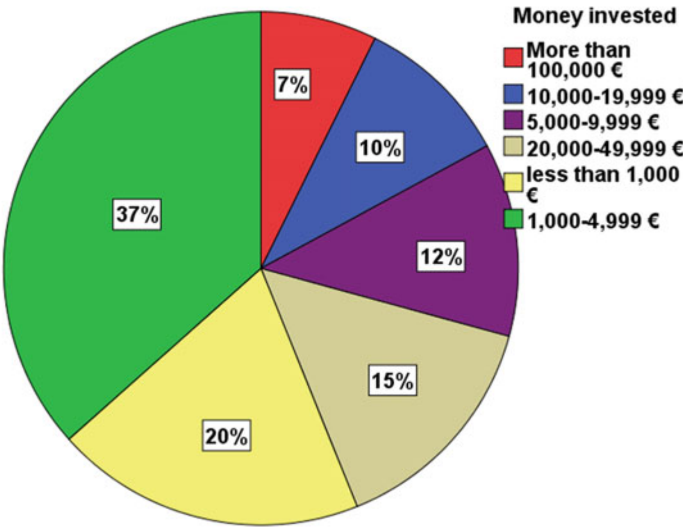


Fig. 16 Financial resources of all kinds (including loans) invested by the founder and his partner(s)

customers, friends, employers and colleagues, potential or actual suppliers and structures dedicated to supporting entrepreneurship (incubators, accelerators), are in the fifth position.

Diversity of sources of advice does not mean that the knowledge-intensive innovative startups are satisfied with what they are getting. 67% of interviewed startups expressed a need for support in customer acquisition issues related to marketing and sales respectively 58% and 9%, followed by legal aspects 13%, funds raising 11%, and business modeling and planning 4%. Interestingly, customer acquisition and sales issues were also cited as the top major challenge by 19.5% of the European startups according the European Startup Monitor (ESM) followed by product development (17.1%) and growth management (16.6%). Funds raising was also an important challenge for 12.1% of the European startups (Kollmann et al. 2016).

11 Expected Outcomes and Growth Aspirations

The expected future size of knowledge-intensive innovative startups in Morocco may not be very impressive in absolute sense, but in comparison with the regular startups are significant (Fig. 17). Although knowledge-intensive innovative startups are more challenging and take more time and resources to launch, 60% of them expected to create 6 or more jobs in 5 years while only 10.8% of the regular startups captured by the Global Entrepreneurship Monitor (GEM) report of 2017–2018 reported the same figures (El Ouazzani et al. 2017; Singer et al. 2018).

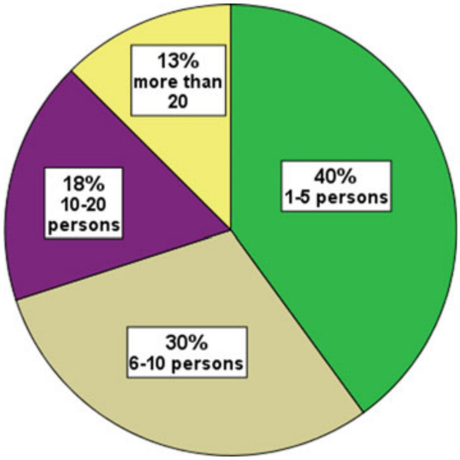


Fig. 17 Expected number of employees in five years

In terms of openness to international market 60% of the interviewed startups expect 25% or more of their revenues to be from foreign markets in five years (Fig. 18). This is a very interesting result, first because these numbers are not far from those reported by the European Startup Monitor (Kollmann et al. 2016) where 77.7% of the startups claimed that they are planning further internationalization, second it provides some hope for a country suffering from a chronic and large trade deficit where only 1% of existing enterprises are exporting according to the Moroccan Ministry of Industry and trade (Dref 2018).

Regarding their survival in 5 years, understandably interviewees' aspirations were overstated. All of them believe that they have more than 50% chance that their startups will be operating businesses of which 60% of the respondents are confident that they have 100% chance to be in business in the next 5 years (Fig. 19). Knowing that

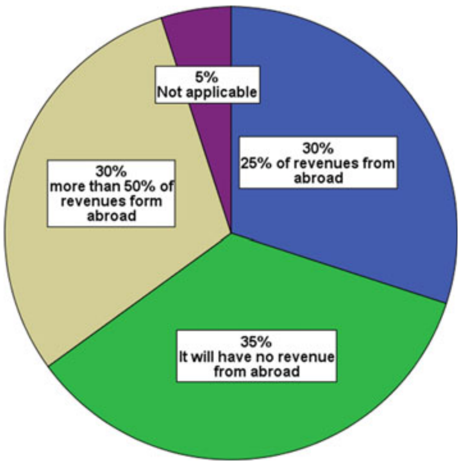


Fig. 18 Expected revenues from abroad in five years

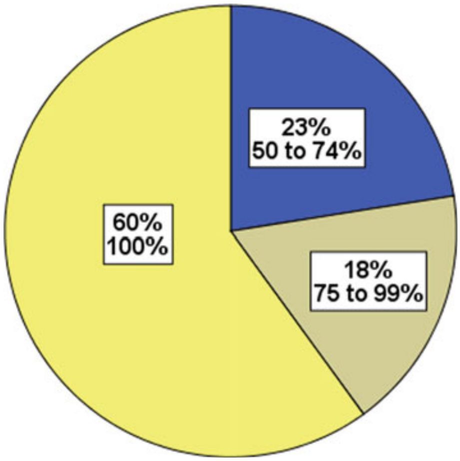


Fig. 19 The likelihood that this business will be operating 5 years from now (0–100%)

according to the Global Entrepreneurship Monitor report of 2017–2018 Morocco was ranked the 4th out of 54 countries in terms of fear of failure (Singer et al. 2018). It seems that these results could be partially explained by the fear of some of the interviewees to admit their failure and the overoptimistic attitude of the nascent entrepreneur that are at the very beginning of their entrepreneurial journey.

The last question that closed the survey was not about the expectations of the interviewees but more about the present and the impact of their entrepreneurial venture on their net income. Only 25% of the respondents said that their net income has increased after launching their innovative startups (Fig. 20).

12 Conclusion and Policy Recommendations

The objective of this report is to provide some early hints and observations on the entrepreneurial emergence of knowledge-intensive innovative startups in Morocco. We have selected some descriptive findings from using the first wave of survey data analysis. Below we reiterate some of the key findings:

- An innovative startup in Morocco is typically launched by a solo young man having a university degree; many of them are very young and lack the necessary experience and social capital to leverage required resources.
- Most of the startups are selling services or a combination of products and services. Startups in the sector of manufacturing and agriculture are very rare in comparison with Australia. The lack of resources pushes potential innovative entrepreneurs towards less resource intensive sectors.
- A majority of the entrepreneurs were mainly driven to the startup process by the business idea rather than the wish to start a business and were overwhelmingly motivated by opportunity perception.

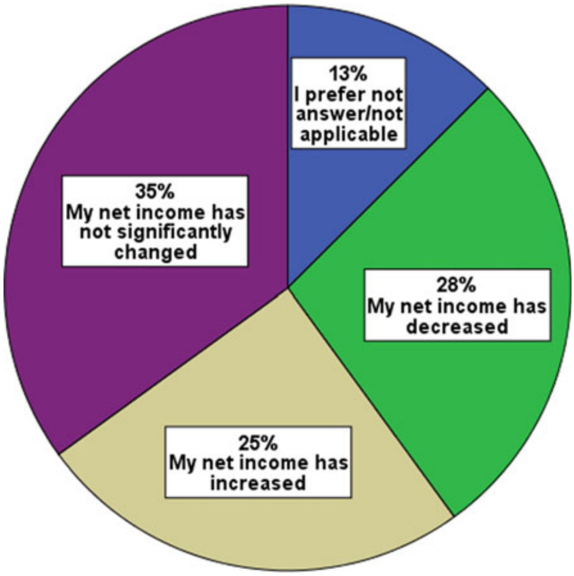


Fig. 20 Change in the net income before and after launching the startup

– As expected, knowledge-intensive innovative startups in Morocco are less sophisticated and innovative in comparison with similar structure in more developed countries. However, in several criteria they are not very far behind and score by far better than regular or imitative businesses in developed countries.
– Knowledge-intensive innovative startups feel more confident in their technical skills and report more competitive advantage in terms of product development expertise and its uniqueness and the knowledge of the latest technological trends but feel disadvantaged when it comes to soft and business skills such as networking, marketing and sales, finances and accounting, and administration and HR management.
– Knowledge-intensive innovative startups take longer to setup and to abandon. The preliminary findings give some hints on some critical and challenging gestation activities related to some resource-acquisition and legitimacy building activities.
– Most of the knowledge-intensive innovative startups in Morocco lack access to financial resources and rely heavily on their personal resources. The majority of startups remain underfunded.
– The range of sources used for information and advice is considerably more diverse in and includes widespread use of internet-based sources. However, they still ask for stronger support in marketing related issues, legal issues, funds raising, sales and business modeling and planning.
– Investigated knowledge-intensive innovative startups have higher aspirations and growth expectations compared to regular startups in Morocco.

Taken together these findings would have several implications for entrepreneurship practitioners and policymakers in Morocco.

First of all, it seems that knowledge intensive and innovative startups in Morocco are launched disproportionately by young and solo entrepreneurs lacking a lot of resources as well as adequate support from their environment to finish the gestation process and launch successfully high growth potential businesses. If the policymakers have as an objective to promote productivity and economic growth of the country, they should shift their focus to encourage more mature persons with the right skills, experiences and resources who are more likely to be successful in launching their startups. Although, there is a dilemma since these kinds of competencies are the most desirable employees and usually have already families to take care of. It is not straightforward how could Moroccan government encourage highly valued employees to become innovative entrepreneurs. We believe that there should be some experiments and trial and error to figure out how. A starting point could be a matchmaking and a team building program that invite

Second, these results suggest there may be a need to review the nature and type of the support provided to emerging entrepreneurs. Innovative startups face challenges in terms of business validation and customers and resources acquisition that are very different from those faced by established regular SMEs. In addition, it is very common that early stage entrepreneurs wouldn't know before the advice is given the nature of the problem they are or their startup is facing. Hence, entrepreneurship practitioners and business support providers should put more emphasis on providing specific and situational advice rather than size fits all advice. Here again, there might be a chicken and egg dilemma because there haven't been enough success and failure stories to learn from and it is extremely hard to find within the country consultants, coaches or mentors that have a credible track record to provide context specific and situational advice to knowledge intensive and innovative startups. In this regard, including highly skilled diaspora and foreign expertise in the business support provided might partially mitigate this problem. Moreover, the study has shown that gestation activities might take years to successfully launch an innovative startup and requires a sustained effort and several iterations. This needs to be taken into consideration in reviewing different entrepreneurship support programs that are frequently designed for much shorter time horizons.

This research has provided many new useful insights and observations about the entrepreneurial emergence of knowledge-intensive innovative startups in Morocco that could serve as a base for future studies in other countries in the region. If the debate is to be moved forward, a better understanding of the pace by which progress is made in the startup emergence process in terms of the total number of activities that are completed at different points in time, and how this differs by venture type, country, available resources, amounts of entrepreneurial ability in terms of human and social capital and the degree of the success of the business would provide much more insights into this topic.

Appendix: List of Gestation Activities

A-At what stage of development is the product or service that will be provided to the customers?
A Idea or concept
B Initial development
C Tested on customers
D Ready for sale or delivery

B Have you prepared a business plan? ☐Yes ☐No

C Is your plan written, (includes informally for internal use)? ☐Yes ☐No

D Is your plan written formally for external use? ☐Yes ☐No

E Have you started any marketing or promotional efforts? ☐Yes ☐No

F Have you applied for a patent, copyright, or trademark? ☐Yes ☐No

G Has the patent, copyright, or trademark been granted? ☐Yes ☐No

H Have you purchased any raw materials, inventory, supplies, or components? ☐Yes ☐No

I Have you purchased, leased, or rented any major items like equipment, facilities or property?
☐Yes ☐No

J Have you gathered any information to estimate potential sales or revenues, such as sales forecasts or information on competition, customers, and pricing? ☐Yes ☐No

K Have you discussed the company's product or service with any potential customers yet?
☐Yes ☐No

L Have you asked others or financial institutions for funds? ☐Yes ☐No

M Has this activity been completed (successfully or not)? ☐Yes ☐No

N Have you developed projected financial statements such as income and cash flow statements, break-even analysis? ☐Yes ☐No

O Have you saved money in order to start this business? ☐Yes ☐No

P Have you established credit with a supplier? ☐Yes ☐No

Q Have you arranged childcare or household help to allow yourself time to work on the business?
☐Yes ☐No

R Are you presently devoting full time to the business, 35 or more hours per week? ☐Yes ☐No

S Do you have any part time employees working for the new company? ☐Yes ☐No

T-How many employees are working full time for the new company? (write a number)

U Have you hired any employees or managers for pay, those that would not share ownership?
☐Yes ☐No

V Have you taken any classes or workshops on starting a business? ☐Yes ☐No

W How many classes or workshops have you taken part in?

X Does the company have its own phone number? ☐Yes ☐No

Y Does the company have its own mail address? ☐Yes ☐No

Z Does anyone in the team have a mobile mainly used for the business? ☐Yes ☐No

AA- Does the company have its own visiting address? ☐Yes ☐No

AB Does the company have its own fax number? ☐Yes ☐No

AC Is there an e-mail or internet address for this new business? ☐Yes ☐No

AD Has a web page or homepage been established for this business? ☐Yes ☐No

AE Do the monthly expenses include owner/manager salary in the computation of monthly expenses? ☐Yes ☐No

AF Has the new business obtained any business licenses or operating permits from any local, county, or state government agencies? ☐Yes ☐No

AG What were the major startup activities in which you have invested more than 20% of your time so far:

References

Acs ZJ, Szerb L, Autio E, Lloyd A (2017) Global Entrepreneurship Index GEDI. The Global Entrepreneurship and Development Institute, Washington, D.C., USA

AEGIS Research Project (2013) AEGIS stands for: Advancing knowledge-intensive entrepreneurship and innovation for economic growth and social well-being in Europe, grant agreement number 225134. European Commission, DG Research, Brussels

Aldrich HE (1999) Organizations evolving. Sage Publications, Newbury Park, CA

Audretsch DB, Thurik AR, Verheul I, Wennekers S (eds) (2002) Entrepreneurship: determinants and policy in a European–US comparison. Boston, Dodrecht and London Kluwer

Azoulay P, Jones B, Kim D, Miranda J (2018) Research: the average age of a successful startup founder is 45. Harvard Bus Rev. https://hbr.org/2018/07/research-the-average-age-of-a-successful-startup-founder-is-45

Bandura A (1982) Self-efficacy mechanism in human agency. Am Psychol 37:122–147

Barney JB, Arikan AM (2001) The resource-based view: origins and implications. In: Hitt MA, Freeman RE, Harrison JS (eds) Handbook of strategic management. Oxford, Blackwell, pp 124–188

Bhave MP (1994) A process model of entrepreneurial venture creation. J Bus Ventur 9:223–242

Birch D, Haggerty A, Parsons W (1995) Who's creating jobs? Cognetics Inc., Boson, MA

Blank S (2013) Why the lean start-up changes everything. Harvard Bus Rev 91(5): 63–72

Cassar G, Craig J (2009) An investigation of hindsight bias in nascent venture activity. J Bus Ventur 24(2):149–164

Crick D, Spence M (2005) The internationalisation of 'high performing' UK high-tech SMEs: a study of planned and unplanned strategies. Int Bus Rev 14

Davidsson P (2003a) The domain of entrepreneurship research: Some suggestions. In: Katz J, Shepherd D (eds) Advances in entrepreneurship, firm emergence and growth, vol 6. Elsevier/JAI Press, Oxford, UK, pp 315–372

Davidsson P (2003b) Method issues in the study of new venture start-up processes. Paper presented at the NFF Conference, Reykjavik

Davidsson P (2004) Researching entrepreneurship. Springer, Boston, MA

Davidsson P (2006) Nascent entrepreneurship: empirical studies and developments. Found Trends Entrepreneurship 2:1–76. https://doi.org/10.1561/0300000005

Davidsson P, Steffens P, Gordon S, Reynolds PD (2008) Anatomy of new business activity in Australia: some early observations from the CAUSEE project. Available at: eprints.qut.edu.au/archive/00013613. Brisbane: School of Management, Faculty of Business, QUT

Davidsson P et al (2008) Characteristics of high-potential start-ups: some early observations from the CAUSEE project. Research Report. Available at https://www.researchgate.net/publication/27477895_Characteristics_of_high-potential_start-ups_some_early_observations_from_the_CAUSEE_project

Davidsson P et al (2009) Growing profitable or growing from profits: putting the horse in front of the cart? J Bus Ventur 24(4):388–406

Davidsson P, Steffens P, Gordon S (2011) Comprehensive Australian Study of Entrepreneurial Emergence (CAUSEE): design, data collection and descriptive results. In: Hindle K, Klyver K (eds) Handbook of research on new venture creation. Edward Elgar, Cheltenham, UK, pp 216–250

Delmar F, Shane S (2004) Legitimating first: organizing activities and the persistence of new ventures. J Bus Ventur 19:385–410

Dref N (2018) Compétitivité industrielle: a peine 1% des entreprises font de l'export, L'Economist, Edition N°:5218 Le 27/02/2018

Drucker P (1985). Innovation and Entrepreneurship. New York, Harper & Row

Durand R, Coeurderoy R (2001) Age, order of entry, strategic orientation, and organizational performance. J Bus Ventur 16:471–494

El Ouazzani K et al (2017). La dynamique entrepreneuriale au Maroc en 2017. Global Entrepreneurship Monitor Morocco report. Available at: http://www.gemconsortium.org/report
Fischhoff B, Beyth R (1975) I knew it would happen: remembered probabilities of once-future things. Organ Behav Human Perform 13:1–16
Freeman C (1992) The economics of hope. Pinter Publishers, London, New York, p 77
Gallagher KS (2006) Limits to leapfrogging in energy technologies? Evidence from the Chinese automobile industry. Energy Policy 34:383–394
Gartner WB, Shaver KG, Carter NM, Reynolds PD (2004) Handbook of entrepreneurial dynamics: the process of business creation. Thousand Oaks, CA, Sage
Gartner WB, Shaver KG, Carter NM, Reynolds PD (2010) Entrepreneurial behavior: firm organizing processes. In: Acs ZJ, Audretsch DB (eds) Handbook of entrepreneurship research: an interdisciplinary survey and introduction. Springer, New York, pp 99–127
Gundry LK, Welsch HP (2001) The ambitious entrepreneur: high growth strategies of women-owned enterprises. J Bus Ventur 16(5):453–470
Henrekson M (2007) Entrepreneurship and institutions. Comp Labor Law Policy J 28(3):717–742
Henrekson M, Stenkula M (2010) Entrepreneurship and public policy. In: Acs ZJ, Audretsch DB (eds) Handbook of entrepreneurship research: an interdisciplinary survey and introduction. Springer, New York, pp 595–637
Iversen J, Jørgensen R, Malcow-Møller N (2008) Defining and measuring entrepreneurship. Found Trends Entrepreneurship 4(1):1–63
Katz J, Gartner WB (1988) Properties of emerging organizations. Acad Manag Rev 13(3):429–441
Kollmann T, Stöckmann C, Hensellek S, Kensbock J (2016) "European Startup Monitor" (EMS), German Startups Association. Available at: https://europeanstartupmonitor.com/fileadmin/esm_2016/report/ESM_2016.pdf
Lazear EP (2005) Entrepreneurship. J Labor Econ 23(4):649–680
Lundvall B-A (1988) Innovation as an inter-active process: from user-producer interaction to the national system of innovation. In: Dosi G (ed) Technical change and economic theory. Pinter Publishers, London
Malerba F, McKelvey M (2018) Knowledge-intensive innovative entrepreneurship: integrating Schumpeter, economics and innovation systems. Small Bus Econ. https://doi.org/10.1007/s11187-018-0060-2
OECD (2005) Oslo manual: guidelines for collecting and interpreting innovation data, 3rd edn. OECD Publishing, Paris. Available at: https://www.oecd.org/sti/inno/oslomanualguidelinesforcollectingandinterpretinginnovationdata3rdedition.htm
Reynolds PD, Miller B (1992) New firm gestation: conception, birth and implications for research. J Bus Ventur 7(5):405–418
Reynolds PD (1997) Who starts new firms? Preliminary explorations of firms-in-gestation. Small Bus Econ 9:449–462
Reynolds PD (2000) National panel study of US business start-ups. Background and methodology. In: Katz JA (ed) Advances in entrepreneurship, firm emergence and growth, vol 4. JAI Press, Stamford, CT, pp 153–227
Reynolds PD, Curtin RT (2007) Panel study of entrepreneurial dynamics program rationale and description (October), pp 1–15
Reynolds PD, Curtin RT (2008) Business creation in the United States: panel study of entrepreneurial dynamics II initial assessment. Found Trends Entrepreneurship 4
Roese NJ, Olson JM (1996) Counterfactuals, causal attributions, and the hindsight bias: a conceptual integration. J Exp Soc Psychol 32:197–227
Sarasvathy SD (2001) Causation and effectuation: towards a theoretical shift from economic inevitability to entrepreneurial contingency. Acad Manag Rev 26(2): 243–263
Sauter R, Watson J (2008) Technological leapfrogging: a review of the evidence report for UK department of international development. SPRU, University of Sussex. Available at: http://sro.sussex.ac.uk/id/eprint/29299/

Schumpeter JA (1934) The theory of economic development. Harvard University Press, Cambridge, MA

Schumpeter J (1942) Capitalism, socialism and democracy

Senyard et al (2009) The comprehensive Australian study of entrepreneurial emergence (CAUSEE) high potential nascent entrepreneurs: some preliminary findings. In: Gillin L (ed) Proceedings of the 6th international AGSE entrepreneurship research exchange, 3–6 Feb 2009, ECIC, University of Adelaide, South Australia, Australia, Swinburne University of Technology, Adelaide, Australia, pp 1–15

Shane S (2008) The illusions of entrepreneurship. The costly myths that entrepreneurs, investors, and policy makers live by. Yale University Press

Singer et al (2018) Global Entrepreneurship Monitor (GEM), Global Report 2017/18. Accessible at: http://www.gemconsortium.org/report

Stuetzer M, Obschonka M, Schmitt-Rodermund E (2013) Balanced skills among nascent entrepreneurs. Small Bus Econ 41(1):93–114. https://doi.org/10.1007/s11187-012-9423-2

Tether BS (2003) What is innovation? Approaches to distinguishing new products and processes from existing products and processes. ESRC Centre for Research on Innovation and Competition (CRIC). University of Manchester and UMIST. CRIC Working Paper No 12

Wagner J (2006) Are nascent entrepreneurs jack-of-all-trades? A test of Lazear's theory of entrepreneurship using German data. Appl Econ 38:2415–2419

Wong PK, Ho YP, Autio E (2005) Entrepreneurship, innovation and economic growth: evidence from GEM data. Small Bus Econ 24(3):335–350

World Bank (2010) Innovation policy. A guide for Developing Countries, Washington, DC

Technology Commercialisation in Africa

Challenges of the Agribusiness Sector in Kenya and Opportunities from Smart Specialisation Policies

Anna Masłoń-Oracz, Anthony Wahome, and Andrew Njiraini

1 Introduction

Agriculture is a major source of employment and provides livelihoods for more than 40% of the population on the continent[1]; the contribution of the sector is even higher when accounting for the informal labour in the sector in Africa (FAO 2018).[2] It is the major source of income and employment of the rural households. The prevalence of extreme hunger constitutes an important barrier to development in many nations. The SDG on zero hunger translates our ambitions to bring to an end to all forms of hunger or malnutrition by 2030. It therefore advocates for the development of sustainable agriculture by providing platforms that endow small holder farmers with the factors of production and markets access whilst leveraging on technology (UNESC 2019).

The agriculture sector is a key contributor to economic development and food security in Kenya. Food security is on the Big Four action plan of the government, which also focuses on manufacturing, affordable housing and affordable healthcare for all.[3] It is estimated that Agriculture contributes about 26% of Kenya's GDP and another 27% through linkages with other sectors. Additionally, the sector creates employment and it is estimated that it employs about 40% of Kenya's population and slightly above 70% of the rural population. Agriculture is the top foreign exchange earner in Kenya with an estimated 65% of the export earnings relating to agricultural

[1] http://www.fao.org/kenya/fao-in-kenya/kenya-at-a-glance/en/

[2] https://www.globalagriculture.org/fileadmin/files/weltagrarbericht/Weltagrarbericht/10BäuerlicheIndustrielleLW/Pocketbook2018.pdf.

[3] See at https://vision2030.go.ke/towards-2030/ (accessed Jan. 2020).

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exports (FAO 2018). In the advent of a significantly fast-growing population, the land parcels in areas with high agricultural potentials have declined in size, thus affecting food production negatively. Weather patterns have also changed significantly with climate change and farmers who rely on rain-fed farming have been affected. As a result, the country is experiencing a greater number of draught seasons, unpredictable weather patterns, which increase the vulnerability of agricultural activities (FAO 2018).

As a result of the prevalent challenges of the agriculture sector in Kenya, the country is not food-secured and has to rely on importation of food. However, Kenya has a high percentage of land which is suitable for agriculture. Yet, the reality shows that farmers have continued to rely on traditional farming methods. This has resulted in decreasing yields and increased costs of production.

In light of this, place-based approach to competitiveness such as smart specialisation can help thinking about what to do best in order to achieve food security considering the specific challenges of the place or territory. Achieving food security is not only a goal, but is itself an essential enabler for economic growth and can contribute to reduce inflation levels (Ngare et al. 2015). Smart specialisation is a place-based innovation policy approach that enables territories to construct competitive advantages through a better exploitation of the specific strengths and assets of the given territory (Foray 2015, Foray et al. 2012, Capello and Kroll 2016, Gianelle et al. 2016, Matusiak and Kleibrink 2018, Masłoń-Oracz 2018). In their policy application smart specialisation strategies (S3) rely upon regional partnerships, participatory discovery processes and can help developing a vision for transformation. However the policy implications of smart specialisation are complex and based on important assumptions. We need to bear in mind at least three important and related components or dimensions: (i) the role of scientific, technological and economic specialisation to develop comparative advantages and to drive economic growth; (ii) policy intelligence for identifying domains of present or future comparative advantage and; (iii) governance arrangements that give a pivotal role to regional authorities, private stakeholders and entrepreneurs in the process of translating strategies into economic and social outcomes (Gianelle et al. 2016, OECD 2013). Adopting a Smart specialisation strategy also means supporting local innovation systems, maximizing knowledge flows, and spreading the benefits of innovation across the entire regional economy (Foray et al. 2012).

Smart specialisation is enabled for instance by clusters activities and dynamics that build upon the concentration of various organisations and firms in close or related business lines or knowledge fields. Clusters could be referred to as geographic concentrations of related parties as they provide a base for transformation whose strengths result from the outcome of the synergies (Masłoń-Oracz et al. 2018). The aim of smart specialisation is economic development from the incremental competitive advantages possessed by regions that other regions are unable to imitate with ease. It involves the identification of a goal and the unique measures a region will implement to achieve the goals (Lopes et al. 2018).

The importance of regions (sub-national administrative entities) has not decreased with the intensification of the global competition and competitiveness is high on many regional development agendas[4]. Regions are increasingly seen as important players and platforms of the socio-economic and innovation processes. They are the subject of statistical mapping and extensive researches dedicated to examine their knowledge production and innovation processes and the trust- and cooperation-building or dynamics mechanisms.

This chapter discusses the Kenya's agriculture sector and the innovation systems the sector and highlights potential opportunities of adopting smart specialisation for the agribusiness sector development in Kenya.

Drivers of regional competitiveness: building blocks

The definition of the region as an interdisciplinary concept, for the purposes of this work understood as the economic region, is the initial and basic concept. Generally speaking, the economic region is a specialised economic area that arose as a result of endogenous and exogenous development factors. The economic region is shaped on the basis of interrelated socio-economic processes and interactions that occur in its area. It can thus differ from the administrative region. Domański proposes a definition of the economic region as "[…] forming part of a larger whole and geographically distinctly dense, compact set of elementary spatial units having some common or complementary features and a clearly shaped or shaping economic system, whose elements are interrelated with each other and with the natural environment, coexistence and interdependence relations, and with the external environment interdependence relations of high intensity." (Drozdowski 2004, p. 132.)

Thus, the modern economic region takes part in market processes, competes with or cooperates with other market players. The literature (Eurostat Regional Yearbook 2017; Markowska et al. 2015; Tkaczynski 2017)[5] on the subject suggests the following features of the economic region:

(a) It consists of similar elementary units,
(b) Its internal and external connections are distinguished,
(c) it specializes in activities,
(d) the regional community has similar characteristics within the framework of regional identity,
(e) has an economic profile,
(f) it has at least one urban center as an integrating factor,
(g) its elements are located close to each other,
(h) his community is able to formulate goals and achieve them independently.

Regions, also within the same country, present heterogeneous characteristics which implies that contemporary conditions for their development will greatly differ. This is underlined in the considerations of smart specialisation, in which regional

[4]See for instance the OECD's Regional Statistics and Indicators (and resources) at http://www.oecd.org/governance/regional-policy/regionalstatisticsandindicators.htm.

See also Fawn (2009) for an thematic conceptual discussion. (Fawn (2009). 'Regions' and Their Study: Wherefrom, What for and Where to? Review of International Studies, 35, 5–34. Retrieved January 26, 2020, from www.jstor.org/stable/20542776).

[5]See also the historical contribution of Lösch (1938).

knowledge and innovation assets are essential drivers for transformation and competitiveness. Florida (2008) proposed a new approach to the classification of the economic region precisely because of the attractiveness of knowledge and innovation locations. Florida's typology distinguishes between (i) knowledge generating regions; (ii) regions successfully absorbing knowledge; (iii) megacities in under developed countries, often taking the form of mega slum and; (iv) underdeveloped and peripheral regions competing with cheap unskilled labour. Regional competitiveness is multifaceted and has different meanings that often reflect the views on what make a region more competitive than other (Table 1).

The lack of a clear and commonly used definition reduces considerations to the analysis of factors that affect the competitiveness of the subject of the study (The "pyramid model" of regional competitiveness the Fig. 1). The pyramid model provides a hierarchical synthesis and explain what different regional factors and determinants that could also be activated in order to enhance the region's attractiveness and performances. The topic of regional competitiveness has gradually become

Table 1 Selected definitions of regional competitiveness

Author/Source	Definition/essence of regional competitiveness
Sixth Periodic Report on the Social and Economic Situation and Development of the Regions of the European Union[a]	1. The ability to produce goods and services that pass the international markets test while maintaining a high and balanced level of income 2. The ability to generate relatively high income and employment in international competition
Winiarski[b]	The ability of regions to adapt to changing conditions in terms of maintaining or improving their position in ongoing competition between regions
Courlet[c]	The success with which regions compete with each other. The term refers to the relative dynamics of production and employment, participation in international exchange, ability to attract investment (public and private, local and foreign), qualified employees and entrepreneurs and technological development by attracting innovative activities to the region
OECD[d]	The definition emphasizes three aspects of competitiveness: "the ability of enterprises, industries, regions, nations or transnational regions to generate in the long run, relatively high revenues and a high level of employment in the conditions of international competition"

[a]European Commission (1999, p. 75)
[b]Winiarski (1999), p. 9
[c]Courlet (2008), p. 75
[d]OECD (2010), p.16

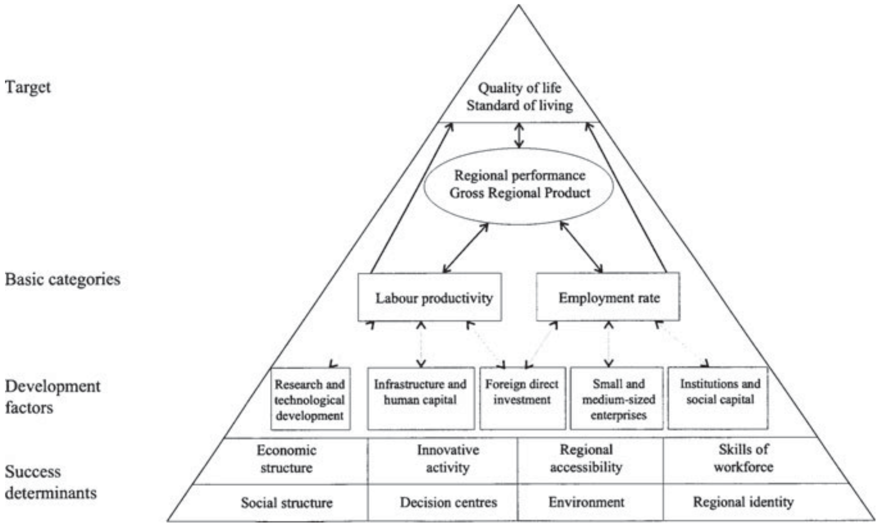

Fig. 1 A "pyramid model" of regional competitiveness. *Source* Lengyel I., *The pyramid model: enhancing regional competitiveness in Hungary*. Acta Oeconomica, 54(3) (2004), pp. 323–342

a central issue or concern of economic sciences, in particular with the globalisation of the world economy and the development of telecommunications.

Although the regional competitiveness profiles are almost unique, several successful stories suggest that pro-active clusters or universities are determinant actors for building up regional competitiveness and well beyond for economic development.

Considering the multidimensional character of competitiveness when making a region's smart specialisation means that different scenario are envisioned as part of the initial stages of the innovation strategy design. The selected development scenario will in turn depend much on the intensity of internal and external links between individual regions and actors (Table 2).

Innovations arise in a stimulating environment, in an innovative environment supported by the private and public sectors, and in particular due to expenditure on research and development activities generated by the private sector, strengthened by the presence of research institutions and universities and their cooperation with industry (Shearmur and Bonnet 2011).

Benneworth and Dassen (2011) synthetise the key elements of global-local connections in regional innovation ecosystems (Fig. 2).

Understanding and shaping inclusive regional innovation ecosystems constitute a key policy lever for improving the competitiveness of regional or local actors. Dedicated gaps mapping and innovation policy instruments are required to foster regional innovation systems in order to improve the business and entrepreneurial environment conducive to innovation, growth and competitiveness (OECD 2013; Benneworth and Dassen 2011; Masłoń-Oracz and Proczek 2017).

Table 2 Innovation strategies for individual types of regions according to the intensity of internal and external links

	Connecting globally	Sustaining momentum	Cluster-building	Deepening pipelines
Archetype for region	Peripheral regions lacking	Regions with strong local cluster organisations well networked with policy actors	Small groupings of competitive businesses with limited local connectivity	Region dependent on limited number of global production networks/value chains
Key weakness	Absence of connection to external actors—no external stimulus for innovation	Risk of hollowing out and being left behind by GPNs—maintaining global lead	Regional firms tend to look outwards—contagious local undervaluing of partners	Dominance by a single firm or chain that exploits not supports regional actors
Existing strengths	Latent innovative actors with potential to grow quickly and deliver change	Highly innovative, well networked clusters playing leading role globally	Industrial districts with competitive advantages and global profile	Industrial ecosystem supporting value chains with diversification opportunities
Optimal solutions	Helping regional actors take the first steps in international cooperation (collectively?)	Bringing outside actors in, and helping to collectively shape future trends	Channelling innovation support to stimulate growth through regional clusters	Helping second-tier innovators became market leading and shaping
Example regions	Madeira, Portugal Tallinn, Tartu Estonia Attica, Greece Sardinia, Italy	Île-de-France, France Baden-Württemburg, Germany Flanders, Belgium Toronto, Canada	Skåne, Sweden Navarra, Spain Auckland, New Zealand Zuid-Holland, Netherlands Nord-Pas-de-Calais, France	Eindhoven, Netherlands Piemonte, Italy Limburg, Belgium Seattle, USA North East of England, UK

Source: Benneworth and Dassen (2011), pp. 22–26

2 Agricultural Innovation Systems in Kenya: Challenges, Trends and Opportunities

Agriculture is critical in meeting Sustainable Development Goal No. 2 on Zero hunger. It reflects the world's ambitions to provide nutritious food for all, whilst generating income and preserving the environment. According to the UN Agenda

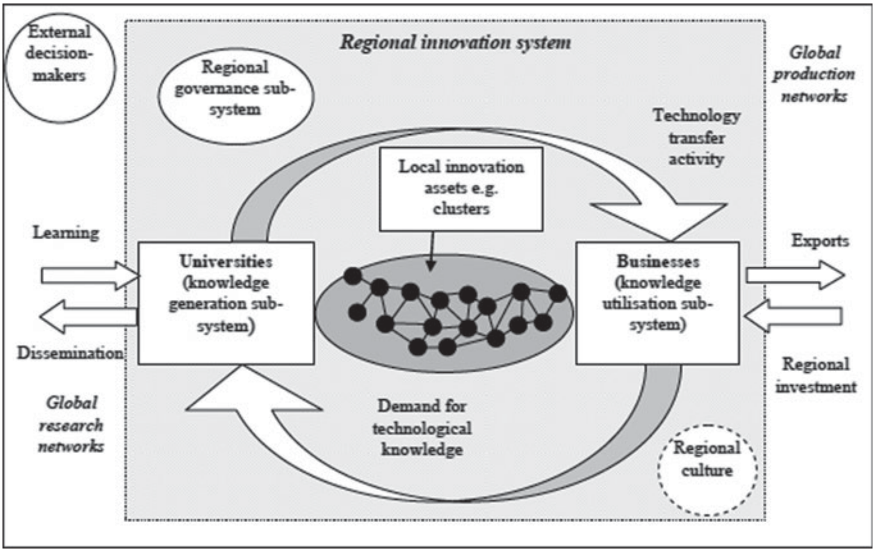

Fig. 2 Global-local connections in regional innovation ecosystems *Sources* Benneworth and Dassen (2011), based on Cooke (2005)

2030, an estimated 821 million people were undernourished in 2017 and the highest proportions are found in developing countries. For instance, Sub-Saharan Africa was the region with the highest dominance of hunger in the world in 2017 (UNESC 2019).

The Comprehensive African Agricultural Development Programme (CAADP) is a continental framework under the Agenda 2063 of the African Union (African Union Commission, AUC 2015). The programme aims to assist countries in Africa in order to eliminate hunger and reduce poverty by increasing economic growth through agriculture led development. It further calls for enhanced national budgets for agriculture and rural development in African countries. The target share is 10% of the national budgets with an annual growth rate of 6% in the agriculture sector. The program also targets increased yields, farm incomes, use of natural resources and enhancement in sustainability of agricultural production[6] (AUC 2015).

In Kenya, the importance of agriculture is seen in Vision 2030, the Medium Term Plan III and the President's Big Four Priority Agenda for the year 2017–2022 which insists on the importance of 100% food security for all Kenyans. According to the 19th Kenya Economic Update, the agricultural sector is a significant contributor to the gross domestic product (GDP) of the country, employment and total exports hence the government focus on agriculture under the Big 4 Agenda among other initiatives (GoK 2017). The government of Kenya has come up with the Agricultural Sector Transformation and Growth Strategy (ASTGS), which underlines three driving pillars for the agricultural sector transformation. The three pillars are (i) to increase small-scale farmer, pastoralists and fisher folk incomes; (ii) to increase

[6] https://au.int/en/agenda2063/continental-frameworks.

agricultural output and value add, and; (iii) to increase household food resilience (GoK 2017). The transformation strategy is informed by the fact that food security needs a vibrant, commercial and a modern sector which can sustainably support the country's economic development.

The following pages discuss some of the key challenges that the agriculture sector is confronted with in Kenya.

2.1 Climate Change

Agriculture continues to be the mainstay of the Kenyan economy with a significant contribution to GDP. Climate change has affected the agriculture landscape in the twenty-first century. The majority of the countries are expected to experience increases in the average temperatures (Ochieng et al. 2016). The changes have already affected the drought and food security patterns of local communities in Kenya through their effects on rainfall, soil conditions and the yields. The lack of proper systems to predict monitor these changes and to provide advisory services to farmers will continue to harm the sector development (Ochieng et al. 2016).

In response to these trends, the government of Kenya has established a National Climate Change Response Strategy with the aim to address the resultant challenges and opportunities from climate change. The related mandate entails the design of strategies and the implementation of focused actions to help farmers to mitigate the negative effects of climate change. As a result, the government has come up with irrigation schemes in which the private sector contributes through for instance land leasing and support services for farming activities. A key role for research is also emphasised in relation to the support for the design of drought resistant crops which have a greater adaptability to current and emerging climatic conditions (Ochieng et al. 2016).

Kenya could also leverage on clustering regions and adapt specific crops that would thrive in the conditions prevalent in the region. Opportunities from climate smart agriculture are also relevant to improve production and productivity, while fostering resilience to climate change.[7] Such avenues should be experimented in order to shift away from traditional farming methods which show their limit in ensuring food security in Kenya.

2.2 Declining Farm Sizes

More than 70% of the poor population live in rural areas and make above half of their livelihoods from farming activities. These shares justify the policy focus on agricultural growth as one of the most effective way of reducing poverty. The growth

[7] Kenya Climate Smart Agriculture Strategy-2017-2026.

of small holder farming activity is expected to result in sustainable poverty and hunger reduction in Africa. Studies observe that rising population densities are associated with declining farm sizes and cultivation areas. Land sizes are declining in Kenya and in Sub-Saharan Africa. These declines have resulted in fragmented agricultural activities, thus questioning the feasibility of smallholder agricultural plans in the light of important competing needs for the use of land like housing (Muyanga and Jayne 2014).

There is need for innovative solutions on the way out of poverty for the constrained farming systems in the rural areas. In the Kenyan contexts, this means enhancing the equitable land access through new redistribution approaches to reduce existing inequalities. Additionally, the government should scale up the investments in infrastructure, access to water and to electricity especially in rural areas. Such actions would further value rural areas and can relevantly limit the rural-urban migration (Muyanga and Jayne 2014).

2.3 Research and Development

Investments in research and development activities have been on the rise in Sub-Saharan Africa; however, they have come with inadequate investments strategies (Dosso et al. 2017). Among the many causes, the performance of the agriculture sector has been declining partly because farmers have continued to employ the same farming methods, often not more suitable. In parallel, the degradation of soil nutrients has worsened owing to the lack of cropping patterns and rotational crops that help restoring soils nutrients. Research and development on more efficient farming methods can support tailored crop selection and farming techniques. The volume of the crops and livestock can be tripled with the adoption and use of modern technology (Mohajan 2014).

Mariussen and the co-authors stress the need to build sound research capacity together with relevant investments as a precursor innovation (Mariussen et al. 2016). Kenya has potential for more than it is currently doing as demonstrated by the decreasing yields which are a predominantly as a result of lack of innovation. Kenya as a country needs to invest in research and development and to build up strong capabilities in research and innovation policy making, monitoring and funding instruments design. Research and innovation potentials should be better matched with the specific community challenges and farmers needs to ensure effectiveness (Dosso et al. 2018).

A good example is the rice milling process that yields a conversion rate of about 60% whereas milling in Asian countries yields a conversion of around 70%. There is need for research institutions to conduct research and propose solutions to ensure optimized milling (Ndirangu and Oyange 2019). The Kenya Agricultural Livestock Research Organization (KALRO) is a dedicated government body with the mandate to conduct research in the entire agricultural spectrum. The organisation informs both the government for policy formulation and the private sector's investments strategies.

2.4 Market

Markets shape the different opportunities for producers, traders, transporters and service providers and the organisation of agricultural value chains which impact the production and food security patterns. The lack of markets has been emphasised by Kenya's Vision 2030 as a main barrier to achieving food security in the country (Muyanga and Jayne 2014). Despite the benefits that accrue from commercialising agriculture, small holder farmers face two big challenges which are access to inputs and markets for their products. The costs associated with obtaining market information is another hindrance to commercialisation of agriculture whilst the information is supposed to guide farmers in making informed decisions relating to their farming activities (Mwema and Crewett 2019). The World Bank Kenya economic update, edition 19, notes that increasing productivity and market access is a catalyst for food production growth in rural areas and is instrumental in reducing the poverty levels (World Bank 2019).

Kenya scores poorly when it comes to markets as a result of obstacles in production certification, cost of production, marketing and exporting of the agricultural products. Access to markets contributes significantly in determining the farmer incomes. There is a need to strengthen markets also to incentivise early farming activities for instance through ensuring ready markets and optimal prices. Mwema and Crewett recommend the design of policies that strengthen network linkages targeting better commercialisation (Mwema and Crewett 2019).

2.5 Financial Knowledge and Access to Credit

Cherotich et al. (2019) observe that financial knowledge has a significant contribution to the performance of women farm enterprises. Women with higher financial knowledge were found to have more savings and margins on their farming activities. Due to low awareness and often costly insurance schemes, small scale farmers largely have to bear the effects of the weather such as crop failure. Large scale farmers are able to mitigate such risks using insurance schemes. The agriculture sector continues to lack adequate credit extension from financial institutions which would be paramount in creating growth in the sector (Ngare et al. 2015).

Farmers in Kenya have suffered heavy losses from the effects of climate change and the weather conditions has become very unpredictable leading to crop failures. Ultimately, this has resulted into defaults with the financial services institutions. There is need to find solutions to make agriculture bankable and more attractive for investments actors (Ngare et al. 2015). Farmers are thus unable to scale their production due to lack of capital and the requisite insurance products which are stifled due to the lack of historical yield data that are needed to design suitable products that are well priced.

2.6 Failure to Adopt Technology

Low literacy levels and poor ICT skills reduce the opportunities for improvements in production efficiency through IT-enabled dissemination of information and therefore the rural extension services (Ameru et al. 2018). Adoption of appropriate technologies can significantly increase the production volumes and the benefits in the form of higher prices, food security and employment creation. Technology is critical in the revolution of the agricultural sector. Although the adoption of technology remains slow in the Kenya's agricultural sector it embeds real opportunities to develop new narratives for stronger agricultural innovation systems within the country (Mwangi and Kariuki 2015).

Farmers are usually informed of the existence of technology in their agricultural space by extension offices. However, extension services are on the decline due to reduced government funding resulting in even lower rates of technology adoption. There is need for innovative technology platforms with a wide coverage of the agricultural sector and relevant information about the available extension services to support appropriate technology adoption. Research has found a positive correlation between extension services and the adoption of technology (Mwangi and Kariuki 2015). Information technology plays a crucial role in complementing the farmers' observations and knowledge. Furthermore, IT can support the implementation of system evaluation tools and enable the monitoring of various information sources that can be mined to improve farmers performance (Jiménez et al. 2016).

3 Leveraging on Smart Specialisation to Foster Integration in the Agricultural Sector in Kenya

According to (FAO 2018) in the Zero Hunger recipe, there must be multiple players who will need to work together towards eradicating hunger. The recipe observes that the way forward require the involvement of governments, private sector and civil society. Governments and political leaders should re-focus on agriculture, climate change and job creation goals and support market access for small holder farmers and decent revenues from their harvests. Small holder farmers own about 90% of the farms in the world and FAO portends that they should come together to form cooperatives and unions which will increase their bargaining power, improve their access to inputs and help to maximize returns (FAO 2018).

In Kenya, the Agricultural Sector Transformation and Growth Strategy (ASTGS) proposes the launching of knowledge and skills building programs and the designation of national and county government leaders responsible for driving the strategy. These programs will aim to strengthen the skills of implementing bodies towards the adoption of digital-enabled government extension services. The government bodies dealing with agriculture should commit in the development of policies and regulations that are essential in delivering the ASTGS. The Agricultural Transformation Office will provide inter-ministerial coordination of all the organs. The sustainability of this type of programme also depend on the involvement of relevant stakeholders, universities and the private sector. Agricultural growth and transformation can hardly be achieved without a dynamic private sector serving and driving agriculture, farming and food value chains. The private sector is able to revolutionize agriculture by improving yields, creating employment and modernising the value chains. However, government should support conducive environments for incentivising value creation activities by the local private sector's actors (Ferroni and Zhou 2012). In such environment, Universities and higher education institutions are also expect (i) to contribute for instance through challenges-solving research, evidence for informing policy decisions and, (ii) to interact with policy makers and the private sector to develop new paths for technology commercialisation and local value creation in the agricultural sector in Kenya.

From such perspective, Kenya's agricultural sector can draw from the conceptual and participatory approach advocated by smart specialisation policies. It also means that policy makers should seek to enhance the fit of their actions to the place-specific societal challenges (Foray et al. 2012; Capello and Kroll 2016; Gianelle et al. 2016) of agricultural and rural communities in Kenya. In addition, through smart specialisation cooperation regions can come together around similar priorities and or strengths in order to benefit from synergies and develop together unique competitive advantages. In contrast with the potential benefits of clusters formation and organised farming groups, Kenya continues to have fragmented systems where the majority of the farmers engage 'alone' in their activities. Consequently accessing markets and obtaining favourable pricing for their commodities remain extremely difficult because they are not able to compete individually. This gives relevance for experimenting smart specialisation policies for creating clusters and boosting local and regional competitiveness (Pires et al. 2014)

Smart specialisation is promoted as a strategy that enable territories to increase their strategic use and efficiency of their research and innovation investments (Foray et al. 2012; Capello and Kroll 2016; Gianelle et al. 2016). The Kenyan agricultural sector has great potentialities for contributing to economic growth but the lack of systemic integration hampers the positive benefits of agriculture from spilling over to the whole value-chain actors. Novel approaches for realising the full potential of the sector should be methodical (i) starting from the opportunities scanning to scenario building for constructing competitive advantages in the areas with strong potentials for growth and (ii) enabling collaborations and clusters formation (Gedminaitė-raudonė et al. 2020). Smart specialisation processes can be embedded into regional partnerships and clusters. Clusters are considered to be an enabler for economic growth, technological advancement and industrialisation. Clusters organisations can indeed support the development of common agenda and joint strategies to create synergies, economies of scale, stimulate markets expansion and higher revenues (OECD 2013). Kenya's agricultural systems can benefit from clusters formation based on the better integration of production capabilities and derive the benefits that accrue from having clusters.

Regional integration catalyses framework conditions, institutionalisation and market access opportunities. It enables various actors to join efforts to draw from knowledge resulting from local and international research and development activities. Regional integration enhances market opportunities, reduces the cost of operation and stimulates investments in knowledge or resources for production. It is indeed instrumental for regions to come together in order to harness the immense opportunities that accrue from integration (UNECA 2016).

Moreover, there is need to build innovative governance structures that are representative of the regional needs and also support cooperation (Ciampi Stancova and Cavicchi 2017). This increases the opportunities to reach out to other markets and to limit farmers' losses di to low domestic demand for instance. Adopting smart specialisation practices in Kenya's agricultural sector will certainly require strong governance structures that are favourable to interregional cooperation, open markets and international trade. It is important to have an outward looking perspective to attract entrepreneurial knowledge with a view of linking emerging markets to local product development (Pires et al. 2014).

Smart specialisation departs from aspects of rural financing policies and places emphasis in supporting sectors through an integrated investment approach which focuses on the specific needs of places. Nonetheless, a challenge lies in identifying various aspects of the local economy and how they interact with indigenous capabilities; a good fit could enable building novel comparative advantages (Pires et al. 2014). Smart specialisation therefore calls for a paradigm shift from individual development to an integrative rural and regional based approach.

4 Conclusion and Further Perspectives

There is no one ideal type of development model for strengthening the competitive position of regions. The case study of Kenya underlined how instrumental is the cooperation between the local authorities, universities alias research institutes and the private sector actors to boost regional economic growth. The case study discusses the various challenges facing the agriculture sector in Kenya and underlines how drawing on novel approach to place-based competitiveness such as smart specialisation can serve in designing policy support that targets a better integration of Kenya's agricultural sector.

Furthermore, in the course of development of modern countries and regions, knowledge, skills, innovation and creativity are gradually gaining the position of the most distinctive and individual resources. This transformation has caused a paradigm shift in thinking about the competitiveness of regions with a greater focus on knowledge and intellectual capital in enterprises. A key concern arising is thus that the range of factors affecting regional competitiveness are not less numerous and can significantly change from one regional economy to another one. Considering in addition that they also differ across development stages of economies and within countries, it becomes even more important for policy practitioners to adopt place-based, outward-looking and dynamic perspectives in designing and implementing policies to make their places more attractive and competitive and to ensure that they remain so.

References

African Union Commission, Agenda 2063: The Africa we want (Popular version)| African Union, (September), pp. 1–24. (2015) doi:978-92-95104-23-5

Ameru JN, Odero D, Kwake A (2018) Towards improving agricultural marketing information systems for smallholder farmers: a Tharaka Nithi case. J Tagricul Sustain 11

Benneworth P, Dassen A (2011) Strengthening global-regional connectivity in regional innovation. OECD Regional Development Working Papers 2011, No 01, s. 22–26

Capello R, Kroll H (2016) From theory to practice in smart specialization strategy: emerging limits and possible future trajectories. Eur Plann Stud 24(8):1393–1406

Cherotich J, Ayuya OI, Sibiko KW (2019) Effect of financial knowledge on performance of women farm enterprises in Kenya. J Agribusiness Dev Emerg Econom 294–311. https://doi.org/10.1108/jadee-06-2018-0083

Ciampi Stancova K, Cavicchi A (2017) Dynamics of smart specialisation agrifood trans-regional cooperation. JRC Tech R. https://doi.org/10.2760/020864

Cooke P (2005[13]) Regionally asymmetric knowledge capabilities and open innovation: exploring globalisation 2—A new model of industry organisation, Research Policy, vol 34

Courlet C (2008) L'économie territoriale. Grenoble, PUG, p 75

da Pires AR et al (2014) Smart specialisation and innovation in rural areas. JRC Tech Rep 9:19. https://doi.org/10.2791/13227

Dosso M, Kleibrink A, Matusiak M (2018) Smart specialisation in sub-saharan Africa: opportunities and challenges, (March). https://doi.org/10.4108/eai.21-3-2018.2275700

Dosso M et al (2017) Research and innovation, in European Commission, JRC, Science for the AU-EU Partnership: building knowledge for sustainable development, EU Publications

Drozdowski T (2004) Wpływ dużych ośrodków miejskich na konkurencyjność regionu, [w:] Wiedza, innowacyjność, przedsiębiorczość a rozwój regionów, red. nauk. A. Jewtuchowicz, Wydawnictwo Uniwersytetu Łódzkiego, Łódź 2004, s. 132

Eurostat (2017) Eurostat regional yearbook 2017 Edition; Publications office of the European Union: Luxembourg. ISBN 978-92-79-71616-4

FAO (2018) ACTIVITY working for zero hunger. p. 20

Fawn R (2009) Regions and their study: wherefrom, what for and whereto? Rev Int Stud 35:5–34. Retrieved January 26, 2020, from http://www.jstor.org/stable/20542776

Ferroni M, Zhou Y (2012) Achievements and challenges in agricultural extension in India. Glob J Emerg Market Econ 4(3):319–346. https://doi.org/10.1177/0974910112460435

Florida R (2008) Who's your city. how the creative economy is making where to live the most important decision of your life, Basic Books, New York 2008, s. 27, in S. Korenik, Region ekonomiczny..., op.cit, s. 15

Foray D (2015) Smart specialisation, opportunities and challenges for regional innovation policy. Routledge, Abingdon (UK) and New York (NY)

Foray D et al (2012) Guide to research and innovation strategies for smart specialisation (RIS3). European Commission, available at http://s3platform.jrc.ec.europa.eu

Gedminaitė-raudonė Ž, Vidickienė D, Vilkė R (2020) Unused potential for smart specialization development through collaboration: Lithuanian case. 2019(10) 463–469

Gianelle C, Kyriakou D, Cohen C, Przeor M (eds) (2016) Implementing smart specialisation: a handbook, Brussels: European commission, EUR 28053 EN. https://doi.org/10.2791/53569

GoK (2017) Executive and growth strategy towards a dustainable agricultural transformation and food security in Kenya—A bridged version. Available at: http://www.kilimo.go.ke/wp-content/uploads/2019/01/Download-here.pdf

Jiménez D et al (2016) From observation to information: Data-driven understanding of on farm yield variation. PLoS ONE 11(3):1–20. https://doi.org/10.1371/journal.pone.0150015

Lengyel I (2004) The pyramid model: enhancing regional competitiveness in Hungary. Acta Oeconomica 54(3):323–342

Lopes J, Farinha L, Ferreira J, Silveira P (2018) Smart specialization policies: innovative performance models from European regions. J Eur Plann Stud 26(11):2114–2124

Lösch A (1938) The nature of economic regions. South Econ J 5(1):71–78. https://doi.org/10.2307/3693804

Masłoń-Oracz A, Proczek M (2017) Klastry a zrównoważony rozwój Unii Europejskiej w świetle inteligentnej specjalizacji na przykładzie Mazowieckiego Klastra Chemicznego (Clusters and the sustainable development of the European Union in terms of the smart specialisation—the case of Mazovian Chemical Cluster). Przemysł Chemiczny 2017

Masłoń-Oracz A, Balkiewicz-Żerek A, Eso A (2018) Global value Chain of clusters enhancing EU competitiveness. In Studia Europejskie—Studies in European Affairs. ISSN: 1428-149X

Mariussen A, Rakhmatullin R, Stanionyte L (2016) Smart Specialisation: Creating Growth Through Trans Cooperation Value Chains. https://doi.org/10.2791/658931

Markowska M, Sokołowski A, Strahl D, Sobolewski M (2015) Dynamic classification of regions of the European union at the NUTS 2 level with regards to sensitivity to the economic crisis in the area of the labour market. HSS 22:37–50

Matusiak M, Kleibrink A (eds) (2018) Supporting an innovation agenda for the western Balkans: tools and methodologies. Publications Office of the European Union, Luxembourg

Mohajan HK (2014) Cite this article: Haradhan Kumar Mohajan. Am J Food Nutr 2(2):28–38. https://doi.org/10.12691/ajfn-2-2-3

Muyanga M, Jayne TS (2014) Effects of rising rural population density on smallholder agriculture in Kenya. Food Policy Elsevier Ltd 48:98–113. https://doi.org/10.1016/j.foodpol.2014.03.001

Mwangi M, Kariuki S (2015) Factors determining adoption of new agricultural technology by smallholder farmers in developing countries. Issn 6(5):2222–1700. Available at: www.iiste.org

Mwema C, Crewett W (2019) Social networks and commercialisation of African indigenous vegetables in Kenya: A cragg's double hurdle approach. Cogent Econom Fin Cogent 7(1):1–15. https://doi.org/10.1080/23322039.2019.1642173

Ndirangu SN, Oyange WA (2019) Analysis of millers in Kenya' s rice value Chain. 12(1):38–47. https://doi.org/10.9790/2380-1201033847

Ngare P, Kweyu M, Huka C (2015) Modelling risk of financing agribusiness in Kenya modelling risk of financing agribusiness in Kenya KBA centre for research on financial markets and policy® Working Paper Series. Available at: https://www.kba.co.ke/downloads/Working Paper WPS-03-15.pdf

Ochieng J, Kirimi L, Mathenge M (2016) Effects of climate variability and change on agricultural production: the case of small scale farmers in Kenya. NJAS—Wageningen J Life Sci R Neth Soc Agric Sci 77(2016):71–78. https://doi.org/10.1016/j.njas.2016.03.005

OECD (2013) Innovation-driven growth in regions: The role of smart specialisation. pp. 1–202. Available at: https://www.oecd.org/innovation/inno/smart-specialisation.pdf

Shearmur R, Bonnet N (2011) Does local technological innovation lead to local development? A policy perspective, regional science policy and practice. vol. 3.3, pp 249–270

Tkaczynski A (2017) Segmentation using two-step cluster analysis. In Segmentation in Social Marketing. Springer: Singapore, pp. 109–125

UNECA, United Nations Economic Commission for Africa (2016) Assessing regional integration in Africa (ARIA VII): innovation. Competitiveness and Regional Integration, United Nations Economic Commission for Africa, Addis Ababa, Ethiopia

UNESC, United Nations Economic and Social Council (2019) High-level segment: ministerial meeting of the high-level political forum on sustainable development, convened under the auspices of the economic and social council; special edition: progress towards the sustainable development goals

Winiarski B (1999) Czynniki konkurencyjności regionów (Regional competitiveness factors), w: Konkurencyjność regionów, red. M. Klamut, Wyd. Akademii Ekonomicznej we Wrocławiu, Wrocław, p. 9

World Bank (2019) Kenya economic update, edition 19, Unbundling the slack in private sector investment transforming agriculture sector productivity and linkages to poverty reduction

A Guideline for Technology Commercialisation in the 4IR Era

Joe Amadi-Echendu

1 Introduction

As a preamble, it pertinent to state that discourse on technology commercialisation may be found under several extant subject areas such as entrepreneurship, innovation management, intellectual property management, knowledge management, new product development, new ventures and entrepreneurship, research and development (R&D), technology and innovation management, science and technology policy, systems of innovation, and related subject matters and topics. In this chapter, we draw from these subject areas and articulate a brief and concise guideline on technology commercialisation intended for both the novice and the experienced practitioner. Therefore, the content of this chapter complements well established discourse on the commercialisation of technology. Our discourse commences by combining intuitive and literary definitions of the terms ‘technology’ and ‘commercialisation’.

1.1 Forms of Technology

‘Technology’ is defined from many perspectives [see, for example, a review by Wahab et al. 2012]. This is because the cross-, multi-, and trans-disciplinary nature of technology conjure up multifarious meanings in different contexts. We learn from history that earliest humans found *ways* and *means* towards satisfying basic needs. They developed techniques, invented and used tools for gathering food, and especially for hunting animals. They devised methods and developed materials for building shelters. As human needs and desires have become increasingly sophisticated (cf:

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Maslow 1943), the ways and means of satisfying the needs and desires have also become increasingly sophisticated. It seems that increased sophistication in the ways and means of satisfying human needs only leads to insatiable desires! In fact, the sequence of industrial revolutions bears testimony to the intertwined and symbiotic transformation of human society and technology.

In the context of this chapter, 'technology' encompasses the *ways* and *means* that extend human abilities, enhance livelihood, and improve living experience of human beings. So *ways* and *means* constitute two primordial forms of technology. A third and more sublime form of technology is inherently embedded in the two basic forms. We refer to this third and implicit form of technology as *knowledge* or *knowhow*. Hence, for the purposes of this discourse on technology commercialisation, we decompose technology into three basic co-existing and complementary forms as illustrated in Fig. 1.

- Form 1—'*ways*' translate into methods, processes, and techniques plus inherent knowledge of how to apply method/process/technique to doing something.
- Form 2—'*means*' translate into tangible physical artefacts plus inherent knowledge of how to use the artefacts to do something.
- Form 3—'*knowledge*' of how to do something, and the *knowhow* may be tacit or explicit.

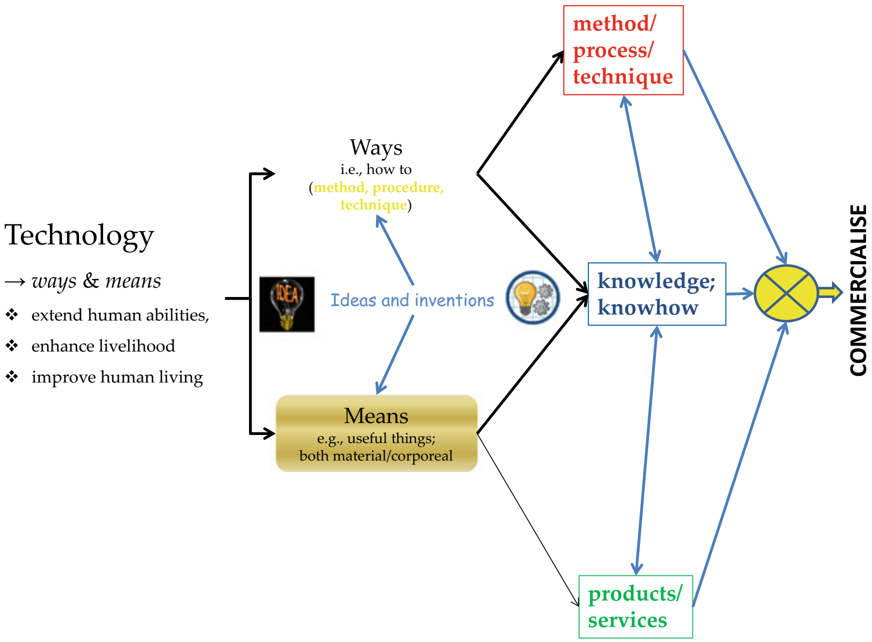

Fig. 1 Forms of 'technology'

Form 2 is better visualised in terms of products[1] and services. For instance, an aircraft provides the means to satisfy human desire to travel by air. An aircraft is manufactured as a product, while an airline operator uses aircraft to provide the service of air travel. Interestingly, in the modern era, a personal gadget like a mobile phone combines many 'technologies', thus making it possible to deliver a range of services well beyond satisfying the preliminary human desire to communicate. In fact, it is arguable that in the era of fourth industrial revolution (4IR) with corresponding trends in globalisation and globalism, commercialisation seems to be more about finding new combinations of many original technologies in order to provide solutions to seemingly insatiable human needs and desires.

1.2 Commercialisation

Although 'commercialisation' is also defined from many perspectives, however, the central tenet is commercial success which, in general, tends to be narrowly characterised by, or measured only in terms of financial gain. In this chapter, we shall adopt the definition that commercialisation is 'the process of transforming ideas, knowledge and inventions into greater wealth for individuals, businesses, and society at large[2]' (re: Australian Government 2003). This viewpoint allows us to redefine commercialisation in terms of the wider ethos of value well beyond the narrow focus on financial gain. The value ethos is inherent to the commercialisation of the various forms of technology. After all, why should anyone gain from *ways* and *means* (i.e., technologies) that do not extend human capabilities, or that do not enhance human livelihood, or that do not improve the lived experience of human beings? This does not vitiate the fact that there are positive and negative consequences of technology, that is, that technology may be commercialised for purposes that raise ethical issues. The discourse surrounding the commercialisation of somatic cell nuclear transfer (SCNT) or 'cloning' technology (cf: Lee et al. 2016) provides a good example of ethical concerns.

1.3 Outline of the Chapter

The rest of this chapter includes brief discourse on.

- commercialisation theory in terms of
  - innovativeness and commercialisation potential,
  - systems of innovation and commercialisation models;

[1] See extant literature on New Product Development for extensive discourse on the commercialisation of products.

[2] 'Society at large' encompasses human society and the natural environment.

- commercialisation practice in terms of
  - the entrepreneurial process coupled with
  - commercialisation knowledge areas and enablers; and
  - routes to market.

The chapter concludes with remarks postulating that commercialisation will increasingly involve the conflation of technologies directed towards instant gratification of human life styles.

2 Commercialisation Potential and Systems of Innovation

It is common practice to discuss technology commercialisation within the parlance of innovation,[3] albeit that the term gives rise to a range of ambiguities and different meanings to different disciplines and persons. In fact, *ways* and *means* (i.e., technologies) that extend human abilities, enhance livelihood, and improve living experience should inherently feature some element of *newness* or innovativeness. Notwithstanding the various meanings, there is a common understanding that innovation involves the creation and delivery of value in a manner that must not only motivate enterprise but also, must provide positive returns to sustain enterprise. After all, the goal of enterprise is to enhance human livelihood, extend human capabilities, and improve the living experience of human beings.

2.1 Commercialisation Potential

Innovativeness or ability to innovate is an inherent feature of technology (Bubou and Amadi-Echendu 2013), while commercialisation forms part and parcel of, and characterises innovation. That is, commercialisation is a process that not only demonstrates the ability to innovate but also, results in the realisation of innovation. Conceptually, an innovation index or the potential for commercialisation may be expressed as:

$$\text{Commercialisation potential, (CP)} = \frac{\text{value}}{\text{cost} * \text{time}} \tag{1}$$

[3]*Innovation is the process of turning new ideas into value, in the form of new products, services, or ways of doing things. It is deceptively complex, and goes beyond mere creativity and invention to include the practical steps necessary for adoption. New innovations tend to build on earlier versions and, in turn, to lay foundations for others. It is now widely accepted that innovation fuels the majority of the world's long-term productivity and economic growth—and that innovative firms significantly outperform non-innovators, in terms of both revenue and employment growth*—World Economic Forum.

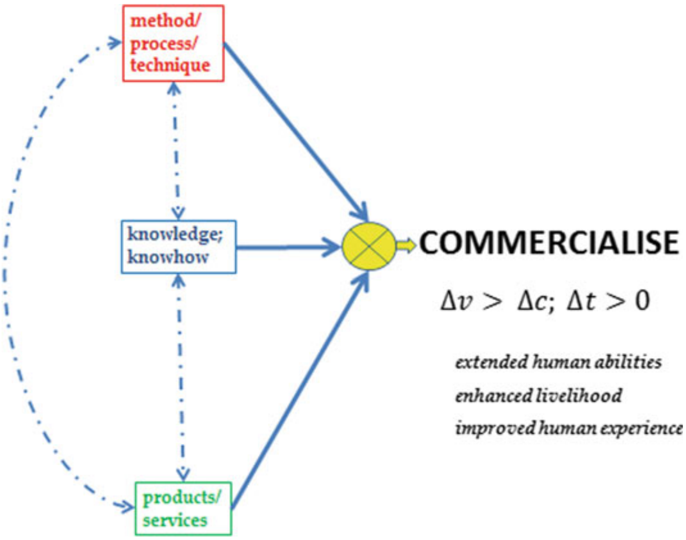

Fig. 2 Commercialisable forms of technology

In this expression, value may be defined either quantitatively, or qualitatively, or both. In the paradigm of commerce and economics, value and cost are both characteristically stated as financial quantities, i.e., in monetary terms. In socio-political paradigm, both value and cost contain quantitative and qualitative parameters such that commercialisation extends beyond pure financial gain. Often, the socio-political paradigm requires that technology should be commercialised for the so-called 'greater public good'. Paradoxically, the metrics for 'public good'[4] can be extremely fuzzy, and this presents an interesting conundrum for the 'social entrepreneur' and for policy makers.

Both value and cost are functions of time, therefore Eq. 1 can be restated as:

$$\mathrm{CP}(t) = \frac{v(t)}{c(t) * \text{time}};\ \mathrm{CP}_{t_2-t_1} = \frac{v_2 - v_1}{(c_2 - c_1) * (t_2 - t_1)};\ \mathrm{CP} \triangleq \frac{\Delta v}{\Delta c * \Delta t} \quad (2)$$

Focusing on the last part of Eq. 2, the first issue is that, to be innovative, the process of commercialisation must create new value (Δv) within a given cost regime (Δc) and time frame (Δt). This implies that any technology to be commercialised must offer new value ($\Delta v > 0$) that corresponds to, and results in the extension of human capabilities, and/or enhancement of livelihood, and/or the improvement of living experience (see Fig. 2).

The second issue is a paradox because the creation of value comes at a cost, that is, Δv is correlated to Δc. For success, the cost of commercialising technology must be bounded ($\Delta c \leq \Delta v$) so as not to demotivate enterprise, diminish or vitiate the

[4] *Good or service that provides non-excludable and non-rival benefits to all people in the population.*

new value, or even eliminate enterprise altogether. Thirdly, there is a time frame or window of opportunity (Δt) for commercialisation to succeed. In short, there has to be a real need!

Suppose Δv equals Δc, i.e., strictly correlated, then, the potential for commercialisation is solely determined by the time window of opportunity. Although such situation may not readily appeal to private sector enterprise where the motivation is financial gain, however, it may pertain to public sector enterprise to commercialise the technology for the public good. In fact, the essence of commercialising the technology for public good could create an environment for private sector enterprise to flourish. Take for example, public sector commercialisation of technology that lowers or removes barriers that encourage private sector participation in highly competitive global markets.

The scenario where Δc perfectly tracks Δv presents very interesting challenges and conundrums for policy makers. Such policy issues are discussed throughout this book. Thus, it is appropriate here to consider the influence of the systems of innovation concept on the commercialisation of technology.

2.2 Systems of Innovation

It is widely acknowledged (e.g., Manzini, 2012) that the systems of innovation (SI) concept gained prominence sequel to Freeman (1982). A notable and significant antecedent to the SI concept is the 1962 OECD Working Party of National Experts on Science and Technology Indicators. The outcome resulted in the wide adoption of the OECD Frascati guidelines for collecting, measuring, and reporting scientific, technological and innovation activities (OECD Frascati Manual 2015). Another important antecedent is the United States Bayh-Dole Act (1980) dealing with intellectual property arising from publicly funded research. Edquist (1997) presented an overview and assessment of the SI concept which is still relevant and instructive. The SI concept is typically used to characterise the fostering of innovation, or more precisely, to encourage the commercialisation of technology.

As an extension of the SI concept, the 'national system of innovation' (NSI) construct has been defined as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies". This definition is common from the policy viewpoint as it characterises a country's collective effort to organise and holistically integrate science and technology endeavour towards economic and socio-political development. This stems from the notion that science and technology endeavour as formalised through educational and research institutions, or from other actors within a country, region or sector, result in ideas and inventions, or better still, in technologies that should be commercialised to create economic and social prosperity. The notion has long been strengthened by the wide adoption of the aforementioned and standardised application of OECD Frascati guidelines for collecting, measuring and reporting scientific, technological, and innovation activities.

The SI/NSI construct influences technology commercialisation. An understanding of the network of interrelationships between SI/NSI actors, agents and institutions in both the public and private sectors is vital for successful commercialisation of technology (e.g., van Zyl et a. 2007; Kirchberger and Pohl 2016). The network of interrelationships between SI/NSI actors, agents and institutions accentuates access to complementary resources that are crucial for the commercialisation of technology. In essence, the SI/NSI construct more or less conceptualises how the market interfaces with the network of interrelationships between actors, agents and institutions that facilitate the commercialisation of technology. The emphasis here is that the market predominantly determines the parameters of value, cost, and time. Therefore, technology commercialisation essentially involves a determination of the normative distance between the technology and the market (Amadi-Echendu and Abanum 2012). This normative distance shall be explained in terms of commercialisation models and framework discussed as follows.

3 Commercialisation Models: The TAPM Framework

The terms 'model' and 'framework' are used here as theoretical representations or depictions of a process that can only be actualised through practice. Thus, at best, the models and framework discussed herein illustrate how the commercialisation process may be imitated.

3.1 Commercialisation Models

Discussion of commercialisation models often dovetails towards activities of research and development (R&D) actors, agents, and institutions. This is more or less a policy tradition which derives from the OECD Frascati Manual definition of R&D as "creative and systematic work undertaken in order to increase the stock of knowledge—including knowledge of humankind, culture and society—and to devise new applications of available knowledge." By convention, the policy driven or R&D heuristic approach promotes linear transformation of ideas and/or knowledge into commercialisable products and/or services (see, for example, Amadi-Echendu and Alan 2008; Dorf and Worthington, 1987; Kelm et al. 1995). Whereas the policy driven approach largely created two patterns, however, empirical evidence indicates that there are at least three paradigms for commercialising technology, viz:

- *Market-pull*—where the technology commercialisation process commences with establishing the market need. This paradigm is perceived as the purview of the classical entrepreneur endowed with entrepreneurial flair (cf: Baron 1998), the cliché being that classical entrepreneurs possess special or instinctive aptitudes or ability to identify opportunities in the market space.

- *Technology-push*—where the commercialization process tends to focus on marketing what the technology can do. This paradigm tends to be the purview of the 'techpreneur' searching for the 'capable' technology to be accepted by the market. A contrary and arguable cliché is that the 'techpreneur' generally lacks entrepreneurial flair.
- *Functional paradigm*—this combines market-pull and technology-push, and should be the purview of most current generation entrepreneurs who are supposed to be 'tech-savvy', linked, networked, market-intelligent, and market-oriented. The functional paradigm demands concurrent development and exploitation of existing linkages and networks between actors, agents, and institutions so that the commercialization activities and functions are performed as necessary to track the vagarious nature of the value ethos. The functional paradigm is accentuated by 4IR technologies and new business models that are stimulated, triggered and fostered by trends in globalisation and globalism. The point is that the commercialisation of technology cannot be isolated from trends in globalisation and globalism because these macro factors exert extraneous influence on the variables shown earlier in Eqs. 1 and 2.

3.2 TAPM Framework

We adopt the functional paradigm to describe the ***t***echnology-***a***pplication-***p***roduct/service-***m***arket (TAPM) framework as illustrated in Fig. 3 (see also, Amadi-Echendu and Rasetlola 2011).

In the market-pull paradigm, the TAPM commercialisation process commences with evaluation of the conceived product/service configuration against the verifiable need. A verified need refers to the situation where there is proof that $\Delta v > 0$. The conception of the product/service configuration should be based on validated applications of combinations of complementary technologies which, in turn, must include the unique feature(s) of the particular technology(ies) selected. This implies estimating Δc within an acceptable Δt. On the one hand, the market-pull paradigm demands backward integration of functions and activities (i.e., technology management) implicit in the TAPM framework in order to provide credible estimates of Δv, Δc, and Δt.

On the other hand, in the technology-push paradigm, the TAPM commercialisation process stimulates forward integration of activities and functions. The process requires searching for the market that will provide the highest demand ($\Delta v \gg \Delta c$) for the candidate technology, i.e., searching for the need that will result in the highest level of technology acceptance. This process must also yield estimates of Δv within confidence limits that correspond to acceptable Δc and Δt.

The significance of the TAPM framework is that it facilitates determination of the normative distance between the technology and the market. Firstly, the TAPM framework presumes the existence of technology (in any of its forms, and stages

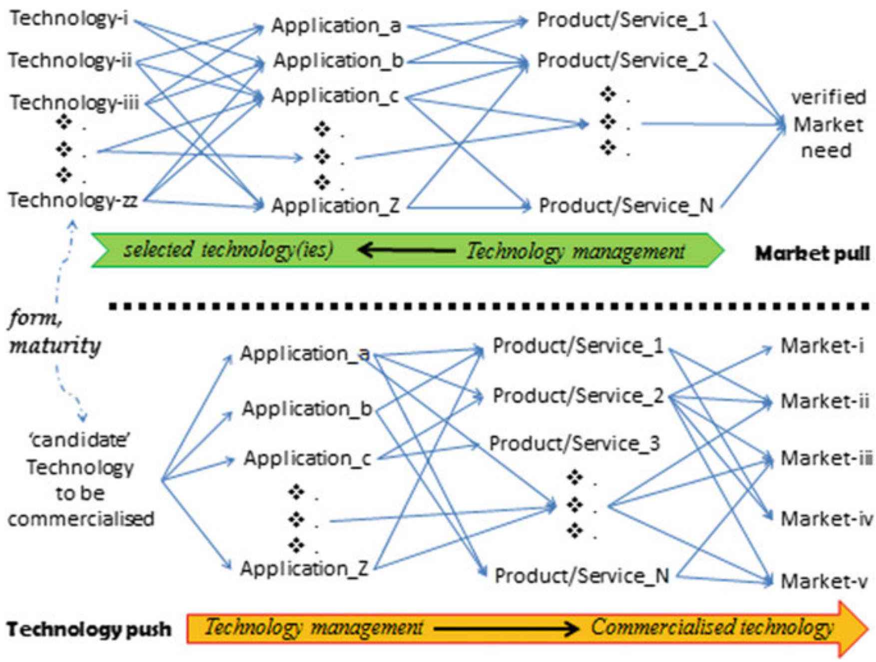

Fig. 3 TAPM framework for commercialisation

of maturity[5]). Secondly, the framework also assumes the existence of verifiable market need. Based on these two hypotheses, then, the primary challenge becomes how to package candidate or selected technology(ies) towards satisfying verified need(s). In essence, the functional paradigm demands that the verification of needs is symbiotically intertwined with development of candidate technology(ies).

4 Commercialisation Practice

In this section, we discuss some of the structural components or enablers implicit in the aforementioned paradigms and framework such as entrepreneurship, knowledge areas, and routes to market.

[5] *So called "s-curve" depicting performance of the technology against time.*

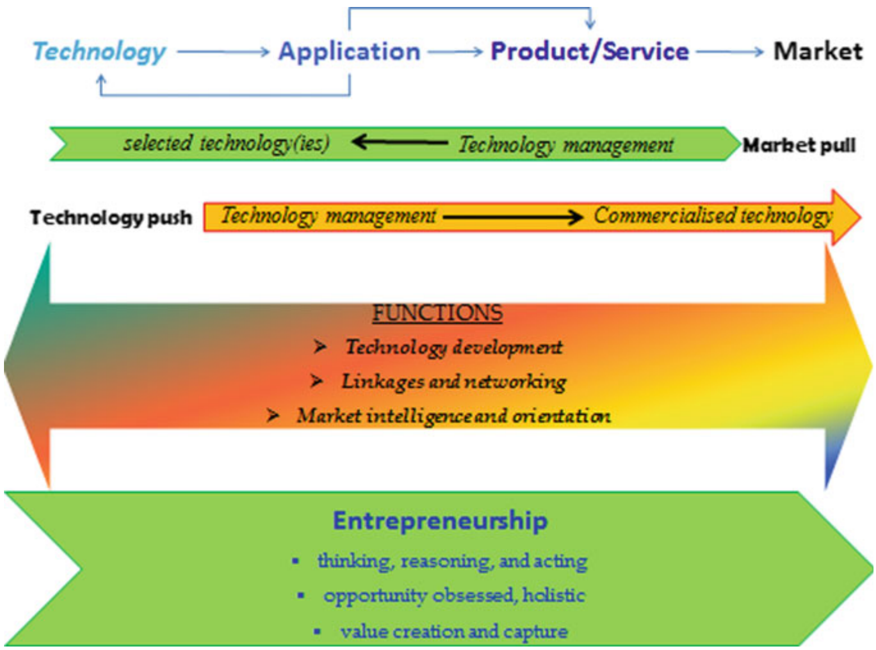

Fig. 4 TAPM framework and entrepreneurship

4.1 *Entrepreneurship*

Quoting Timmons and Spinelli (2009), "entrepreneurship is a way of thinking, reasoning, and acting that is opportunity obsessed, holistic in approach, and leadership [based on balancing risks] for the purpose of value creation and capture." As illustrated in Fig. 4, the TAPM provides a framework for the breed of entrepreneurs who must be (i) 'tech-savvy', (ii) linked, (iii) networked, (iv) market-intelligent, and (v) market-oriented. This brand of entrepreneurship[6] is vital in the era of 4IR technologies, pervasive globalisation and globalism.

Activities underpinning market orientation and intelligence, linking and networking of actors, agents and institutions, and technology development must be rapidly and concurrently performed so as to increase the likelihood of commercialisation success (Otejere and Amadi-Echendu 2015). Market-pull is established through intelligence and orientation activities while technology acumen and associated development activities provide the push. Activities which connect the actors, agents and institutions also establish linkages and networks that stimulate, facilitate and support 'techpreneurship' and the entrepreneurial process.

[6]*The capacity and willingness to develop, organize and manage a business venture along with any of its risks in order to make a profit. Entrepreneurial spirit is characterized by innovation and risk-taking, and is an essential part of ability to succeed in an ever changing and increasingly competitive global marketplace.*

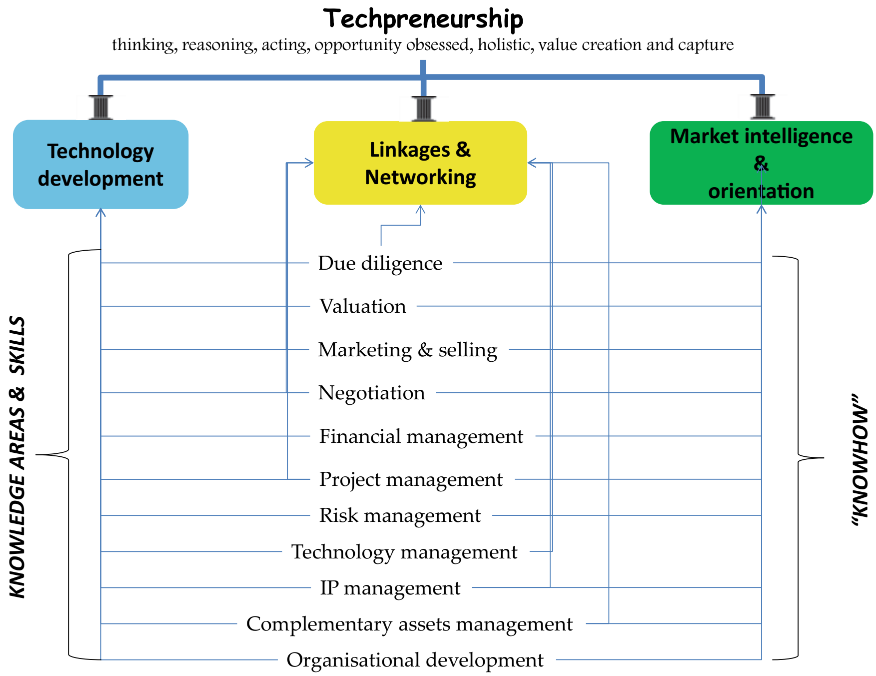

Fig. 5 Pertinent skills and knowledge areas for technology commercialisation

Each task or activity is underpinned by several areas or fields of knowledge, therefore, from an academic viewpoint, technology commercialisation inherently involves multidisciplinary endeavour. Thus, the entrepreneurial process demands a team composed of complementary skills to rapidly perform the concurrent functions, tasks, and activities necessary to commercialise technology. Some of the pertinent skills and knowledge areas are briefly itemised.

4.2 Knowledge Areas for Commercialisation

Given that technology commercialisation is multidisciplinary in nature, there are many knowledge areas, skills, and competencies required; thus the attempt here is to highlight a few of the pertinent knowledge areas and enablers, or better still, what might be regarded as high level team competencies.

First, it is vital that the team has capability to conduct due diligence[7] across the three broad functional areas depicted in Fig. 5. Second, the team must be able to

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[7] *…reasonable steps taken by a legal person in order to establish claims, rights and privileges, especially before entering into an agreement or contract with another party, or an act within a legally certain standard of care.*

conduct valuation across the three functional areas in order to determine/estimate both the qualitative and quantitative aspects of value encapsulated within the technology commercialisation process.

Third, the process of technology commercialisation involves more than one person or legal entity, therefore, the ability to negotiate is a paramount skill that the team must possess. In the fourth instance, it is equally vital that the team possesses marketing and selling skills, not only to create awareness and publicity but also, to explain the commercialisation value proposition succinctly.

For the purposes of this chapter, it is useful to highlight some academic compartmentalisations of the extensive body of knowledge that is intrinsic to technology commercialisation. Whilst acknowledging that the aforementioned skills areas also depend on knowledge of respective academic disciplines, however, conventional disciplines include financial, project, risk, and technology management, as well as organisational development.

Financial management knowledge is required at least to determine and control Δc succinctly and to provide credible estimation of Δv. Matters such as cost of capital, capital allowances and taxation regulations need to be given due consideration. Project management knowledge is required, at least to order and track the sequence of tasks and activities to be carried to commercialise technology, so as to provide better estimation and management of Δt.

Commercialisation happens within the realm of uncertainties, risks and opportunities. Therefore, identification of sources of risks, as well as mitigation and treatment of risks are vital to commercialisation team capabilities, and should result in improved estimation of the parameters of the commercialisation potential. At least, the team should be able to carry out technology management activities such as scanning, forecasting, and roadmapping.

The formation of the commercialisation team and sustenance of team dynamics requires knowledge of how organisations learn and evolve. It is important that the entrepreneurial team should be able to conflate necessary knowledge areas from the many disciplines that are intrinsic to technology commercialisation. The ability of the team to synergise the complementary knowledge areas and skills increases assurance of the choice of the route to successful commercialisation.

4.3 Commercialisation: Routes to Market

With regard to routes to market, there are three unique areas of knowledge that may be specifically highlighted as follows. These are (i) technology transfer mechanisms and modalities, (ii) intellectual property (IP) management, and (iii) complementary assets management.

First, commercialisation invariably involves the transfer of technology in any form, or combinations of the forms discussed earlier. Therefore, an understanding of the mechanisms and modalities of transferring the forms of technology is crucial to the commercialisation process. For example, training is a classic mechanism for technology transfer. The challenge is to determine how much or what aspect of the technology must be confidentially transferred during training in order to facilitate the commercialisation process. This challenge applies to any other mechanism and modality of technology transfer.

Second, IP management generally deals with issues such as confidentiality, invention disclosure, patenting, material transfer agreement, legal assignment, licensing, commission, royalty, and similar concerns that are usually embodied in contractual arrangements. IP management is strongly emphasised from the policy approach as a route to commercialise technology arising from *apriori* investment in R&D. In this regard, licensing tends to be a prominent route to market in both technology-push and market-pull paradigms. On the one hand, an existing firm with strong market presence may wish to outsource and licence an emerging technology to increase market presence and strengthen its competitive position. On the other hand, a technology developer may desire to outsource access to the range of complementary assets (resources) necessary to ensure that maximum value is realised and appropriated from the technology that is being commercialised.

It can be argued that the form of technology coupled with requisite complementary assets (i.e., intangible and tangible resources) primarily determine the commercialisation route to market. For example, the risk appetite of a commercialisation team will be influenced by the range of complimentary assets that the team can access. Consider a situation where the commercialisation team has very limited access to the range of complementary assets that are necessary to realise maximum value from the technology to be commercialised; and, suppose that commercialisation is initiated from the technology-push paradigm; then, it seems logical that to minimize the normative distance to market, the team should first search for areas where the candidate technology can be applied. In terms the TAPM framework, this translates into a business concept phase of the commercialisation process (see Fig. 6). Where there is access to internal complementary assets in relation to a particular area of application of the technology, the team may wish to start-up a business, or better still proceed to the full commercial phase, especially if the risks are manageable and the candidate technology proffers high growth opportunities. In general, technologies that exist in the form of product/service are regarded as near-market whereas so-called early stage technologies are often regarded as high risk from a market stance. The TAPM framework shows that the entrepreneurial team capabilities and concomitant organisational development should evolve through the business concept, start-up, and commercial phases.

A crucial matter about routes to market relates to how to apportion value from the commercialisation process. This issue, in conjunction with the mechanism and modality of technology transfer, IP regime, and access to complementary assets leads to other options or routes to market such as (i) franchising, (ii) management contracting, (iii) joint venturing, (iv) strategic alliancing, and (v) selling-off IP. Having mentioned licensing earlier, the significant challenge is to evaluate each option whilst considering that a hybrid of options may be feasible.

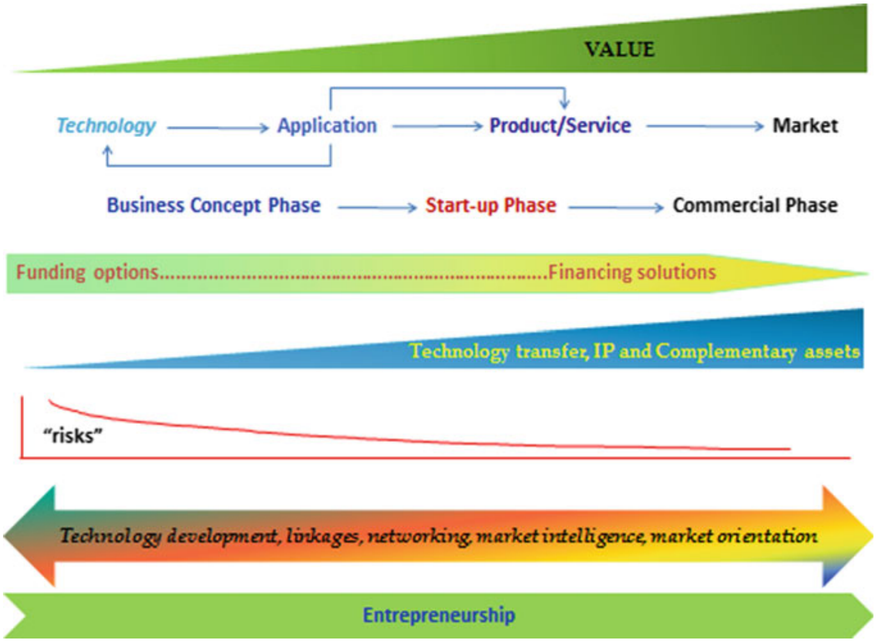

Fig. 6 Technology commercialisation and business development

5 Concluding Remarks

In this chapter, we have defined technology primordially as the *ways* and *means* that extend human abilities, enhance livelihood, and improve living experience of human beings. Also, we have adopted the value ethos to define commercialisation as a process that encompasses the packaging of one or more 'candidate' technologies towards satisfying human needs and desires in a manner that not only creates greater wealth for individuals and businesses but also, leads to sustainable development of society at large. Furthermore, we have posited commercialisation potential, TAPM framework and entrepreneurship as theoretical and philosophical foundations for the commercialisation of technology.

In reiterating the widely acknowledged paradigms of *market-pull* and *technology-push*, we have stated three categories of concurrent commercialisation functions as (i) technology development, (ii) linking and networking, and (iii) market intelligence and orientation. *Techpreneurs* of the 4IR era need to possess T-shaped knowledge[8] with interdisciplinary capabilities (cf: Amadi-Echendu 2007; Gwata 2019). Given that technology commercialisation is multidisciplinary in nature, we have emphasised a team approach whilst highlighting some crucial knowledge areas, skills, and competencies that may provide assurance towards success.

[8] *T-shaped person—one who has in-depth knowledge of a specific field, with sufficient knowledge in other fields outside her own specialisation.*

It is worth emphasising that every commercialisation process is peculiar (Amadi-Echendu and Mngadi 2015), so there is no magic wand that guarantees success. However, based on empirical evidence garnered from practitioners, we reiterate that the *market-pull* paradigm should be preferred over the *technology-push* paradigm in order to minimize the normative distance between technology and market. After all, if there is no need ab initio (i.e., if $\Delta v \leq 0$ in a quantitative sense), there is no motivation since no one will be willing to pay for technology commercialisation, let alone sustain the associated enterprise. The era of third industrial revolution gave rise to massive integration of technology into business and society, and further highlighted the social good tenet. This meant that commercialisation could no longer be measured only via the quantitatively narrow lens of financial gain.

We posit that the value ethos which promotes both financial gain and public good increasingly drives technology commercialisation in this era of 4IR and corresponding globalisation and globalism. Thus, an optimistic proposition is that commercialisation should be about the conflation of technologies that not only continue to improve business efficiencies and reduce the costs of goods and services but also, successful conflation of technologies must concomitantly and sustainably improve quality of human life styles for all members of society.

Policy making with regard to technology commercialisation has conventionally followed the SI concept and OECD Frascati approach where significant emphasis is placed on R&D expenditure particularly by public sector institutions and corporate businesses. Since the dawn of the third industrial revolution, commercialisation of technology has largely become the purview of small, medium and micro enterprises. It is generally acknowledged (cf: Solow 1956; OECD 2017) that this trend will increase well beyond the current era of 4IR, globalisation and globalism. The techpreneurship functions of technology development, linking and networking, plus market intelligence and orientation encapsulated in the TAPM framework allude to three paradigms for policy making and interventions, viz: market-pull, technology-push and functional paradigms. First, policy interventions based on the technology-push paradigm need to focus on avoiding, minimising or mitigating risk. Second, policy interventions based on the market-pull paradigm need to focus on maximising value. Third, policy interventions based on the functional paradigm need to balance value against risk.

References

Amadi-Echendu JE (2007) Thinking styles for technology management in the innovation, knowledge and learning economy paradigm. Technol Forecast Soc Chang 74(2007):1204–1214

Amadi-Echendu JE, Alan J (2008) On the commercialisation of "trailing" knowledge and intellectual property. In: Proceedings of PICMET'08, Cape Town South Africa, July 28–Aug 1, 2008

Amadi-Echendu JE, Rasetlola TR (2011) Technology commercialization factors, frameworks and models. https://doi.org/10.1109/ITMC.2011.5995939

Amadi-Echendu JE, Abanum NF (2012) On commercial exploitation of indigenous technology in developing countries. In: Proceedings of IEEE ITMC 2012, Dallas Texas USA 24–27 June 2012
Amadi-Echendu JE, Mngadi MF (2015) An examination of success criteria for technology-based start-ups in South Africa. In: Proceedings of IEEE TEMS-ICE, Belfast, Northern Ireland, 22–24 June 2015
Australian Government (2003) Mapping Australian science and innovation: main report, p 37
Baron RA (1998) Cognitive mechanisms in entrepreneurship: why and when entrepreneurs think differently than other people. J Bus Ventur 13(4):275–294
Bayh–Dole Act or Patent and Trademark Law Amendments Act (Pub. L. 96–517, 12 Dec 1980)
Bubou GM, Amadi-Echendu JE (2013) Measuring innovativeness of petroleum firms. In: Proceeding of XXIV ISPIM conference, Helsinki Finland, 16–19 June 2013
Dorf RC, Worthington KKF (1987) Models for commercialization of technology from universities and research laboratories. J Technol Transfer 12:1. https://doi.org/10.1007/BF02371357
Edquist C (1997) Systems of innovation: perspectives and challenges. In: Fagerberg, Mowery (eds) The Oxford handbook of innovation. https://doi.org/10.1093/oefordhb/9780199286805.003.0007
Freeman C (1982) The economics of industrial innovation, 2nd edn. Francis Pinter, London
Gwata M (2019) "The future employee will be an entrepreneur" We need to reconfigure our perception of education, employment and entrepreneurship. An article in World Economic Forum blog, 9 Aug 2019
Kelm KM, Narayanan VK, Pinches GE (1995) Shareholder value creation during R&D innovation and commercialization stages. Acad Manag J 38 (3), 770–786
Kirchberger MA, Pohl L (2016) (2016) Technology commercialization: a literature review of success factors and antecedents across different contexts. J Technol Transf 41:1077–1112
Lee JE, Chung YG, Eum JH, Lee Y, Lee DR (2016) An efficient SCNT technology for the establishment of personalized and public human pluripotent stem cell banks. BMB Rep 49(4):197–198
Manzini ST (2012) The national system of innovation concept: an ontological review and critique. S Afr J Sci 108(9/10), Art. #1038, 7 pages. https://doi.org/10.4102/sajs.v108i9/10.1038
Maslow AH (1943) A theory of human motivation. Psychol Rev 50:370–396
OECD Frascati Manual (2015) Guidelines for collecting and reporting data on research and experimental development, The Measurement of Scientific, Technological and Innovation Activities. OECD Publishing Paris. https://doi.org/10.1787/9789264239012-en
OECD (2017) Enhancing the contributions of SMEs in a global and digitalised economy
Otejere JA, Amadi-Echendu JE (2015) A study on innovation activities of SMEs in a developing country. In: Proceeding 13th Globelics, Havana, Cuba, 23–25 Sept 2015
Solow RM (1956) A contribution to the theory of economic growth. Q J Econ 70 (1), 65–94
Timmons JA, Spinelli S (2009) New venture creation: entrepreneurship for the 21st century. McGraw-Hill Education. ISBN 9780073381558
van Zyl A, Amadi-Echendu JE, Bothma TJD (2007) Nine drivers of knowledge transfer between universities and industry R&D partners in South Africa. SA J Info Management 9 (1) 2007
Wahab SA, Rose RC, Osman SIW (2012) (2012) Defining the concepts of technology and technology transfer: a literature analysis. Int Bus Res 5(1):61–71

New Entrepreneurial Narratives in Urban West Africa: Case Studies of Five Innovation Hubs and Communities

Mafini Dosso, Fatima Braoulé Méïté, Gilles Ametepe, Cyriac Gbogou, Gildas Guiella, and Daniel Oulaï

1 Background: The Rise of Technology and Innovation Hubs Across Urban Africa

1.1 Mapping the Rise of Technology and Innovation Hubs

The rise of innovation hubs and communities in Africa is increasingly being monitored (infoDev 2014; IST-Africa 2014; Firestone and Kelly 2016; Liotard 2019 and references; Briter Bridges, GSMA Ecosystem Accelerator programme, World Bank's

This chapter builds upon original contributions from early founders of youth-led innovation hubs in West Africa. As a pioneering initiative, it aims at bringing West Africa's youth voices and bottom up perspectives on the dynamics of their own innovation micro-ecosystems. It carries the optimistic ambitions and the new narratives that accompany their actions and social missions in favour of prosperous and inclusive development and digital transformation of their communities.

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blogs).[1] The following sub-sections synthetise the findings from these prior mapping and evidence on the dynamics of African tech hubs' and the rapid changes observed mainly in urban technology ecosystems.

The latest survey of Briter Bridges and GSMA Ecosystem Accelerator program (2019) records more than six hundreds active technology hubs on the continent; that is about twice the number in 2016. Under the term *tech hubs*, the authors refer to the active organisations that provide facilities, financial, or in-kind support to tech-entrepreneurs or tech start-ups. The mapping thus adopts a broad definition and covers incubators, accelerators, co-working spaces, digital fabrication laboratories (fablabs), maker spaces, hacker spaces, technology parks and other types of innovation centres or communities. They are considered active if they can demonstrate digital presence through websites, news or social events on a given time period (Briter Bridges and GSMA 2019, GSMA 2016, 2018).

Earlier analysis by Firestone and Kelly (2016) already underlines the contrast between the high potential of tech hubs for jobs creation and their social impacts and, yet the great disparities that exist between tech hubs or alike in terms of failure and success rates. Their societal impacts can be much more important than what can eventually be monitored in terms of economic successes; the majority of hubs surveyed are civil society-led ones, which co-exist with hubs mainly relying on government support (funding and or organizational support) or spaces that are located within or led by universities. Amid the fast-evolving entrepreneurial and business ecosystems[2] in Africa, key structuring trends seem to shape the emergence and development of tech and innovation hubs. The surge in funding for African tech start-ups and the increased support to innovation ecosystem and skills building mainly from international development organisations, donors, non-governmental organisations, venture and development funds and large African and international companies (AfriLabs and Briter Bridges 2019; see also African venture capital figures in Partech Africa Team 2020). Among corporate actors, the largest mobile and internet operators on the continent are represented as well as global tech giants together with a few large and more traditional companies. In addition of access to funding, these actors have significantly contributed to the development of local innovation ecosystems for instance by providing access to Information Technology (IT) infrastructure, tools and services, access to international knowledge and networks, training, mentoring and networking programs and digital platforms.

Several partnerships bringing together actors from the public and private sectors' and the civil society are emerging at the country, continental and international levels. Coordination is also more visible across the continent with the emergence of alliances, hubs, innovation and entrepreneurial networks, joint initiatives and

[1] Original map at https://pubdocs.worldbank.org/en/652861444073319429/AFC41639-9-25-15.pdf (access February 2020).

[2] Here the term 'entrepreneurial or business ecosystem' refers in general to the urban and sub-urban dimension, for instance of economic and innovation activities, interactions between actors and socio-institutional environment. A generic definition by Audretsch et al. (2019): "…organized attempts to establish environments that are conducive to increasing the success for newly established ventures". See the article for a discussion of the origin of the term and academic debates on its meaning.

regular social gatherings (AfriLabs and Briter Bridges 2019, World Bank's blog 2017, 2018a, GSMA 2016–2018). AfriLabs is such an example of a pan-African network of technology and innovation hubs, which registers to date more than 200 member hubs originating from 46 countries. The network promotes entrepreneurship in all its form and offers a unique interactive platform to bring Africa-tailored solutions and technologies for tackling the challenges of sustainable development. Another pioneering network in french-speaking countries is the social change hub Jokkolabs, born in Dakar (Senegal). Since 2010, the membership has been extended to twelve innovation spaces from West Africa—Benin, Burkina Faso, Côte d'Ivoire, Gambia, Mali, Senegal—, to Cameroon, Morocco and France, to this date. All spaces adhere to Jokkolabs's co-working manifesto. In addition of these networking organizations, a few pilot programs and initiatives such as Afric'innov and Bond'innov funded by the Agence Française de Development (AFD) and the FabLab Network are also very active for the development of global North-global South's incubators and start-ups promotion networks.[3]

Networks of tech and innovation hubs and start-ups are also consolidating their efforts, becoming more pro-active towards the policy agenda. One of the well-known initiatives, i4Policy provides an African platform for bottom-up and participatory approaches to public policy reforms at the national and regional levels. In May 2018, the *African Innovation Policy Manifesto* is co-created and a recent revision is under consultation at the continental level. The recommendations of i4Policy refer both to the general principles of better governance and public policy and to thematic areas such as infrastructure; education, research and development (R&D); multidisciplinary public spaces; ease of doing business; finance for innovation and entrepreneurship; local and pan-African cultures products and markets; intellectual property rights; and taxation systems.[4]

"…over 150 hubs seem to have shut down operations since 2016" (Briter Bridges and GSMA 2019). These burgeoning dynamics on the continent raise the issue of the sustainability of tech hubs' business models and that of their role in the broader entrepreneurial and business systems at the national and local levels. The eventual causes for failures are multiple and include the lack of professionalism, the low maturity and diversity of the business models, the misalignment between organisational goals and the capabilities or business structures, between the goals and the needs of the operational environment or with local societal needs (Firestone and Kelly 2016; World Bank blog 2018b; Briter Bridges and GSMA 2019). In addition to these, some hubs remain relatively isolated and often lack access to basic tools, to adequate facilities or are facing frequent infrastructure shortages. In this context, partnerships

[3]See details about AfriLabs: https://www.afrilabs.com/; Jokkolabs at https://www.jokkolabs.net/a-propos; Afric'innov: https://www.africinnov.com/fr and Bond'innov: https://bondinnov.com/ (Access: May 2020). The World Bank joined Afric'Innov's steering committee as an observer member (see World Bank's blog 2018b).

Fablab Network: https://www.fablabs.io/ (Access: May 2020).

[4]See i4Policy's document in consultation at https://i4policy.org/documents/1 (Access: May 2020).

with governments, companies and universities can help overcoming some important shortages, while also enabling greater ties to the broader learning and business ecosystems.

1.2 New Urban Tech Narratives in West Africa

Across West Africa's major cities such as—Abidjan, Accra, Bamako, Dakar, Lagos and Ouagadougou—the new entrepreneurial communities and networks are reshaping the region's technology and innovation ecosystems. They are holding the pen and are writing new urban and rural community narratives across Africa. They prompt new local and continental dynamics and significant signals of fast-emerging cross-borders platforms are visible, thanks to the advent and adoption of digital technologies and a greater access to enabling IT infrastructure.

The development of tech and innovation hubs occurs within the context of rapidly growing urban populations in Africa (Fig. 1), driven by population growth and the search for employment opportunities, although often at the expenses of high-potential rural areas. In parallel, a number of reclassifications of rural settlements has occurred for instance due to the growth of settlements, their integration in larger urban areas or the mergers of rural settlements. All in all, Africa's urban population has increased from 27 million in 1950 to 567 million in 2015, equivalent to about 50% in terms of urbanisation level in this latest year (OECD/SWAC 2020).

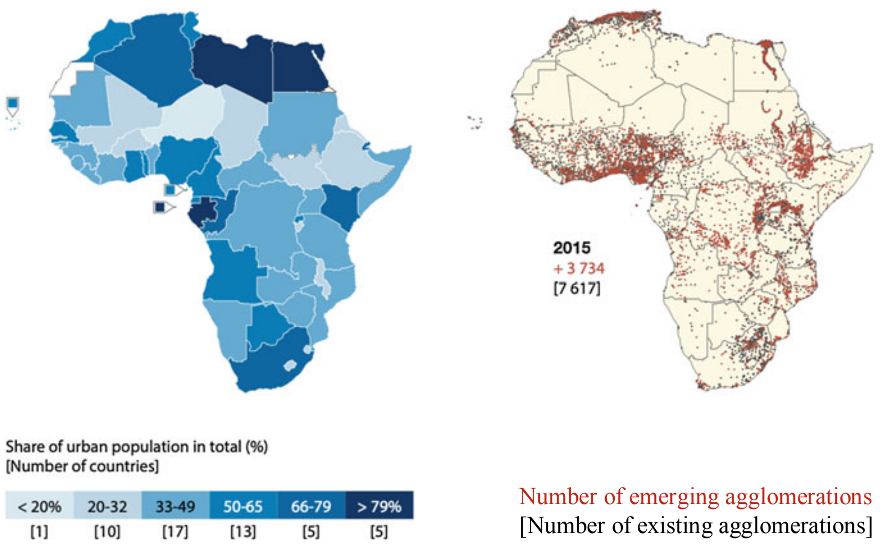

Fig. 1 Urbanisation in Africa [*Source* OECD/SWAC 2018, Africapolis (database); Geopolis 2018 in OECD/SWAC (2020)]

Table 1 Urban West Africa: population, hubs and mobile/internet penetration

Cities (capital, economic or administrative capital)	**Urban population, 2018** (thousands) & **Growth 2015-20** (%) [a]	**Urban Density, 2015** (thousands inhabitants/km2) [b]	**City-Tiers categories** (number of hubs) [c]	**COUNTRY**	**Change of Urban / Change of Rural populations 2015-2020** **	**Number of Tech Hubs in 2019** [d]	**Mobile connections in January 2020** [e] *(equivalent % of total population)*	**Internet penetration in January 2020** [e] *(share of pop. with access)*
Abidjan	4921 (2.79%)	12.1	Tier 2	**Côte d'Ivoire**	2.2	22	131%	47%
Accra	2439 (1.87%)	3.7	Tier 2	**Ghana**	4.8	27	130%	48%
Bamako	2447 (3.30%)	5.6	Emerging	**Mali**	3.0	17	108%	24%
Cotonou	685 (0.30%)	4.3	Nascent	**Benin**	2.3	10	82%	25%
Dakar *	2978 (2.60%)	15.1	Emerging	**Senegal**	2.0	15	109%	46%
Lagos *	13463 (3.21%)	10.8	Tier 1	**Nigeria**	4.5	90	83%	42%
Lomé	1746 (2.23%)	4.9	Emerging	**Togo**	2.5	14	80%	21%
Ouagadougou	2531 (4.68%)	5.7	Nascent	**Burkina Faso**	2.5	10	97%	22%

Sources elaborated from

[a] UN DESA, Population Division (2018) and projections (see definitions and projections methodology details at https://population.un.org/wup/General/FAQs.aspx)

[b] *Density: number of inhabitants per square kilometre*—Africapolis (database), www.africapolis.org

[c] City-tiers categories rely on Briter Bridges and GSMA (2019). They include the following ones: Tier 1 (20 to 40 hubs); Tier 2 (15+ hubs); Emerging (10+ hubs). Besides, the category Nascent cities (10 hubs and less) is not reported on the map, but the reference is made in the article

[d] AfriLabs and Briter Bridges Building (2019)

[e] DataReportal

Notes

*Urban population (and growth rate) refers to the sum of the Departments of Dakar, Pikinie and Guédiawaye, in Dakar Region and they refer to Lagos state for Lagos

**Computed as the ratio of Average Annual Rate of Change of the Urban Population to the Average Annual Rate of Change of the Rural Population. Numerators and denominators obtained from (1)

Table 1 shows a few statistics for selected West African cities including the urban population, the hubs presence, as well as the mobile phone and internet penetration at the country level. It confirms the urbanisation trends and the increasing access to mobile technology and internet across selected countries. In West Africa, the urban population grew by 4.6% in between 2000 and 2015 (OECD/SWAC 2020). The region is also home to 185 million of unique mobile subscribers (penetration rate equivalent to 48% of the population) and 100 million of mobile internet users (equivalent to 26% of the population); the respective penetration rates are expected to grow by 4 and 9% by 2025 (GSMA 2019).

The new narratives from West Africa emerge in very heterogeneous urban and socio-cultural contexts, which also shape their uniqueness, goals and ambitions. Their respective contexts reflect place-based challenges and opportunities for novel entrepreneurial and value creation activities. Capital cities, and increasingly emerging cities, are the main locations of the innovation hubs and communities, which benefit from and contribute to vibrant local tech-ecosystems in the region.

Figure 2 gives a snapshot of the diversity of industrial potential and tech-actors, which are actively shaping the diffusion of new technologies for major cities of Côte d'Ivoire and Ghana (Fig. 2).

The next section details the methodology and the questions for the interviews (Sect. 2). Section 3 presents five case studies[5] of West African innovation hubs and communities. Adopting the lenses of their founders, it brings some light on their social missions and on the technology diffusion and commercialization within the innovation hubs and local communities.[6]

2 Methodological Approach: Interviews and Conversations with Shareholders

2.1 Definitions and Perimeter of Analysis

The evidence and insights of this chapter draw from five case studies of West African innovation hubs and communities. The generic term "innovation hubs and communities" allows for a broader perspective on hubs or communities that goes beyond technology-centred support. The case studies rely on a series of structured interviews run in 2019 and conversations between the corresponding author and hubs or network's founders and or managing stakeholders.

Table 2 summarises the information on the hubs—name, type, and representative—and their social media identification. The social media operators shown here include only the ones mentioned by the interviewees. The 'WhatsApp group'[7] is an affordable and practical internet-based messaging application to exchange text or voice messages and to share image or video within community groups. The corresponding author is also involved in a few digital conversation groups and maintain regular contacts with the hubs and community's representatives through different social media.

Column 2 gives the types of innovation hubs and communities as they are own stakeholders identify them. We provide below some common definitions, while it is important to remind that hubs or communities do have similar or overlapping roles or activities. In particular, several centres or communities offer also safer spaces, stable access to internet and networking platforms for youth and tech-entrepreneurs.

[5] See Flyvbjerg (2006) for a discussion on the relevance of case-study research to have finer understanding of a phenomenon in real-world settings.

[6] See Amadi-Echendu and Rasetlola (2011) for an academic contribution on the factors, frameworks and models for technology commercialization.

[7] "WhatsApp Messenger, or WhatsApp, is an American freeware, cross-platform messaging and Voice over IP service owned by Facebook, Inc. It allows users to send text messages and voice messages, make voice and video calls, and share images, documents, user locations, and other media."

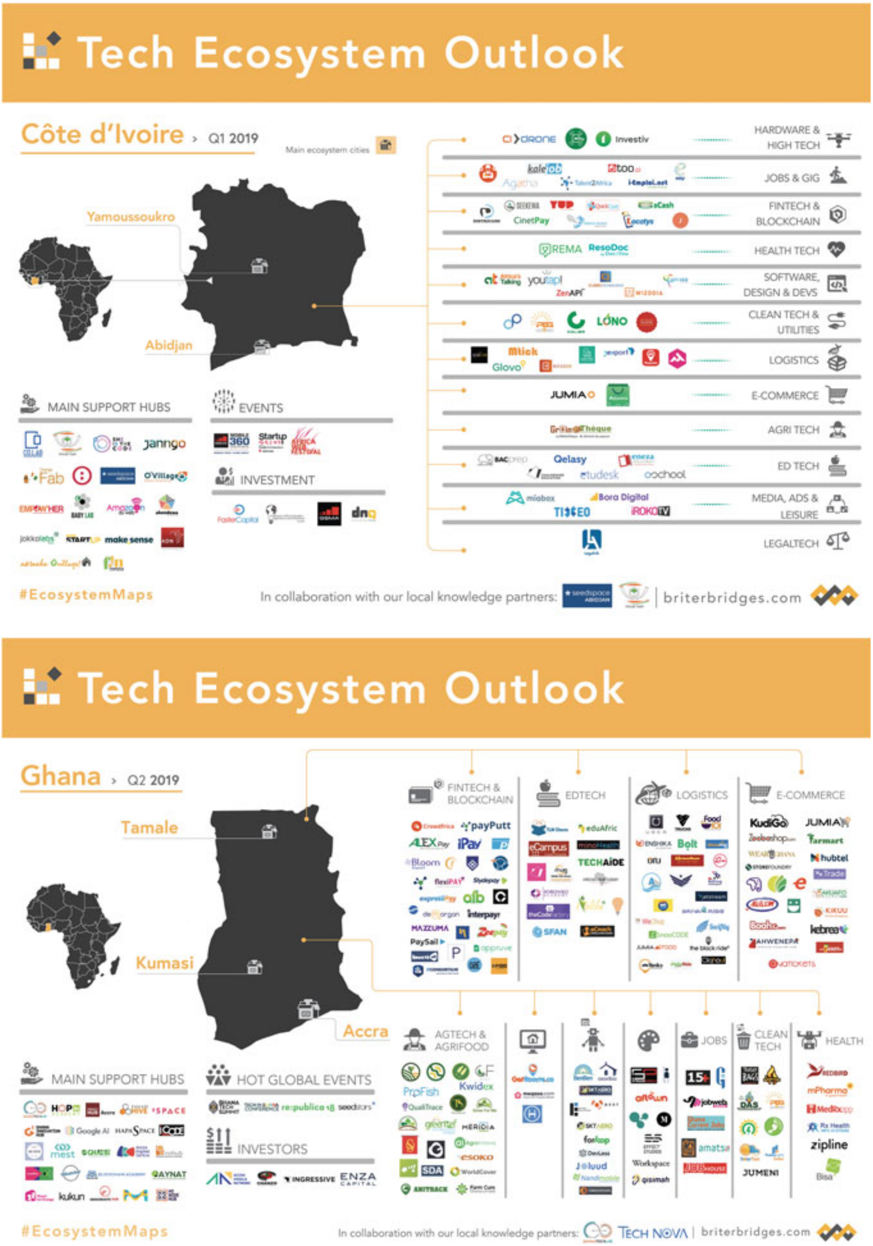

Fig. 2 Tech ecosystem outlook in Côte d'Ivoire and Ghana (2019). *Source* Briter Bridges: https://briterbridges.com/ecosystem-maps

Table 2 The five case studies in West Africa

Full name of the hub or community (country)	**Type of innovation hub or community**	**Name of Founder or co-founder** (interviewee—contributor)	**Website**	**Social Media presence** Facebook, Instagram, LinkedIn and Twitter WhatsApp group (Yes/No)
Bamako Incubateur (Mali)	Incubator	Fatima BRAOULÉ MÉÏTÉ	http://bamako-incubateur.com/	Twitter: https://twitter.com/BIncubateur Facebook: https://www.facebook.com/BIncubateur LinkedIn: https://www.linkedin.com/in/fatima-meite Instagram: bamakoincubateur
Ghana Startup Network (Ghana)	Start-up network	Gilles AMETEPE	in creation	LinkedIn: https://www.linkedin.com/company/ghana-startup-network/ Instagram: ghanastartupnetwork WhatsApp groups: YES
Grainothèque (Côte d'Ivoire)	Rural Tech Hub	Daniel OULAÏ	http://grainotheque.ci/	Facebook: https://www.facebook.com/Grainotheque.ci/
Wakatlab (Burkina Faso)	FabLab	Gildas GUIELLA	https://wakatlab.org	Twitter: https://twitter.com/WakatLab
Ovillage (Côte d'Ivoire)	Social innovation community	Cyriac GBOGOU	https://ovillage.ci	Facebook: https://www.facebook.com/OvillageCi/ Twitter: https://twitter.com/OvillageCi WhatsApp groups: YES

A *fablab* or *fab lab* is a digital fabrication laboratory, which provides access to the environment, skills, materials, machinery, equipment and technologies to allow anyone anywhere to make (almost) anything, to create and test prototypes and new products. The approach encourages the DIY ("do-it-yourself", buy and assemble) and promotes the support to local communities and individuals. Fablabs.io is the online social network of the international Fab Lab community and gathers about 1750 fab labs from more than 100 countries (https://www.fablabs.io). The Fablab Network welcomes *fabbers*, and in general any maker, hacker, DIY and amateurs for collaborative innovation, knowledge and project sharing and co-creation. Fablab Network's members share common principles, tools, and a philosophy around the future of technology and its role in society. (see also Liotard 2019; Leyronas et al 2018 for an analysis of the distinctive features of African fablabs)

"An *incubator* is a support structure that helps early-stage start-ups transform from idea to venture, by offering advisory services, resources, workshops and hands-on training that guide entrepreneurs in defining and refining their business models and value propositions with the goal of becoming sustainable businesses. They sometimes have a limited pool of cash to support the portfolio companies." (Hub Glossary, AfriLabs and Briter Bridges 2019, p. 3).

A *rural innovation hub* can provide facilities, tools, technologies and or networking platforms for various stakeholders supporting entrepreneurship, innovation, capacity building and knowledge sharing in the agriculture and or rearing sectors. They mainly aim at improving the ecosystems and capabilities of farmers, their access to markets, and ultimately, at addressing local food security and youth employment challenges.

A *social innovation community* refers here to a community, group of people interacting regularly and sharing knowledge and common principles with the aim to develop new ideas, services, products and models to tackle local social and community issues and support skills building.

A *start-up network* brings together start-ups, entrepreneurs and stakeholders from the public and private sectors, the academia and the civil society with the aim to support innovative projects, entrepreneurs and start-up firms through, for instance, knowledge and experience sharing, capacity building, investments, promotion and networking activities. These networks constitute relevant platforms to enhance the visibility of start-ups next to local and international investors and they contribute significantly to the development of the local start-up ecosystems.

2.2 Questions for Interviews

Prior to the interviews, each representative of the five innovation hubs or communities received a short questionnaire made up of 14 questions. One hub, the Bamako incubator provided a written contribution, while the four other ones opted for an online interview. The founders have further contributed after the interviews; to this date, informal conversations are still taking place.

Note that the questionnaire was not mandatory, but rather indicative as the interviewees could also decide to suggest different formulations or thematic related to their context-specific challenges and perspectives. Nevertheless, a minimum of information contents was required. Moreover, for reading and comparability purposes, the case studies adopt a similar structured based on the four-sections questionnaire, as it follows:

(i) Identification information

1. A title or very short sentence featuring the specificity of the hub or community
2. The full official name, date of foundation and physical address of the hub or community
3. Name, Surname of author(s) and Role (or just Founder or co-Founder if applicable)
4. Website and social media (Facebook, Instagram, LinkedIn, Twitter, etc.)
5. The mobile APP name (if available)
6. Official LOGO (provide also extra file in JPEG or PNG).

(ii) Aims (missions) and activities

7. Main aims in short sentences (they can rely on an illustration or graph)
8. Scope of membership (and local names you give to your different members): number of entrepreneurs/start-ups supported since foundation and last year (2018)
9. Activities and/or main stages of intervention in the development of entrepreneurial and innovation projects *(bullet points or short expressions).*

(iii) Institutional partnerships, international alliances and awards

10. Examples of official alliances or thematic affiliations (AfriLabs? Fablab.io? etc.)

11. International Prizes/Awards received by Hub/Lab or Founder(s) (*last 3–5 years*).

(iv) Challenges and recommendations

12. Main challenges or opportunities with respect to technology diffusion and or commercialization *(2–4 points)*
13. Practical recommendations to improve the entrepreneurial or innovation ecosystems and/or their impacts in your region and or country? *(2–4 points)*
14. Any additional section you think should be integrated (specific to your hub) (text, graphs, statistics, etc.…).

3 Case Studies of Five Innovation Hubs and Communities[8]

3.1 Ovillage (Côte D'ivoire): A Space for Collective Intelligence and Social Innovation

ID info
Ovillage (non-for-profit)
Date of creation: April 2014
Location : Zone 4 Rue Paul Langevin, Abidjan, Côte d'Ivoire
Website/email: https://ovillage.ci / info@ovillage.ci
Facebook: https://www.facebook.com/OvillageCi/
Twitter: https://twitter.com/OvillageCi (@OvillageCi)

Interviewee: Cyriac GBOGOU, co-Founder and Chief Innovation Officer
Awards (to makers, co-founder and or hub):
2017: 1st Prize ICT vulgarisation, National Award of Excellence - Côte d'Ivoire
2016: 2nd Prize Youth digital initiative of the National Award of Excellence - Côte d'Ivoire
2015: Prize Africaweb Festival edition 2015
1st Prize Youth digital initiative, National Award of Excellence - Côte d'Ivoire

Ovillage is a social innovation community, a space for collective intelligence and social innovations linked to the digital economy. Located in the south of Abidjan, this third-location, neither home nor the office, was officially born with the launch of a Linux-related activity. Ovillage now offers a co-working space and in-kind support for the incubation and acceleration of projects related for instance to the development of mobile applications, supporting ideation, digital creativity or open sources software. The hub also actively promotes digital thinking in everyday life with the following main objectives:

– Support and coach/mentor pre-entrepreneurs and ideas holders;

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[8] We prefer the term "innovation hubs and communities" allowing for a broader perspective on hubs or communities that goes beyond technology-centred support. Actually, more than a half of hubs are incubators or accelerators, while one fourth of the 618 hubs are co-working spaces rather than tech-focused programmes or funding (Briter Bridges and GSMA 2019).

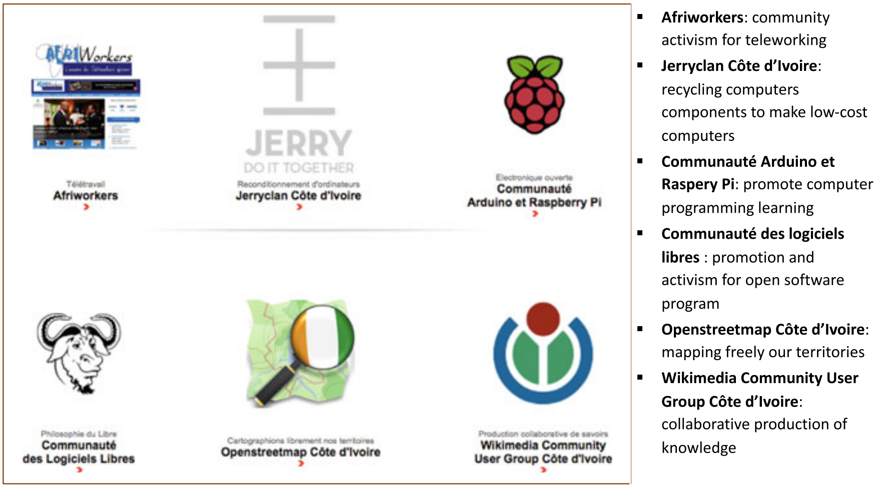

Fig. 3 Communities' projects @ Ovillage. *Source* Ovillage.ci (*translated from*)

- Skills building (coding, app development, digital/internet skills, curriculum, etc.);
- Enable exchanges, collective brainstorming sessions and immersion and discovery trips;
- Foster network, partnerships and visibility next to local and international investors.

Ovillage is actually a community of communities, whose members, les "villageois" (villagers), are also leading the different communities (see Fig. 3). In practice, the organisational model relies upon a community-led management approach with an orchestrator "le consierge" who facilitates the interactions and community dynamism. The consierge also ensures that members can access the collective capital—knowledge, network and experience—. A project responsible is in charge of the evaluation and monitoring of projects developed in the space. A monitoring committee composed of '*villagers*' defines the orientations of the space in the short and long terms. All '*villagers*' belong to a diffusion list enabling an even access to information.

Up to mid-2019, Ovillage has supported about 150 young (pre-) entrepreneurs and about 40 projects have been brought to maturity. The community operates at different stages of the entrepreneurs and innovation development including (i) the mind setting: innovation culture and commitment; (ii) the generation of ideas through learning by interacting, mentoring and brainstorming; (iii) the strengthening of capabilities and; (iv) the prototyping and demonstration in real environments. To this end, the community relies upon institutional partnerships at the local and international levels. Such partnership include i4Policy,[9] AfriLabs and, at the national level, it participates in the Fondation Jeunesse Numerique (FJN, *Foundation digital youth*), among other.

[9]Cyriac GBOGOU, on the behalf of Ovillage, is a member of the i4Policy Task Force, see the map at https://i4policy.org/ (May 2020).

The FJN aims at fostering the innovation ecosystem for young entrepreneurs of the digital economy through awareness, detection activities and start-ups support.

Young people in Ovillage embrace digital technologies and tools. However, the level of digital literacy remains very low and thus constitutes a major barrier to technology diffusion and commercialization. "Digital literacy is the ability to access, manage, understand, integrate, communicate, evaluate and create information safely and appropriately through digital technologies for employment, decent jobs and entrepreneurship. It includes competences that are variously referred to as computer literacy, ICT literacy, information literacy and media literacy" (Law et al 2018, see also UNESCO's TVETipedia Glossary). International institutions such as the UNESCO (see for instance, A Global Framework of Reference in Law et al 2018) and the European Commission (DigComp framework), as well as several national organisations and large IT firms, provide detailed classifications of digital competences areas and competences. In addition of continued policy leadership and commitment, another major obstacle to technology commercialization relates to the valorisation in local markets and to the acceptance by local customers of the digital services' prices. This means that the entrepreneurs and start-ups often face an under valorisation of their innovative activities, meanwhile the demand is expected to increase.

Improving the local entrepreneurial ecosystems will require, among other, to promote the networking activities and the networking of networks in the region and beyond at the continental level. This pan-African dynamics is already visible. Still, it needs to be upscaled and supported by enabling regulation (such as *Startup Acts*) and appropriate infrastructure in order to overcome the bottlenecks to innovation cooperation across African countries. Relatedly, boosting collaboration dynamics across the continent also requires a change in mind-sets, since trends to individualism combined with institutional instability remain among the biggest challenges.

3.2 Ghana Startup Network, GSN: Empowering Entrepreneurs, Shaping Ghana's Future

ID info

Ghana Startup Network (non-for-profit)

Date of creation: November 2019

Location : Accra, Ghana

Instagram : https://www.instagram.com/wearegsn/?hl=fr

Website/email: info.ghanastartup@gmail.com

LinkedIn : https://www.linkedin.com/company/ghana-startup-network/

Interviewee: Gilles AMETEPE, co-Founder, Senior Partner, Policy and Institutional Relations

Awards (to co-founder):

2019: University of Ghana Student Innovation

GHANA STARTUP GSN NETWORK

Fig. 4 Pillars of GSN. *Source* Ghana start-up network

Ghana Startup Network is start-up community born on the Legon campus of the University of Ghana in Accra. The majority of the founding members started their entrepreneurial journey while being students, and by the end of 2019, the initiative has gathered more than 60 entrepreneurs and startup founders. Monitoring and informing policy are at the core of GSN's missions, which focuses on (i) the promotion of start-ups and entrepreneurs, the supply of ecosystem and network support; (ii) the mapping and monitoring of Ghana's start-ups ecosystem; (iii) the improvement of the policy and public sector understanding of Ghana's entrepreneurial and start-ups ecosystem and; (iv) the support to the globalisation and regional integration agenda. The objectives of GSN build upon a few shared principles embedded in five pillars (see Fig. 4). The Ghana Startup network relies upon an executives' team made of thematic senior partners. Four senior partners, also start-up founders, overview the organisational aspects as it follows: Policy and institutional relations; Partnerships and fundraising; Brand and digital strategy and; Operations and membership. GSN also has a global team of more than twenty (20) volunteers operating from Ghana, the United Kingdom, France and the United States of America.

The network is still nascent, but it is already initiating different types of activities in order to fulfil its missions. Indeed GSN's ambitions to intervene in policy design and to encourage the popularisation of entrepreneurs-policy dialogue. Besides this pro-active policy perspective, GSN also considers training as an essential strategy for fostering local entrepreneurial ecosystems; this has also been underlined by the four other interviewees. Training programs should help start-ups to brand their products and their company, to be investors- and investment-ready and to attract co-founders. In the current business model, the attractiveness of local start-ups can trigger virtuous dynamics by improving the country's international investment profile. Besides, GSN also provides start-ups support through learning by interacting as well as advice for the identification of funding opportunities. Furthermore, several projects and programs make up the services portfolio of the startup network. They are designed according to the lessons learnt and the observations of the challenges or bottlenecks to entrepreneurship development in Ghana (Table 3).

The interviewee underlines significant challenges in relation to the costs of technology and technology transfer, the skills gaps, the mismatch between the technical know-how and the demand for skills and the lack of basic enabling infrastructure

Table 3 Projects/programmes of GSN (*selected ones in progress or planned*)

Ghana Starts up – The Annual Start-up Report	Provide a baseline to assess the contribution of start-ups to the economy, inform policy and investors
Entrepreneurship Policy Dialogue	Engage industry, policy and other stakeholders, review policies and suggest start-up-friendly policy reforms
Founders' labs	Matching for teamwork or joint start-ups foundation
Funders' Hack	Capacity-building for fundraising and VC opportunities identification
Startup legal	Foster legal knowledge and bridge legal and industrial frameworks
Startups campus tour	Awareness raising for entrepreneurship and innovation
GSN Masterclass	Knowledge sharing, learning from experts/achievers
GSN exchange program	Inter-ecosystems exchange for start-ups in Africa

Source elaborated from Ghana Startup Network's information

such as a stable access to electricity and the shortage of IT training products and tools (for instance holding a book-based IT training or an IT training without a computer). Besides enhancing the provision of basic infrastructure, services and a broader and better access to available quality technology, other levers are actionable. They include the integration of entrepreneurial training in STEM education, the awareness raising about "tax vacation for start-ups", the support to starting and scaling up and the creation of entrepreneurs' pools and entrepreneurship centres across the regions of Ghana.

3.3 *Wakatlab (Burkina Faso): A Collaborative Makers Space for Technology Democracy and Digital Youth*

ID info
WakatLab (non-for-profit; < 10 employees)
Date of creation: December 16th 2011 (*previously OuagaLab*)
Location : Kalgodhin, close to Ecole Kamgodhin Ouagadougou, Burkina Faso
Website/email: contact@wakatlab.org
Twitter: https://twitter.com/WakatLab (@WakatLab)

Interviewee: Gildas GUIELLA, Founder and President
Awards (to lab and or makers' inventions):
2018 : Semaine Nationale de l'Internet SNI
Innovation Prize, Fair of Banks and SMEs of WAEMU/UEMOA
2016: Rebranding Africa Awards for the Laafi Bag

WakatLab

Faire participer,Co-construire avec les usagers

Fig. 5 WakatLab. Source '*Ouagalab: le fablab burkinabé des solutions faites maison'* at https://www.solidarum.org/vivre-ensemble/ouagalab-fablab-burkinabe-des-solutions-faites-maison. *Notes* 'Guiella Gildas, the lab's president is tidying up' (*left picture*) and 'The famous Jerry (computer), with its power and keyboard cables' (*right picture*)

WakatLab, the fablab of Ouagadougou, is the first makerspace of West Africa. Self-built and funded through participative funding, WakatLab is first and foremost a learning community dedicated to solving local community issues with affordable means and technologies. WakatLab's makers and friends advocate open source culture, democratisation of technology and capacity building to facilitate the adoption of new technologies and digital tools, in particular since and with the youngest ones. The main objectives consist in (i) training youth for building digital competences and stimulate the DIY "do-it-yourself" and DIWO "Do It with Others"; (ii) developing digital literacy and education in Burkina Faso and; (iii) setting up or stimulating thematic fablabs to address place-specific societal issues. To achieve these objectives, the fabrication laboratory undertakes various collaborative activities and offers several services. The lab is an open and co-working space, which give access to a variety of tools and machines—3D printers, laser cutters, computers, computer numerical control (CNC) milling machines, self-made computers, recycled electronic components and parts, etc.—for the design and development of objects (Fig. 5). It also offers advisory services, incubation-prototyping support and market studies to support entrepreneurs, practitioners and companies settled or willing to do so.

With 10 employees at the end of 2019, the lab provides solutions to local development issues related to health, education and agriculture sectors (see a few examples in Box 1). Since 2016, the lab incubates about 10 youth projects yearly. Accordingly, it operates at different levels of the innovation value chain, including the ideation, the pre-incubation, the prototyping, the incubation, the networking and (search for) funding opportunities. In addition to partnerships with local and international NGOs, WakatLab is member of the pan-African network AfriLabs. It also contributes to i4Policy and to the recently constituted REFAO (network of West African fablabs), headquartered in Cotonou, Benin.

Box 1. Examples of Self-Made Products and Projects at WakatLab

- **Seeds drying system:** the solar-based system allows limiting the losses due to bad weather conditions or pecking and includes humidity sensors that provide information to farmers.
- A **wind turbine made from a hub of a motorcycle wheel**. It can produce enough power to turn on a lamp in a bush hut.
- Prototype of **Laafi Bag** developed by Christian Cédric Toé within the WakatLab. The Laafi Bag would enable the transport and conservation of vaccines and other medical products for up to 90 days allowing to reach critical areas of the country.
- **Jerry school faso**: the school to learn the assembling and functioning of Jerrycan computer, the do-it-yourself and do-it-together computers made from plastic jerrycans, other recycled material and parts of old computers
- Contribution to **Open Street Map (OSM)** to improve the mapping of cities in Burkina Faso
- **3D printers built up from recycled parts**
- **SMS-based solutions for the localisation and tracking of cattle**
- **SMS Baoré**: connecting farmers and enabling the diffusion of relevant market and weather information in remote areas
- Setting up of a **humanitarian fablab** with local NGOs with machines and tools adapted to the working contexts of artisanal gold mining in Burkina Faso

In relation to the commercialization of technology, the interviewee underlines the lack of interoperability between payment systems as a major obstacle in Burkina Faso. One implication is that multiple Application Programming Interfaces (APIs) are needed to support the variety of payment methods (mobile money, mobile cash, etc.). The standardisation of APIs would facilitate the interoperability and the integration of software applications and web mobile platforms developed by the fabbers. In addition, several opportunities exist such as the development of short message service-based solutions for a population, which has one of the highest illiteracy rates in the world (see detailed country statistics at https://uis.unesco.org/en/country/bf). Considering the shortage of IT infrastructure and the limited internet access, these solutions can help providing offline access to pedagogical and educational contents and to a virtual library.

Connecting entrepreneurs and learning by failing are key ingredients to foster entrepreneurship, enterprise and ecosystem development, according to the lab's founder. On the one hand, creating bridges between local ecosystems and entrepreneurs in the same or related domains can help scaling up partnerships to compete with multinational companies. On the other hand, the development of pedagogical frameworks based on the learning by failing requires enabling environments in which failure is instrumental in the learning processes. In other words, attempting not to fail can actually limit the development of fabbers and makers' abilities.

3.4 *Grainothèque (Côte D'Ivoire): Act for Peasant Agriculture*

ID info
Grainothèque (social entreprise)
Date of creation: 2017 (*previously non-for-profit*)
Location : Man (city), region of Tonpki, Côte d'Ivoire
Website/email: http://grainotheque.ci/
Facebook: https://www.facebook.com/Grainotheque.ci/

Interviewee: Daniel OULAÏ, Founder & General manager
Awards (to founder and or hub):
2019: Awards of the African Entrepreneuship, cat. Positive Impact (Africangels)
2018: Pierre Castel award for impactful youth agri-projects
Social Entrepreneur Award, Orange Côte d'Ivoire
2017 : Trophies Initiatives Climate – COP22 (Morocco)
Prix Foundation Tony Enumelu for Grainothèque initiative

Grainothèque
Agir pour l'agriculture paysanne

Grainothèque has started as a unique library project to preserve genetic diversity of nutritive plants seeds and reduce the dependency of local farmers to genetically modified organisms (GMOs) and to exports. Since 2017, Grainothèque has dedicated itself to enhance the rural agricultural ecosystems, the small farmers' capabilities (technical, organisational and market-oriented), while contributing to food security and best practices sharing in Africa. It ambitions, among others, to establish a national bank for seeds and plants and to facilitate the access to biological seeds and the integration of local traditional knowledge and new technologies. The social innovation hub for young rural entrepreneurs counts to this date more than 120 members, called agri-preneurs or rural entrepreneurs, Their actions extend nonetheless beyond the countryside as the social enterprise connects with various markets and institutional actors within the country. An advocate of the "eating local" and agro-ecology principles, the rural hub relies upon citizens' commitment and the strong belief in intergenerational knowledge transmission for sustainable agricultural development.

Selected among the initiatives climate—Conference of Parties COP22,[10] Grainothèque's key objectives include (i) reducing post-harvest losses; (ii) developing local value chains for cereals and vegetables; (iii) fostering the employability of youth from rural areas and; (iv) improving the access to technological tools for rural agriculture development. Accordingly, the hub undertakes or supports several activities along the innovation value chain such as the ideation, the incubation, the development of capabilities, the prototyping for new products and packaging, the networking, labelling and promotion activities. In particular, the hub promotes networking among agripreneurs for both knowledge and experience sharing, but also for the exchanges of extra-production/products subsequently re-used in alternative value chains and production activities.[11] The achievements and ongoing projects of Grainothèque

[10] See at www.initiativesclimat.org (Access May 2020).

[11] Unsold production of cereals and vegetables are processed through a community mill to produce cattle food; cattle wastes are themselves used for bio fertilizers production, which are used in cereals and vegetables culture.

are numerous, as illustrated in Box 2. At the international level, the hub cooperates with Ashoka changemakers, a global network of social entrepreneurs, and with the French public research institution, the IRD (Institute for research and development). Grainotheque's founder has also participated in the continental Tony Elumelu Entrepreneurship Programme (see at https://www.tonyelumelufoundation.org).

Box 2. Achievements and contributions of grainothèque to sustainable rural farming

- **Seeds ban**k: Grainothèque's library counted a great **variety of local seeds**, including mucuna seeds (a natural herbicide), jatropha seeds (the oil can be used as biofuel) or neem, which can be used as fertilizers for plants and vegetables, but also for veterinary and medicinal purposes.
- Grainothèque co-leads the **FeproAgr, an annual forum for rural agricultural transformation** and agripreneurs promotion in Côte d'Ivoire. **Agricultural Fab Lab** or AgriLab of Danané (west of Côte d'Ivoire) is an outcome of the FeproAgr. It is a collaborative space for competences pooling and networking between students, researchers, and rural agriculture actors with the aim to find or develop sustainable solutions.
- Grainothèque produces and markets an **innovative mixed solution** (bio fertilizers and bio pesticide) based on liquid foliar fertilizer from local plants. This formula allows limiting environmental impacts of chemicals.
- **Project Rice Danané**, a quality and labelling initiative with the municipality: it gathers about seven women groups for the production of biological irrigated rice under a community label "Riz Danané".
- **Farm-school project** to reduce the dependence to GMOs, chemical fertilizers and stimulate bio compost/fertilizers production.
- **Yri drotro**, a mobile application to help for the diagnostics of plants to help farmers identify disorders, stimulate, forecast and make decisions, among other.

In Côte d'Ivoire, the rural agricultural sector suffers from a low attractiveness and employability and it present an ageing farming workforce. Moreover, significant post-harvest losses and the extensive use of chemical inputs reduce small famers' incomes and products quality. For instance, more than fifty percent of losses in Man's region can relate to road infrastructure shortage that is combined with inappropriate conservation methods. Genetic diversity decreases with monoculture modes and the use of agrochemicals. Technology diffusion remains limited towards local small farms as also illustrated by existing irrigation systems or modes or non-sustainable conservation and farming techniques.[12] Together these factors favour the development of subsistence agriculture (producing goods exclusively for own use), while the impacts on food security are far below local potentialities.

[12]See the JRC report "*L'agriculture de la Côte d'Ivoire à la loupe*" for a comprehensive mapping and situational analysis of the agricultural system of Côte d'Ivoire (Ducroquet et al. 2017).

For the interviewee, public policy should extend the efforts towards the scaling up of youth-led initiatives in rural areas, the improvement of local farmers' capabilities and the access to appropriate technologies and the promotion of local products and labelling ("eating local"). Furthermore investments in IT—access to mobile technologies, network coverage and to quality internet—and denser financial and banking infrastructure appear essential both for information, social, transactional and security purposes.

3.5 Bamako Incubateur (Mali): A Tech Hub for the Social Fabric and Innovative Entrepreneurship in Mali

ID info
Bamako Incubateur (non-for-profit; < 10 employees)
Date of creation: October 2016
Location : Missira Rue 08- Porte 1039, Bamako, Mali
Website/email: bamako.incubateur@gmail.com
Facebook: https://www.facebook.com/BIncubateur
Instagram: bamakoincubateur
Twitter: https://twitter.com/BIncubateur (@BIncubateur)

BAMAKO INCUBATEUR

Interviewee: Fatima BRAOULÉ MÉÏTÉ, Founder
Awards (to start-ups):
2020: 1st Prize for start-up challenge & Best woman-led digital start-up (Bamako Digital Days)
2019:
Jury Prize of the African final by ESSEC in Morocco (Global Social Venture Competition)
Laureate for the contest «Ville durable et intelligente » by Paris city's incubator, Paris & Co, and the French Ministry of foreign Affairs (« Sustainable City Boot, Paris »)
3 start-ups won the African Business & African Rethink Award
Prize for youth women entrepreneurship (Salon de l'entrepreneuriat et des PME, Salep, Bamako)
2018: Accompaniment prize by Côte d'Ivoire's Chamber of Commerce (IV *Rencontres Land of African Business*)

Bamako incubator has started as the digital program of the community Mali@venir initiated by the non-governmental organisation Eureka. The Mali-based incubator ambitions to be a leading social fabric or community enabler and to contribute to the fight against local youth unemployment and migration. The philosophy of the hub builds upon a dual principle: the local entrepreneurs and youth are the leading actors of the digital revolution in Mali and beyond and; sustainable transformational paths should integrate and rely on Mali's societal characteristics and realities. Likewise many African countries, Mali is confronted with high youth unemployment, which threatens the stability of the community and favours the extension of extremism and massive youth migration towards Europe. Young people and women, the most vulnerable groups, are often the targets for enlistment by jihadist groups in the north of the country and other terrorists groups as well as human trafficking. They are not only the first victims, but can become unfortunately and ultimately also the main actors of those dramatic situations. Bamako Incubateur targets impact-oriented and socially useful training for young students and graduates women with modest backgrounds and who are insufficiently represented in technical jobs.

Bamako incubator intends to contribute to economic catching up and social development mainly by boosting local capabilities for innovation, entrepreneurship and digitalisation among most vulnerable populations. Accordingly, Bamako incubator undertakes the following actions:

- Promotion of digital literacy among children, women and young people in urban and rural areas, the diaspora and migrants;
- Promotion of digitalisation in developing and emerging industrial and services sectors;
- Identification of digital solutions and appropriate technologies for different types of economic and social activities;
- Detection of youth and women-led projects based on or integrating digital innovations;
- Promotion of the employability of young people, especially the diaspora, students and migrants in the digital economy;
- Mentoring for the identification and access to start-ups funding/investments opportunities.

The organisational model relies upon the collective commitment of start-up founders or stakeholders and upon multidisciplinary teams made up of university students from different departments. The aim is to prompt teamwork around entrepreneurial projects and ideas. The model encourages collective projects and promotes skills pooling, ideas sharing and co-creation. The incubator intervenes at different phases of the start-up development and innovation, ideally up to the generation of corporate revenues.

"GENESIS Startups MALI", an entrepreneurship and innovation training program is one of the major and current initiative led by the Bamako incubator. It offers intensive training to young graduates from the universities of Mali for digital start-ups development supporting jobs creation while addressing the communities' needs.[13] More than 60 people have been trained including trainers from Bamako Incubator, young entrepreneurs and innovative start-up companies in the areas of agribusiness (Food Tech), clean energy (Green Tech), health tech, Education (Edtech), creative industry, services and trade. "The universal code access program" is another major initiative of the incubator. It aims at enhancing youth operational skills for software solutions design. The project enables young graduates to acquire the practical skills in order to improve (self) employability and readiness for labour markets.

The hub also builds upon partnerships with local institutes and organisations, such as the Institute of Applied Sciences, the Faculty of Science and Technology, the National Council of Employers and the Private Sector Center, as well as upon international cooperation (Box 3).

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[13] It is a joint initiative of the NGO Groupe Eureka and the institute for applied sciences (ISA, USTTB) in partnership with the national council of employers of Mali (CNPM) and vocational training institutes (University Institute of Management IUG, USSGB).

Box 3. Examples of international cooperation projects of Bamako Incubateur

Agreement with "the Youth Skills and Employment Development Project (PROCEJ)". PROCEJ is a joint funding program of the World Bank and the government that aims to coach and support ten start-ups. The planned funding amounts 261 000 EUR distributed as follows: 78 320 EUR in the form of a seed grant and 182 748 EUR in the form of bank loans. The program should support the creation of about 115 jobs.

Facilitator of the "Business Creation Support Fund by Youth (FACEJ)" in Mali. FACEJ is funded by the Embassy of the Kingdom of Denmark and targets young people between 18 and 30 years old. The program supports technical and vocational training and other training structures from the high school level and equivalent level to higher education/university, with the ambition to launch business projects in the green economy.

Source: Bamako Incubateur.

Bamako Incubator is connected to the Afric'Innov network. Afric'Innov network is a joint initiative of the French development agency (AFD), Bondy Innovation association and several African and French organisations involved in the development and promotion of innovation. Afric'Innov aims at the professionalisation of incubators and accelerators in Africa through for instance capacity-building and networking activities.

Strengthening the enabling conditions for start-ups and enterprise development in Mali requires upgrading the capabilities of local incubators (updated training

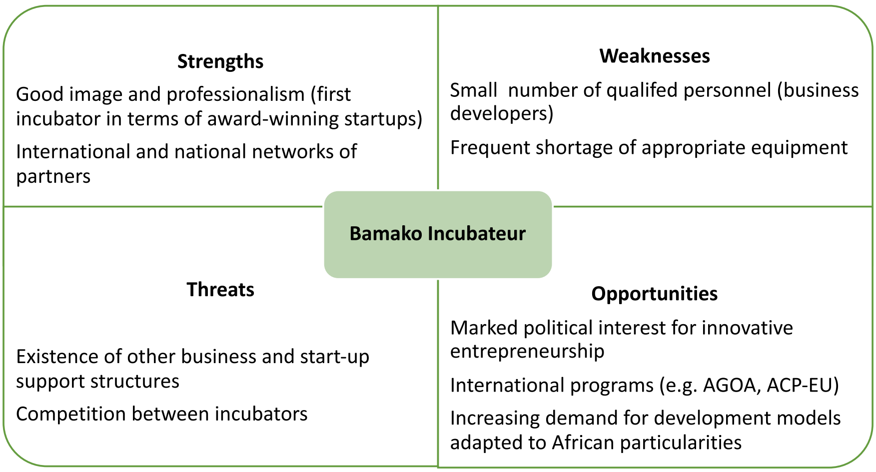

Fig. 6 S. W. O. T. matrix for Bamako Incubateur (Mali). *Source* elaborated by Fatima Méïté Braoulé, founder of Bamako Incubateur

for management trainers). Incubators are critical bottom-up catalysts for youth entrepreneurship. In addition to multiannual programming cycles and affordable facilities, sound technical capabilities in terms of business development and continuous learning are key assets for the sustainability of incubators' business models. The development of critical pools of skilled people in Mali's incubators can play a decisive role in improving youth employability, decent work opportunities, and ultimately, contribute to attenuate migration pressures and extremism violence. The related youth tragedies surely undermine the path of Mali towards a prosperous and sustainable territorial development.

4 Outlook from Case Studies

Novel entrepreneurial communities and networks are reshaping Western Africa's technology and innovation ecosystems in major cities such as Abidjan, Accra, Bamako, Dakar, Lagos and Ouagadougou. The young entrepreneurs are holding the pen and they are writing new urban and rural community narratives across Africa. This chapter illustrates the perspectives from mature and nascent innovation hubs in West Africa. The following paragraphs underline additional avenues of science for policy in order to help for a better understanding of the impacts and for the identification of sustainability enablers of these novel microeconomic dynamics.

Prior mappings have provided a wealth of information on the emergence, characteristics and areas of impacts of tech or innovation hubs and communities. Building upon this evidence, the future surveys and studies should help for the diagnostic analysis of available (digital) skills and competences areas and the skills-services matching across different hubs and communities. Monitoring the skills portfolio and the related gaps can help for designing dedicated curricula development, for capacity-building, retraining or upgrading programs both at the local, national or continental levels. In these latter perspective, combining the experience and knowledge from existing pan-African and international networks and from the actors of technical and vocational education and training (TVET) sectors on the continent, will certainly be instrumental to reach and impact on a wide range of innovation communities.

The case studies and emerging trends confirm the increasingly proactive tone and initiatives from African innovation communities' networks towards local and national processes of policy decision making. Investigating the patterns and enabling frameworks or levers that underpin sustainable dialogues between entrepreneurs and policymakers in different contexts is essential from a dual perspective at least. On the one hand, there is a pressing need for reaching critical masses of skilled entrepreneurs with sound technical, market-oriented and power or soft skills in many sectors to enable sustainable territorial transformations of African economies. On the other hand, innovation hubs and communities are increasingly positioning themselves as relevant catalysts for youth and digital entrepreneurship and for impactful community-led change in Africa. The issue here is not so much about connecting them, but rather about ensuring that the channels or bridges built are sustainable and lead to genuine and more inclusive dialogues around innovation and entrepreneurship.

Finally yet importantly, let us not forget the "elephant in the room", the informal sector. The sector supports large chunks of local livelihoods, economies and mobile and digital ecosystems. At the same time, it is also the sector where the youth entrepreneurial spirits, talent and creativity are flourishing in response to the multiple community challenges and hostilities in their local environment. Future research will be instrumental here to inform policies about how innovation communities interact with the informal sector actors and to suggest frameworks for the promotion of innovation communities that enable to reach the most economically and socially vulnerable groups.

References

AfriLabs, Briter Bridges Building (2019) A conducive setting for Innovators to thrive a qualitative and quantitative study of a hundred hubs across Africa. October 2019, https://briterbridges.com/briterafrilabs2019. Access May 2020

Amadi-Echendu JE, Rasetlola RT (2011) Technology commercialization factors, frameworks and models. In: First International technology management conference, San Jose, CA, pp 144–148

Audretsch DB, Cunningham JA, Kuratko DF et al (2019) Entrepreneurial ecosystems: economic, technological, and societal impacts. J Technol Transfer 44:313–325

Briter Bridges (2020) https://briterbridges.com/ (Briter Bridges collects, analyses and visualises data on technology ecosystems across emerging markets). Access May 2020

BriterBridges and GSMA (2019) 618 active tech hubs: The backbone of Africa's tech ecosystem. Blog article available at https://www.gsma.com/mobilefordevelopment/blog/618-active-tech-hubs-the-backbone-of-africas-tech-ecosystem/. Access May 2020

DataReportal: https://datareportal.com/about. Access May 2020

Ducroquet H, Tillie P, Louhichi K et Gomez-Y-Paloma S (2017) L'agriculture de la Côte d'Ivoire à la loupe: Etats des lieux des filières de production végétales et animales et revue des politiques agricoles, EUR 28754 FR, Publications Office of the European Union, Luxembourg. ISBN 978-92-79-73180-8

FabLab: https://www.fablabs.io/. Access May 2020

Firestone R, Kelly T (2016) How tech hubs are helping to drive economic growth in Africa? Background paper—digital dividend, prepared for world development report 2016

Flyvbjerg B (2006) Five misunderstandings about case-study research. Qualitative Inquiry 12:219–245

GSMA—GSM Association (2016) Ecosystems accelerator—Tech Hubs 2016: https://www.gsma.com/mobilefordevelopment/programme/ecosystem-accelerator/things-learned-tech-hubs-africa-asia/

GSMA—GSM Association (2018) Tech Hubs 2018: https://www.gsma.com/mobilefordevelopment/programme/ecosystem-accelerator/africa-a-look-at-the-442-active-tech-hubs-of-the-continent/

GSMA—GSM Association (2019) The mobile economy West Africa 2019: https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/03/GSMA_MobileEconomy2020_West_Africa_ENG.pdf

GSMA—GSM Association. Access May 2020

infoDev (2014) The business models of mLabs and mHubs—an evaluation of infoDev's mobile innovation support pilots, World Bank, Washington, DC

IST-Africa (2014) Guide to living labs and innovation spaces in IST-Africa partner countries. IST-Africa Consortium. Edited and published by IIMC International Information Management Corporation Ltd ISBN: 978-1-905824-49-6

Law N, Woo D, de la Torre J, Wong G (2018) A global framework of reference on digital literacy skills for indicator 4.4.2. Information Paper No. 51 June, UIS/2018/ICT/IP/51.

Liotard I (2019) Les Fablabs, ateliers au coeur de la ville: Les spécificités des Lieux d'Afrique Francophone. Innovations—Revue d'économie et de management de l'innovation, De Boeck Supérieur. Available : https://hal.archives-ouvertes.fr/hal-02419472/document

Leyronas S, Liotard I, Prié G (2018) Des communs informationnels aux communs éducationnels: les fablabs en Afrique Francophone. WP Mai 2018. Projet de recherche EnCommuns

OECD/SWAC (2020) Africa's urbanisation dynamics 2020, Apricapolis, Mapping a new Urban Geography. West African Studies, OECD publishing, Paris

Partech Africa Team (2020), 2019 Africa Tech Venture Capital Report. https://partechpartners.com/news/2019-partech-africa-report-here-and-its-best-yet-us-2-02-b-raised/ Access may 2020

Quartz Africa (2019) February 28th, 2019, African tech hubs are starting to specialize and build a budding culture of innovation, by Oluwatosin Adeshokan: https://qz.com/africa/1562040/african-startups-cchub-lagos-opens-design-lab-in-rwanda/. Access May 2020

United Nations (2018) Department of Economic and Social Affairs, Population Division, UN DESA (2018). World Urbanization Prospects: The 2018 Revision, custom data acquired via website. UNDESA

United Nations Educational, Scientific and Cultural Organization, UNESCO (2020) TVETipedia Glossary, https://unevoc.unesco.org/home/TVETipedia+Glossary. Access May 2020

World Bank's blogs (2017) https://blogs.worldbank.org/psd/it-takes-ecosystem-how-networks-can-boost-africa-s-incubators, Sept 7th 2017

World Bank's blogs (2018a) https://blogs.worldbank.org/psd/what-did-200-african-incubators-learn-our-webinar-open-innovation, Dec 19th 2018

World Bank's blogs (2018b) https://blogs.worldbank.org/psd/giving-francophone-african-incubators-keys-accelerate-growth-entrepreneurship, Jan 19th 2018

World Bank's blogs. Access May 2020

Other Websites/Pages

AFRIC'INNOV programme: https://www.africinnov.com/fr/a-propos

CHANGEMAKERS: https://www.changemakers.com

https://www.changemakers.com/changemakers-open-pipeline/entries/grainothèque

FRATMAT.INFO: https://www.fratmat.info/article/79296/62/tic-bruno-kone-apporte-son-appui-a-un-centre-d-innovation-technologique-2-2

INFOWAKAT: https://infowakat.net/agriculture-au-burkina-faso-alerte-agri-une-solution-venue-de-ouaga-lab-pour-ameliorer-le-quotidien-des-agriculteurs/

INITIATIVES CLIMAT: www.initiativesclimat.org

LIBRE TRIBUNE: https://libretribune.mondoblog.org/

https://libretribune.mondoblog.org/2020/01/20/transformer-agriculture-dans-louest-ivoirien/

MAKERY: https://www.makery.info

https://www.makery.info//2016/10/10/le-ouagalab-trace-la-voie-dune-silicon-faso-valley/

MYAFRICANSTARTUP: https://www.myafricanstartup.com/

https://www.myafricanstartup.com/fr/cote-d-ivoire/entrepreneur/grainotheque/

OBSERVERS.FRANCE24: https://observers.france24.com

https://observers.france24.com/fr/20160930-cote-ivoire-sangouine-grainotheque-preserver-semences-ogm-agriculture-biologique

RFI: https://www.rfi.fr/fr/

https://www.rfi.fr/fr/emission/20190622-cote-ivoire-grainotheque-une-production-rurale-circulaire
SOLIDARUM: https://www.solidarum.org/
https://www.solidarum.org/vivre-ensemble/ouagalab-fablab-burkinabe-des-solutions-faites-maison

Corporate's Enterprise and Supplier Development (ESD) for SMMEs Through Incubation Programme

Nthabiseng Kenosi and Elma van der Lingen

1 Introduction

An important drive for developing countries is to eradicate poverty through economic development, and to diversify and increase the number of participants in the economy in order to take part in the global competitive market. The philosophy of *think small first* has been adopted by governments globally, creating strategies for the economic development and growth of a country by investing in start-up businesses (Andrew and Paul 2006). One of the fundamental driving forces in the economic development of a country comes from SMMEs, due to their flexibility and quick adaptation to changing markets as they create employment that assists in diversifying economic activities and contributing to exports and trade (Szabó 2006). The BBBEE code was an initiative by South Africa's post-apartheid government to empower previously disadvantaged citizens of the country, to address inequality, to eradicate poverty, and to improve economic growth.

According to Mian et al. (2016), incubators for SMMEs can be referred to as technology/business incubators, innovation/technology centres, science/research/technology parks, and business/seed accelerators. To create cost-effective business development services, incubators were established to provide start-ups with services such as training, marketing, mentoring, and access to external established networks (Lalkaka 2001). Small businesses are entering the market space, making changes to take advantage of the technological changes and global trade; and this can be challenging when undertaken in isolation, without the support of big experienced firms and the government. The implementation of business incubation programmes has been undertaken in many different ways, but mainly to

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assist SMMEs by providing competitively priced rental office space, various administrative functions, mentoring and coaching, and network opportunities (Kutzhanova 2007). Lalkaka and Shaffer (1999) and Masutha and Rogerson (2014) investigated South African business incubation progress related to institutional issues, emerging geographies of business incubators, and networks.

The BBBEE code was an initiative by the post-apartheid South African government. In 2007, the code's name was changed from Black Economic Empowerment (BEE) to Broad Based Black Economic Empowerment (BBBEE). Pooe (2016) proposed a framework for organisations to implement ESD programmes that are linked to the BBBEE code. The code's intentions have been seen to be unrealisable, due to perceptions that the process is simply a tick-box exercise to ensure compliance by companies, and that it is shifting away from the development impact (Mahomed 2015).

This study's aim was to assess various aspects of the business partnerships formed between large international corporates[1] and local black-owned SMMEs through incubation configuration; incubation is used as a vehicle for ESD. The following two research questions were investigated:

Research Question 1: How Are Partnerships Formed Between SMMEs, Corporates and the Incubator and What Kind of Services Are Provided?

Research Question 2: What Are the Effects, Challenges and Benefits Observed During These Partnerships?

2 Background

Background is provided in this section regarding the changes that were made to the original black economic strategy, especially the importance of the ESD component which contributes the most points on the score card and its importance for long-term competitiveness. In 2003 the BEE strategy was released with the aim of transforming the economic landscape of South Africa. It was revised in 2012 due to difficulties experienced in its implementation. The elements indicated in Table 1 were reduced from seven to five by merging 'supplier development' and 'enterprise development', and merging 'management control' with 'employment equity', in order to accelerate enterprise development, which is important to growing the economy of the country (Pooe 2016).

The five elements contribute to the final points and determine the BBBEE status level. The highest level that can be achieved is Level 1. ESD contributes the most points, followed by ownership, skills development, management and control, and socio-economic development. All of these elements are scored according to the number/percentage of black people affected, meaning that, in an organisation, the higher the percentage of black people involved in management, the greater the

[1]In this chapter the word 'corporates' refers also to corporate enterprises and large international corporates.

Table 1 Generic construction of BBBEE score card (The DTI 2018)

Generic construction of BBBEE score card		
Element	Weighting points	Bonus Points
Ownership (or foreign equity equivalents)	25	–
Management control	19	4
Skills development	20	5
Enterprise and supplier development (ESD)	40	4
Socio-economic development	5	–
Total points	109	13
Points (including bonus)	122	

number of points attained; similarly, the higher the percentage of the ownership of the business by black people, the greater the number of BBBEE points attained. Furthermore, the ESD element is divided into two sub-sections, 'preferential procurement supplier development' and 'enterprise development', each containing points, as shown in Table 2. Points are also affected by the BBBEE status of the company from which procurement is undertaken.

Enterprises with a total annual revenue of up to R10 million qualify as an exempted micro-enterprise (EME). A measured entity with a total annual revenue of more than R10 million, but less than R50 million, qualifies as a qualifying small enterprise (QSE).

Krause and Ellram (1997) define 'supplier development' as any effort of a buying firm, with its suppliers, to increase the performance or capabilities of the supplier to meet the buying firm's supply needs. This indicates that the supplier development effort is dependent on effective two-way communication, involvement of top management, the use of teams, and a large proportion of purchasing from the buying firm. According to Bai and Sarkis (2011), supplier management and development is critical to an organisation's strategic and competitive advantage through performance management and continuous improvement efforts for its long-term survival.

A supplier development programme entails activities undertaken by the buying firm in its efforts to measure and improve the products or services it receives from its suppliers, so that it can meet its short- and long-term business objectives (Prahinski and Benton 2004). According to Glock et al. (2017), supplier relationship management is concerned with strategic planning and managing interactions between the buying company and its supplier, and encompasses various activities such as the identification of suitable suppliers and their selection, the evaluation and development of suppliers, and continuous monitoring of the suppliers' performance. Logeek (2010) indicates that the critical factors contributing to the success of supplier development activities are commitment and enhanced communication, and added that the impact of the strategic process and supplier recognition directly enhanced communication and increased supplier commitment.

Table 2 Generic enterprise and supplier development (ESD) (The DTI 2018)

Indicator	Points weightage	Target (%)
Preferential procurement		
Procurement spend from empowering suppliers based on total measured procurement spend (TMPS)	5	80
Procurement spend from qualifying small enterprise (QSE) empowering suppliers based on TMPS	3	15
Procurement spend from exempted micro enterprise (EME) empowering suppliers based on TMPS	4	15
Procurement spend from 51% black-owned empowering suppliers based on TMPS	9	40
Procurement spend from 30% black woman-owned empowering suppliers based on TMPS	4	12
Bonus for preferential procurement		
Procurement spend from designated groups that are at least 51% black-owned	2	2
Supplier development		
Supplier development contribution as a percentage of net present annual tax (NPAT)	10	2
Enterprise development		
Enterprise development contribution as a percentage of NPAT	5	1
Bonus points: Graduation of one or more enterprise development beneficiaries to supplier development status	1	Yes
Bonus points: For one or more jobs created as a direct result of enterprise or supplier development	1	Yes
Total (including bonus points)	44	

The buyer–supplier relationship moves towards cooperation; investments by the buying firm may take the form of information sharing, assistance through training programmes, and technical and managerial assistance (Wagner and Krause 2009). Wagner and Krause (2009) indicate that direct or internalised supplier development contains two conceptually and empirically distinct types of interaction that need to be distinguished: (1) buying firms transfer manufacturing, technological, and other types of knowledge to the supplier; and (2) the transfer and training of employees between the supplier and buying firms. The acquisition and exploitation of knowledge in the relationships with business partners help them to remain competitive (Nagati and Rebolledo 2012). Access needs to be provided to information, knowledge, and expertise, which is vital for the survival of new ventures and young companies, and can reduce the uncertainty they experience (Peters et al. 2004). Nagati and Rebolledo (2012) show that process improvement activities, total-preventive maintenance methods, and lean manufacturing practices can be achieved through knowledge transfer and the linkage to an increase in the supplier's operational performance, measured in terms of product quality, lead time, and production costs. Braziotis and Tannock (2011) note that the exchange of knowledge among partners plays an important role in long-term competitiveness.

Morales-Nieto 2008 defines 'small business and enterprise development' as the process of strengthening the integration of small firms with the potential for growth and expansion into the economic mainstream (i.e., the value chain system) of modern industries. Kutzhanova (2007) notes that the new interest in business creation or enterprise development has raised concerns in economic development about identifying the most effective strategies to accomplish it. Lichtenstein et al. (2004) see ESD as an economic development strategy that seeks to create a supportive environment in which new ventures can flourish. The programme should outline responsibilities, such as who will undertake skills development, in which area, and the nature and the extent of the development (Pooe 2016). According to Kutzhanova (2007) enterprise assistance programmes should offer a range of practices that cover traditional business education topics (e.g., business plan writing, financial advising, marketing strategy, and management issues). These can be offered in business assistance centres, business incubators, venture and angel capital groups, university small business assistance centres, local chambers of commerce, etc. (Kutzhanova et al. 2009).

Nichter and Goldmark (2009) note that, in developing countries, SMMEs lack both profitable business opportunities and capabilities such as skills, resources, and technologies. Soetanto and Jack (2013) categorise the types of resources as tangible (use of equipment, laboratories, facilities, etc.) and intangible (technical support, consultation, information and knowledge of technology development, etc.). There are various channels, such as licensing, publications, meetings, cooperative agreements, and spin-off, through which the transfer of technology can take place (Rogers et al. 2001). According to Liu and Liang (2011), technology transfer involves the transfer of knowledge such as knowledge of how to improve technologies, how to integrate technological systems, and how to package a technology to address a market need through commercialisation. As noted above, tangible resources include financial and physical assets, while intangible resources include intellectual property assets, organisational assets, reputational assets, and skills/capabilities (Soetanto and Jack 2013).

Background was provided above regarding the BBEEE policy and the importance of the ESD component, which is a main component of the BBEEE score card. Supplier Development and Enterprise Development were defined and their significance in partnerships were highlighted. In this study the challenges and benefits of business partnerships between large international corporates and black SMMEs exposed to an incubation programme are further investigated.

3 Research Methodology

This research has social relevance, as it underlines the importance of supporting black-owned SMMEs through incubation programme for the country's economic

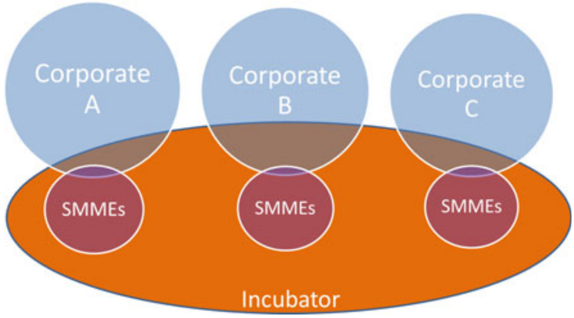

Fig. 1 Business partnership within the incubation context

growth in line with BBBEE policy. The teleological type is an exploratory study; this study explored how business partnerships are taking place through incubation programmes between corporates and SMMEs, and assessed the support services offered to SMMEs and the associated benefits of an improved BBBEE score for corporates from implementing ESD programmes. It falls into the 'applied research and policy research' category by assessing business support services under incubation programme driven by the BBBEE policy. It is theory-building research and theory-testing research, as it aims to add to or build on already existing literature studies on the concept of ESD programmes.

Data acquisition was confined to case studies of three different corporates and their associated SMMEs, using one incubation company (Fig. 1). Multiple cases assist in assessing whether findings can be replicated across cases, thereby providing a basis for replicability (Saunders et al. 2016) and creating a more robust theory (Eisenhardt and Graebner 2007). The case study approach was selected, as this approach is structured within a real-life context (Noor 2008) and has the capacity to generate research that results in intensive and in-depth insights (Saunders 2016). The business functions of the three SMMEs are: engineering procurement and construction management; gas manufacturing; and a conglomerate company producing a variety of commercial and consumer products, engineering services, and aerospace systems. Purposive sampling was done with the respective black-owned SMMEs in the incubator programme.

Semi-structured interviews and secondary data collection were conducted. The 19 participants included chief executive officers, directors, a transformation manager, and a procurement manager. Qualitative analysis was used to evaluate the content of the gathered information. Recordings, notes, and responses from the interviews, and results from the secondary information, were analysed. A deductive approach was used in the analysis, as this uses existing theory to formulate research questions and objectives. The theoretical framework was used to organise and direct the data analysis (Yin 1981).

4 Results

4.1 Enterprise Supplier Development Partnership

The incubator has three categories of clients: start-up businesses, growing businesses, and established businesses; whereas the corporates offer different services that are tailored to meet their specific needs. The SMME is required to complete a few assessments to determine what development needs to be addressed and to establish a development plan. Customised incubator programmes suit the needs of both the corporates and the SMMEs. To enter the programme, an SMME applies either to the incubator or directly to the client. Strategies differ from client to client, depending on their specific need, which might be to improve their BBBEE score through the ESD element (which, as noted earlier, accounts for the greatest number of weighting points of all the elements). Preference is given to 51% black-owned SMMEs with less than R50M annual turnover. Selection is also based on the type of business the SMME is involved in; the corporate will select an SMME that will add value to its own business, or whose services its needs in fitting into the corporate's supplier value chain.

Although the main drive is to comply with the BBBEE policy, there are secondary objectives for the corporates that have embarked on the incubation programme. Each corporate has different strategies for the SMME partnership in the incubation programme. Corporate A involved SMMEs that can be seen as its partners in the ESD programme, whereas Corporate B selected SMMEs that would assist in expanding market reach, and Corporate C's strategy was to develop its suppliers through this programme to improve the service quality they offer.

4.1.1 ESD Partnership Structure

The corporates investigated in this study ESD programme was divided into three categories with each representing various SMMEs:

- ESD core partners—companies that seek the assistance of an enterprise incubator programme and growth potential through partnership.
- ESD extended partners—companies that are established in their own right and seek a partnership to execute projects.
- ESD alumni partners—companies that have graduated from the ESD programme and continue to work closely with corporates in searching for work and in the execution of projects.

4.1.2 Legal Requirements for Partnership

Agreements are signed between the corporate and the SMMEs (agreement type A), as well as between the incubator and the corporate (agreement type B). The corporate appoints the incubator to provide business support to the incubation programme for the SMMEs, and the incubator accepts the appointment through this agreement.

Agreement type A details the services that the corporate aims to offer to the SMME. The agreement first explains that either the corporate or a nominated service provider will undertake a needs analysis with the SMME to determine its current business knowledge/skills/infrastructure; and, based on the outcome, the corporate will establish a development programme with a mutual understanding that it will cover a minimum of three of the development areas listed below:

- Legal compliance
- Marketing and branding
- Establish credit rating/history
- Administrative system establishment
- Business skills transfer, with emphasis on entrepreneurial and negotiation skills
- Management and labour skills transfer
- Procurement skills transfer
- Contractual knowledge transfer
- Access to or implementation of business systems
- Planning, tendering, and programming skills transfer
- Establishment of financial loan capacity and/or history
- Technical skills transfer, with emphasis on innovation.

A schedule is developed, based on the selected activities, to address the needs identified through the development programme, and resources are allocated to those involved in the business mentorship relationship. The agreement further stipulates the requirements and obligations of the SMME, stating that:

- It is a legal entity that is compliant with South African Revenue Services (SARS) requirements;
- It employs at least three permanent employees;
- It is either 50% black-owned or 30% black female-owned.

These requirements are vital to ensure that the money committed by the corporate is indeed spent on an entity that exists and operates in South Africa. A SARS tax clearance certificate is a required legal compliance with South Africa's business regulations. A company's operational status is proven by providing a letter of good standing issued by the Department of Labour. The baseline for the establishment of the development programme by the corporate is its intention to comply with the BBBEE codes requirements. Various products are offered to bridge the gap in the SMMEs' capabilities (Table 3).

4.1.3 Intellectual Property Rights (IPR)

CIPC (2018) describes intellectual property (IP) as the development of something new or original by application of the mind, through various forms such as a new invention, design, brand, or artistic creation. Each type of IPR was clarified in detail

Table 3 Business assistance products

Finance advisor	Independent business leaders who can give level-headed advice, practical solutions for financial difficulties, assist with issues such as increasing profitability and cash flow in the short- and long-term, acquiring funding and financial assistance, etc
Vehicle dealer	Business assist vehicle dealer who will source new or pre-owned vehicles through a network of 120 motor dealerships nationwide. The SMME will be entitled to discounts and cash rebates to get the vehicles it needs
Insurance broker	Business assist insurance service that offers comprehensive long- and short-term insurance advisory and sourcing services, and will also help in processing claims, providing access to quotes and related services
Accounting	Accounting software that offers customised packages that suit the type of business
Tax advisor	Tax advisor with extensive experience
Business advisor	Independent business advisor who can provide advice on business strategies, offer pointers on increasing market share, identify potential business problems, suggest ways to increase profitability and cash flow, change management within a company, and adopt e-commerce
Labour advisor	Labour advisor specialist provides practical information on legislation pertaining to labour law (Labour Relations Act, Basic Conditions of Employment Act, Employment Equity Act, and Skills Development Act) telephonically. Face-to-face consultation can be provided at half-price, which includes • Assistance in preparing for internal disciplinary hearings and appeals • Advice, guidance, and assistance with retrenchments and downsizing • Guidance on matters relating to staff incapacity (illness or disability) • Assistance with workmen's compensation claims
Skills development	Skills assessment tools to determine training needs of business owner or staff
Employee benefits	Advice on pension and retirement funds
Recruitment officer	Free access to a large database of job seekers, with email alerts related to new CVs that fit the required criteria
Medical officer	Assistance with general health matters (minor ailments, self-medication, referral to practitioners, specialists, clinics, and pharmacists)

(continued)

Table 3 (continued)

Trauma counsellor	Professional counsellors provide trauma counselling for violent or non-violent trauma cases
Business information	Business information service provides general business information needed by the SMME, processed through a request system, with feedback via email within 24 h
Legal advisor	Legal advisor helpline connects with advisors who can provide advice within 24 h
Personal assistance	Personal assistance service offers comprehensive assistance with everyday arrangements, such as directions to appointments; facilitates travel bookings, reservations, etc
Black economic empowerment	BBBEE advice through a holistic range of services, and ensures the successful implementation of BBBEE in the business in line with its objectives. This service includes BBBEE reports, monitoring BBBEE status, and ongoing BBBEE consultation
Customer loyalty	This service aims to increase the likelihood of retaining existing customers and acquiring new ones by offering loyalty rewards. The customer loyalty lifestyle programme includes various special deals on everyday commodities
Lead generation	Listing of business and its services on the incubator's supplier database for marketing exposure. It offers a classified advertisement service through which an SMME can sell, swap, or buy business equipment or acquire second-hand equipment
Customer relationship marketing (CRM)	CRM provides the capacity to communicate regularly with customers to build stronger ties; communication campaigns can be run via email and SMS, in print publications or e-zines, to promote special offers, convey information about products and services, and send special birthday or holiday greetings
Graphic design	This service provides graphic designers who will develop a company logo that reflects the appropriate business image, stationery (business cards, letterheads, envelopes, etc.), brochures, and promotional items
Tenders	An email service that will advise on new tenders that are relevant to the business' line
Procurement officer	The incubator has a database of over 140 000 reputable suppliers with whom the incubator regularly negotiates. The procurement specialist will source the needed products/services in an area that is convenient to the SMME, and negotiate better prices on its behalf

(continued)

Table 3 (continued)

Travel desk	The travel desk service enables small business owners to take advantage of benefits and discounts usually reserved for large corporates, to get the best comprehensive business travel packages
Discount vouchers	The SMME benefits from the vast network of business and supplier contacts in order to receive frequent special offers and savings
Road assistance	In the event of any roadside emergency, assistance can be accessed via a telephone call to a call centre that will deal with the problem quickly and efficiently to get assistance without delay, at reduced costs
Office maintenance	Reputable suppliers of appliance repair and support, customer warranty support, office repair emergencies (locksmiths, electronics, plumbers, and builders) and office relocations at reduced rates
Company website	The service offers the designing of a free four-page website for the SMME business and a once-off domain registration payment
IT procurement	An IT expert is provided to advise and assist with the procurement of appropriate systems to ensure effective running of the SMME business
IT helpdesk	Qualified computer technicians provide assistance via telephone or website on various computer-related problems and queries, including hardware and software problems and information

during the interview, and participants were requested to indicate which types were applied during the partnership with the corporate. The SMMEs made use of trade secrets, copyright, trademarks, and industrial designs; patents were not relevant. Figure 2 illustrates that trade secrets were used to 50% of the Case A and B SMMEs, but were not by Case C. Regarding the copyrights exposure of the SMMEs in each case: Case A = 75%; Case B = 25%, and Case C = 0%. Trademarks emerged for all the SMMEs interviewed, whereas industrial design was used by only 25% of the Case B SMMEs. The IPR trend of the SMMEs was characterised by all making use of trademarks, which is important in branding and marketing of products, whereas copyright and trade secrets were used to a lesser extent by two of the three cases, and depends on the importance for the kind of business operations.

4.2 Partnership Collaboration Challenges

According to the participants, the most significant challenges experienced during these partnerships between corporates and SMMEs included:

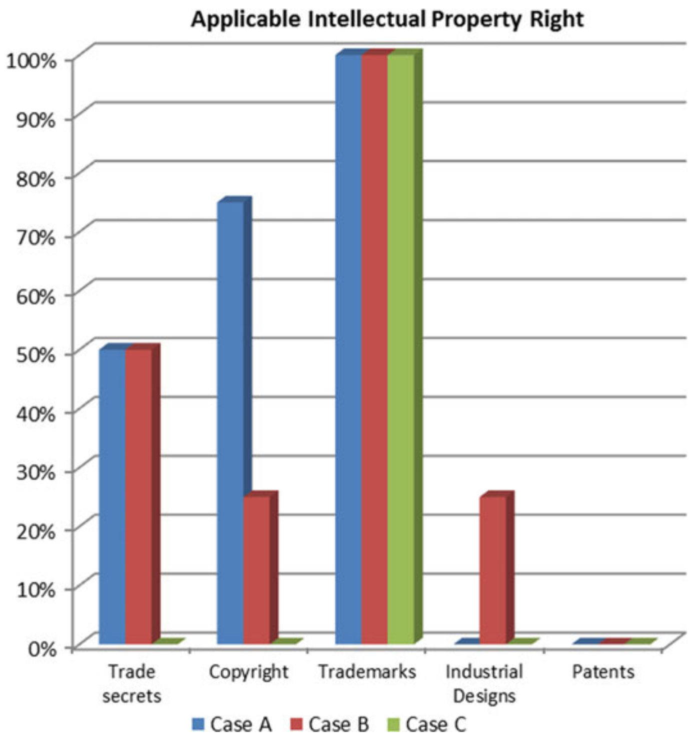

Fig. 2 Intellectual property rights used

- Access to sufficient funds: SMMEs operated on a restricted budget, and knowledge-sharing workshops were missed due to the unavailability of funds for travel during the incubation interactive activities. Corporates assisted as much as they could, but could not meet all the financial needs of the SMMEs.
- Lack of sufficient opportunities from corporate: SMMEs expressed the need to be included in the initial stages of projects (such as the tender process), thus avoiding only approaching the SMME when the project is carried out, which does not allow ownership of the scope and effective development. The corporate responded that the incubation programme was launched in the midst of a recession, with limited opportunities in the market.
- Lack of opportunity to showcase capabilities: SMMEs had to go into the market and search for opportunities to showcase their capabilities. As opportunities arose in the market, there tended to be uncertainty about whether the SMME or the corporate should take the lead, with the result that it appeared that they were competing for the same opportunity.
- Insufficient market access: Sharing of opportunities came more from the SMMEs. The corporate could improve this by involving the SMMEs in projects that were under way, and evaluate where their appetite and capabilities lay.

- Issues related to codes of conduct: Corporate companies' codes of conduct prohibited employees from participating in certain activities (e.g., accepting gifts) as this was a strict requirement for an organisation that was listed on the Johannesburg Stock Exchange. In smaller businesses, individuals will try anything to ensure the survival of the organisation, resulting in more 'grey' areas; whereas for the corporates, it is much more clearly a 'black and white' situation.
- Collaboration restrictions: There were restrictions on how to collaborate with local businesses, seeing that the corporate was an international company. Permission had to be obtained from the global head office, where BBBEE requirements were not particularly well understood. This restriction resulted in a lack of collaboration, information, and experience in the corporate's operations.
- Financial Support: Provision of interest-free loans would have assisted with cash flow, as large corporations have long payment periods, thus straining the SMMEs' cash flow capacity.
- Procurement: Corporate could have opened up more opportunities for the SMME to be a supplier of products to its clients. Only one procurement staff member provided the SMME with a request for quotations. Project managers were comfortable to work with suppliers with whom they had established a relationship of trust in their services, and found it difficult to provide opportunities for new entrants.
- Corporate payment terms: Before introduction to the programme, clients were walk-in clients who would make up-front payments. Since the introduction to the programme, the SMME had to deal with corporate contractual agreements with payment terms of 60 or 90 days, which resulted in needing to implement cash flow projections to use the money in hand more effectively.
- Inadequate interaction with procurement department: the SMME proposed that a portal be created where suppliers could log in and receive information on the status of the invoices so that they knew when payments would be made and could plan appropriately. It also proposed that another portal be created where the corporate could log in and post requests about any items that were needed (clothing, size, colours, etc.), as this would improve communication and fast-track the process.

4.3 Incubator Challenges

Challenges experienced by the incubator company included:

- Financial: There was limited financial support, which came only from the corporate (with an expectation that the government could assist with financial support), thus failing to meet the needs of the SMMEs.
- Time: The incubator could only spend a limited time with each SMME due to the large number of SMMEs enrolled in the programme that required attention.
- Objectives of SMMEs: Some SMMEs were not developing/improving as expected, and this led to a perception that their interest was mainly in receiving financial gains.

- Partnership: The integration of SMMEs into the environment of the large corporates was a challenging task. This could be attributed to either the under-development of the SMMEs or the lack of intent to do away with the perception that corporates only wanted a good BBBEE scorecard.
- Market access: Creating opportunities for SMMEs was also dependent on the corporate; and this could be attributed to the limited number of SMMEs that a corporate could assist at any one time, and the unfavourable state of the economy, as most companies were operating in survival mode.

4.4 Collaboration Benefits

The participants were requested to recount their experiences of the benefits attained through these collaborations. Perspectives from both the corporates and the SMMEs were provided, some of which are listed below.

- Properly structured incubation programmes addressing strategy and compliance requirements resulted in a positive impact of the corporates on the SMMEs.
- Joint marketing by the corporates and SMMEs contributed to larger market span, business growth, and job creation.
- Increased network access and competitiveness as the SMMEs became an extension of the larger organisations' business development and marketing strategy.
- SMMEs could sub-contract their specialist expertise to corporates that was not available in-house.
- Association with multinational corporates provided SMMEs with more legitimacy and international brand associations.
- Corporate office space offered to the SMMEs presented a favourable image to potential clients, and contributed to employee morale, resulting in motivated staff offering services matching their environment.
- Workshop area provided by a corporate to SMMEs allowed effective functioning and reduction in operation costs.

This section discusses the BBBEE score card performance of each of the corporates that undertook ESD programmes to support the various SMMEs they selected. Figure 3 illustrates the BBBEE levels of the three corporates over three years. The highest level that can be achieved is level 1. Corporate A started at level 3 in year 1, and remained on the same level in year 2, but improved to level 2 in year 3. Corporate B started year 1 on level 8—the lowest compliance level—but in year 2 it improved to level 4, and then in year 3 improved further to level 3. Corporate C started with a level 5 BBBEE status in year 1, then improved to level 4 in year 2, and improved further to level 3 in year 3. All three corporates, which undertook the ESD programmes to support SMMEs, showed improvement on their BBBEE status over the three years.

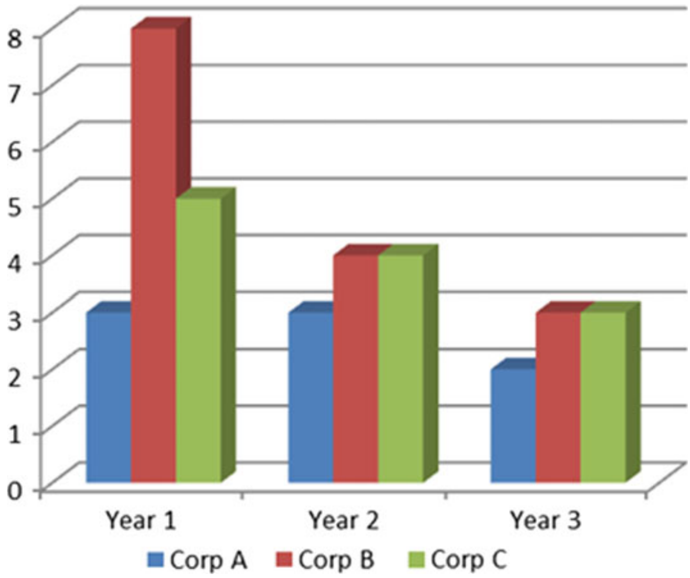

Fig. 3 Corporates' BBBEE score levels

5 Discussion

The research aimed to study the relationship between three corporates and the SMMEs that were part of an ESD programme facilitated by an incubator and driven by the BBBEE policy. Pooe (2016) notes that ESD initiatives should be aligned with corporate strategy, setting out budget parameters and the nature of the ESD activities. The programme should include the responsibilities of who would undertake the development of which area, and the nature and extent of the development. This study evaluated what is entailed in the ESD programme, and the nature of these business relationships. Kutzhanova (2007) says that a business assistance agency offers standard 'cookie-cutter' services to entrepreneurs, thus making a limited impact on their businesses, and recommends that, for ESD programmes to be effective, the services have to correspond to the specific needs of the particular entrepreneur. Of importance is that corporates determine the true needs of the SMMEs, and establish an ESD programme with objectives that benefit both parties, rather than it being merely an exercise in complying with BBBEE policy. The following summarises the findings related to each of the research questions.

Research Question 1: How Are Partnerships Formed Between SMMEs, Corporates and the Incubator and What Kind of Services Are Provided?

The business partnership structure represents an integrated relationship with clear objectives set out in the agreements. The agreements are legal documents that detail the responsibilities of each party ensuring that the objectives of the partnership are met. The corporate has an agreement between itself and the incubator, and another agreement between itself and the SMME, illustrating the different functionality that each relationship has. The products/services offered under the incubation programme outlined in the agreement between the corporate and the SMME are included in the corporate and incubator agreement, illustrating an alignment of all the stakeholders concerning the objectives. The services offered are diverse, and provide relevant support needed by an entrepreneur to operate their business effectively based on financial, legal, and labour-related advice. The visibility of the SMME's name in the market is enhance by providing marketing functions to acquire new clients/customers that will sustain the business. The companies selected to be in the ESD programme offer complementary services to the corporates; and this can be good reason for the corporates to offer full support to these SMMEs, as they can directly affect the performance of the corporates' business. The major requirements are for the SMME to be 51% black-owned, not be a start-up, to have been in business for a few years, and to have achieved tangible turnover, as these criteria are a requirement for achieving BBBEE status.

Free rental space, computers, and access to software licences are offered to the majority of the SMMEs in the incubation programme. The corporate interacted directly with the SMMEs to evaluate their needs and business performance. Some of the SMMEs had the opportunity to collaborate with the corporate on projects, and some in preparing tenders; and this allowed a transfer of knowledge from the corporate to the SMMEs. Knowledge transfer took place through mentorships, and some entrepreneurs took formal courses to fill certain gaps in their skill sets as identified.

The IPR types that emerged during the knowledge transfer activities were trademarks—the type most often used—followed by copyright and trade secrets. Trade secrets arose for SMMEs that were formed through spin-off. Copyright information was made available to the majority of the SMMEs as they collaborated in project implementation. Trademarks were applicable in all three cases. The highest occurrence of trademarks knowledge transfer took place when SMMEs leveraged the corporates' names during marketing campaigns. Interactive activities were largely used as a means of (knowledge) transfer—although the SMMEs did not prefer this channel, as it was informal, and no assessment of absorption could be made. There was minimal understanding among most of the people who were interviewed of intellectual property rights, or about how they could be applied.

Research Question 2: What Are the Effects, Challenges and Benefits Observed During These Partnerships?

Gilsing et al. (2011) note that funding is a challenge in business partnerships. The major challenges pointed out by most of the participants related to funding constraints and market access. Financial constraints were experienced by both the corporates and the SMMEs. The SMMEs required financial support to operate their businesses and grow. This also applied to the corporates, even though they were perceived to be the parties with greater access to funds, as their revenue and profits were much higher than those of the SMMEs. However, careful attention had to be given to reducing operating expenses and simultaneously acquiring capital with the aim of maintaining and growing their businesses. Allocating more project scope and offering longer duration contracts was an issue, as the SMMEs saw this as an opportunity for their business to develop and to increase the likelihood of being independent and self-sufficient. This challenge might have arisen as a result of the country's troubled economy, causing each organisation to be in survival mode. The BBBEE code's objectives include the growth of black-owned enterprises in the economy; but in a weak economy it is difficult to share the remaining profits effectively.

The ineffectiveness of the incubation agencies was another challenge that emerged. The SMMEs' perception was that there was a gap in the agencies' understanding of the SMMEs' needs, and they felt that true value was not added. Another challenge experienced by some SMMEs was the lack of flexibility in the corporates to react quickly to the SMMEs' needs, such as providing better options for payment (that is, quicker payment terms) after services had been rendered, as this affected their business cash flow.

According to Hughes et al. (2007), incubators house small firms to help them grow. This was seen when the corporates housed the SMMEs in their premises and provided free office space. A high-profile address meant a lot to the SMMEs, and it reduced their monthly business expenses. Workshop areas were made available by the corporates, allowing the SMMEs' businesses to meet all of their operational obligations. Their business profiles improved, with opportunities to provide services to the corporates, thus increasing their competitive advantage along with their experience of business. The SMMEs indicated that, since joining the incubation programme and beginning to work with larger firms, they had learned new ways of doing business, making them more innovative in their business operations. The chance to be given an opportunity to market the SMMEs at a business expo increased their networks, and raised clients' awareness of their services. There was a limited response on the number of benefits that the SMMEs derived from the programme; mostly they wanted to be given more opportunities to provide services in order to sustain their businesses.

In order to do business in South Africa, a good BBBEE score puts a company in a better position to win a contract. Large companies that need services to be rendered require the suppliers to comply with the BBBEE policy. Because the ESD element carries the greatest number of points of the five score card elements (with ESD and preferential procurement as sub-indicators), ESD has a major impact on the overall BBBEE status of a company. So each company aimed to achieve the best score—Level 1 BBBEE status—to increase their competiveness. Case A had the highest score (level 2), followed by Case B and Case C, both with level 3. All had improved over the years on the sub-indicators of the ESD score and preferential status. This indicated that corporate A supported more black-owned companies than the other two corporates.

6 Concluding Remarks and Limitations to This Study

Initiatives have been undertaken by corporates to support black-owned SMMEs, and incubation programmes have been structured to provide them with business support; but the entrepreneurs still face challenges, and would welcome more opportunities to sustain their businesses. Operating a business is complex, and is affected by many factors. The poor performance of the country's economy puts pressure on both the corporates and the SMMEs, with limited business opportunities for both. A number of strategies have been devised by the government to improve the country's economy, but global market conditions and corruption remain issues that make reaching the goal difficult. Some knowledge has been transferred, but more knowledge and ownership of intellectual property rights could be transferred by the corporates to the SMMEs in order for them to be independent and innovative. Entrepreneurs could be exposed to practical skills on how to access markets and to depend less on corporates, as they are all competing in the same market. The government could make funds available to SMMEs in order for them to upskill themselves, and inject capital to purchase technology that can assist them in growing their businesses. Stronger relationships between corporates and SMMEs will enhance working towards a common goal and meeting one another's objectives.

In this study, a few limitations were noted that could provide areas for future research. This study only aimed to discover the support provided by corporates to SMMEs. An evaluation of the extent of the impact that these services have on the businesses of the SMMEs can be considered in future research. Furthermore, a number of challenges experienced by SMMEs were uncovered; beneficial would be to include business experts to provide advice on how the SMMEs could overcome these challenges, and which policy makers could consider. Although knowledge transfer from the corporates to the SMMEs took place, there is still opportunity to evaluate the absorption of that knowledge.

References

Andrew A, Paul H (2006) Localised strategies for supporting incubation: Strategies arising from a case of rural enterprise development. JSBED 13(1):48–61

Bai C, Sarkis J (2011) Evaluating supplier development programs with a grey based rough set methodology. Expert Syst Appl 38(11):13505–13517

Braziotis C, Tannock J (2011) Building the extended enterprise: Key collaboration factors. Int J Logist Manag 22(3):349–372

CIPC (2018) Companies and Intellectual Property Commission. South Africa: Companies and Intellectual Property Commission. Available https://www.cipc.co.za/index.php/trade-marks-patents-designs-copyright/what-ip. Accessed 09 October 2018

Eisenhardt KM, Graebner ME (2007) Theory building from cases: opportunities and challenges. AMJ 50(1):25–32

Gilsing V, Bekkers R, Bodas Freitas IM, van der Steen M (2011) Differences in technology transfer between science-based and development-based industries: Transfer mechanisms and barriers. Technovation 31(12):638–647

Glock CH, Grosse EH, Ries JM (2017) Decision support models for supplier development: Systematic literature review and research agenda. Int J Prod Econ 193:798–812
Hughes M, Ireland RD, Morgan RE (2007) Stimulating dynamic value: social capital and business incubation as a pathway to competitive success. LRP 40(2):154–177
Krause DR, Ellram LM (1997) Critical elements of supplier development: the buying-firm perspective. Eur J Purch Supply Manag 3(1):21–31
Kutzhanova N (2007) Entrepreneurial skill development and how best to assist entrepreneurs: policy implications for enterprise development practice, University of Louisville
Kutzhanova N, Lyons TS, Lichtenstein GA (2009) Skill-based development of entrepreneurs and the role of personal and peer group coaching in enterprise development. EDQ 23(3):193–210
Lalkaka R (2001) Best practices in business incubation: lessons (yet to be) learned. In: International conference on business centers: actors for economic & social development. Brussels, November, 2001, pp 14–15
Lalkaka R, Shaffer D (1999) Nurturing entrepreneurs, creating enterprises: technology business incubation in Brazil. Int Conf Eff Bus Dev Serv 1999:2–3
Lichtenstein GA, Lyons TS, Kutzhanova N (2004) Building entrepreneurial communities: the appropriate role of enterprise development activities. Community Dev J 35(1):5–24
Liu H, Liang X (2011) Strategy for promoting low-carbon technology transfer to developing countries: the case of CCS. Energy Policy 39(6):3106–3116
Logeek S (2010) Analysis of success factors for supplier development. Published MBA thesis, San Diego State University
Mahomed H (2015) A tangled web: the perceived influence on broad-based economic empowerment legislation on corporate social investment in South Africa. Available: https://africanphilanthropy.issuelab.org/resources/25746/25746.pdf. Accessed 09 October 2018
Masutha M, Rogerson CM (2014) Small enterprise development in South Africa: the role of business incubators. BOG Socio-Economic Series 26(26):141–155
Mian S, Lamine W, Fayolle A (2016) Technology business incubation: an overview of the state of knowledge. Technovation 50:1–12
Morales-Nieto J (2008) Globalization of microfinance markets: Some conditions for success. AfricaGrowth Agenda, 2008 (Apr/Jun 2008) pp 6–8
Nagati H, Rebolledo C (2012) The role of relative absorptive capacity in improving suppliers' operational performance. Int J Oper Prod Manag 32(5):611–630
Nichter S, Goldmark L (2009) Small firm growth in developing countries. World Dev 37(9):1453–1464
Noor KBM (2008) Case study: a strategic research methodology. Am J Appl Sci 5(11):1602–1604
Peters L, Rice M, Sundararajan M (2004) The role of incubators in the entrepreneurial process. JTT 29(1):83–91
Pooe RD (2016) The latest 'big thing' for South African companies: Enterprise and supplier development—proposing an implementation framework. JTSCM 10(1):1–12
Prahinski C, Benton W (2004) Supplier evaluations: Communication strategies to improve supplier performance. JOM 22(1):39–62
Rogers EM, Takegami S, Yin J (2001) Lessons learned about technology transfer. Technovation 21(4):253–261
Saunders M, Lewis P, Thornhill A (2016) Research methods for business students. Pearson Education, UK, London
Soetanto DP, Jack SL (2013) Business incubators and the networks of technology-based firms. JTT 38(4):432–453
Szabó A (2006) Business incubation as element of business service institution and SME development infrastructure for creation of new enterprises in CITs. ERENET, Budapest 2006–14c
The DTI (2018) Government Gazette No. 41546. The Department of Trade and Industry. Available: https://www.thedti.gov.za/gazzettes/41546.pdf.

Wagner SM, Krause DR (2009) Supplier development: Communication approaches, activities and goals. Int J Prod Res 47(12):3161–3177
Yin RK (1981) The case study crisis: some answers. Adm Sci Q 26(1):58–65

Future Directions for Entrepreneurship, Technology Commercialisation and of Innovation Policy in Africa

Research and Innovation Uptake Landscape in Rwanda: Analysis of the STI Framework

Parfait Yongabo

1 Introduction

Worldwide, developing countries are investing much effort in their socio-economic development. The aspired socio-economic development is expected to be achieved by means of adjusting development strategies that were solely based on natural resources and focus on the use of science and technology to address development challenges. The production of needed knowledge and its application are major drivers for making science and technology important to contributing to the needed socio-economic development. Research is considered as among the potential means for producing the needed knowledge whereas innovation is seen as the result of the application of knowledge for addressing the identified development problems (Bercovitz and Feldmann 2006). However, both research and innovation require a level of capacity that can be acquired through consistent scientific training and exposure. This echoes the importance of a comprehensive Science, Technology and Innovation (STI) framework that can facilitate major operations for the production and use of knowledge for socio-economic development (Clark 2002; Juma and Yee-Cheong 2005; Leslie and hUallachain 2007). Thus, STI organization is considered as a stepping-stone for the development paradigm shift in developing countries, as it was experienced in developed countries.

As a way of shifting from the traditional development approach merely based on natural resources export, some developing countries have opted for technology importation as a first step to ensure they exploit available natural resources for their local needs. This has stunted the motivation for local researchers to engage in

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developing their own technologies beneficial to their countries (Juma 2005). Some imported technologies have even failed to respond to local needs, highlighting the need for contextualization by local researchers who understand their own countries' contexts (Etzkowitz and Dzisah 2008; Lawton Smith and Leydesdorff 2012). However, to do this, there is a need to build internal capacities and establish facilitation mechanisms and conducive environments that allow the production and use of knowledge for addressing real societal problems (Juma 2016). This might require a sustainable investment in education, skill development, science, innovation and technology as a means for paving the way for the progressive shift from technologies importation to internal technologies development and adoption. However, it is essential to have an organizational framework that can accommodate changes and provide the needed operational environment.

The rethinking of development approach from resources-based economy to a knowledge-based economy has caused development stakeholders to pay attention to policy and institutional framework as key facilitating instruments to institutionalize the production and use of knowledge for development (Amsden 2001; Etzkowitz and Dzisah 2008). However, this also requires systemic operational and organizational structures that favor active interactive learning processes for knowledge generation, transfer and application (Chaminade et al. 2018; Lundvall 2010). Knowledge institutions, mainly academic and research institutions are recognized as major sources of knowledge necessary for the development and economic transformation. Whereas industries and policymakers are considered as major end-users of produced scientific knowledge. However, there is the long-lasting claim from end-users that knowledge generated by knowledge institutions remains not available and accessible, and in some case when it is accessed is less responsive to their problems (Bercovitz and Feldmann 2006; Mueller 2006).

This is mainly due to the observed gap between the production of knowledge and the application of knowledge in support of development in most developing countries (Lawton Smith and Leydesdorff 2012; Göransson 2016). The alignment of government structures and development of technological imperatives could be important for facilitating the application of produced knowledge and problem-solving approaches that consider research and innovation as means for development (Juma and Yee-Cheong 2005; NCST 2015). This is likely to depend on proper STI policies and institutional frameworks. However, STI policies seem to be generic in many cases leading to less effective implementation and facilitation in positioning STI in the development process. Thus, there is a quest for a good understanding of how structures and working environment in a specific context can contribute to enhancing the facilitation of production and use of knowledge for development, particularly in developing countries. In relation to this, this chapter uses the Rwandan case to explore the research and innovation uptake landscape through the understanding of efforts that are being invested for accelerating the production and use of scientific knowledge for socio-economic development. An assessment of the STI policy setting, institutional framework, capacity development and discussion on ways for operationalizing research uptake frameworks based on the Rwandan context are presented to underpin this exploration.

2 Background: Contextual and Theoretical

2.1 Research and Innovation Uptake: A Need for Rwanda?

Research uptake is viewed as effective utilization of research-based evidence by research end-users (policymakers, industries, etc.) in order to improve development practices that lead to positive development outcomes with a realizable impact on socio-economic transformation and life standards improvement. At the same time, research uptake is considered to be a systemic and strategic process encompassing the absorption of research outputs and undertaken facilitation processes for the benefits of the society at large (Nguyen 2014; Ahmed 2016). The whole process of becoming aware, accessing and using research outputs by end users requires a comprehensive facilitation mechanism (Adolph, Herbert-jones and Proctor 2010; Nguyen 2014). The latter might take into account the institutional and policy frameworks as starting points for the organization of the process facilitation. However, other specific factors linked to the context need to be explored, such as research production capacity, STI promotion and stakeholders' interaction in general, among others. The organization of research and innovation uptake is seen as a challenge in many parts of the world due to issues mainly linked policy goals and directions concerning STI (Iizuka et al. 2015). To address these issues, analyzing the research and innovation landscape can be a starting point. The main components of the landscape mainly include institutions, their functions, policies and interactions among institutions. These landscape patterns are likely to have different shapes depending on the context and can be linked to standard concepts like National Innovation System and Triple Helix Model.

The analysis of the research and innovation uptake process in the Rwandan context is relevant because of the high demand for knowledge and skills to address Rwandan socio-economic development needs. The small land, limited natural resources, high population density, landlocked geographical location and the historical background explain the high demand for knowledge and skills to supply appropriate technologies and innovation to address development challenges. Based on the current challenges, there is a high commitment from the Rwandan government for investing in technology-based solutions and building internal capacities for knowledge production. This is expressed in most national development plans and programs, in most cases expressed under the "Knowledge-Based Economy" concept (Republic of Rwanda 2012; MINECOFIN 2013, 2017). With the expressed high demand and high commitment, there is a need to understand how the facilitation process for knowledge production and application is structured and what can be better options in the Rwandan context for materializing the high commitment and meet the demand. A comprehensive analysis of the STI framework can contribute to addressing this issue based on the role of STI in the whole process.

2.2 Does STI Framework Matter?

Science, Technology and Innovation (STI) are important for supporting the development of technical skills that respond to community needs and economic growth demand. The integration of STI into development is mainly organized through STI programs, which need tools and organizational framework for their success. STI Policies are among key facilitating tools that are likely to lead to development outcomes resulting from the use of scientific and technological knowledge. However, these policies tend to be generic, which in many cases might lead to less efficiency or unexpected results. It is important to analyze how structures and working environment affect both the formation of those policies and their implementation and outcomes in a specific context (Havas 2002). The importance of STI policies in supporting economic transformation can be observed in the case of the East Asian Tigers (Taiwan, Singapore, Hong Kong and South Korea) (Hobday 1995), where flexible policies allowed the development and adaptation of knowledge for the technological development which resulted into a remarkable economic performance.

The relevance and impact of STI policies are linked to policy goal setting and priority setting in line with the development goals. The focus of STI initiatives may differ from country to country depending on the development strategy and resources as well as operational conditions. This also can determine how STI policies are framed in different countries (Jacobsson and Bergek 2006). In most cases, science policies are separated from technology policies as well as innovation policies. There is no clear cut between these policies, except the way policymakers approach them. Science policies are generally aimed at promoting science in the education system and research institutions while technology policies focus on the development of technologies in areas influencing society's development. Innovation policies typically consider the complexities of innovation processes and facilitate interactions among relevant institutions to ensure quality and socio-economic impact resulting from their relationships (Dodgson and Bessant 1996). In some other countries, research and innovation policies are combined, there are also possibilities of combining research, science, technology and innovation under the same umbrella as a policy. This explains the importance of understanding differences and major orientations of STI framework in individual countries in order to understand how they can contribute to orienting the integration of knowledge into the development process.

According to Ergas (1987) in his analysis of technology policies, countries with high investment in R&D typically define their policy objectives as "*mission-oriented*" whereas countries with medium investment shape theirs as "*diffusion oriented*"; there are others which combine the two objectives, mostly New Industrializing Countries. The policy objective defines the nature of innovation to be focused on and the actors of interest. Mission-oriented policies tend to promote radical innovations aimed at solving state problems whereas diffusion oriented policies favor incremental innovations aimed at addressing society problems through technology uptake at different levels and in different forms. The nature and level of impact of R&D initiatives are then based on policy objectives as well as the operational environment (Ergas 1987; Dodgson and Bessant 1996; Havas 2002).

Taking the example of the United State of America, France and the United Kingdom as discussed by Ergas (1987) in his study of technology policies in these countries, clear differences in technology impact can be identified, although the policy objectives were the same across the three countries. The differences are based on approaches and structures (operational environment) in each country for implementing policies. Bureaucracy and centralization in the UK were at the origin of less effective technologies generated from R&D activities while the high level of autonomy and flexibility in France allowed technology to have a more relevant impact than in the other two countries. The USA had a high level of control in technology dissemination as the UK, but due to the wide market and resources in the USA, technologies have reached other socio-economic sectors beyond the military sector, which was a priority. From this, it can be observed that policies and institutional frameworks are of significant importance for having impactful R&D initiatives, although, external factors in the operational environment can influence their objectives as well.

With the case of Hungary during the late 1990s, instantaneous changes in structures and institutions did not favor the development of STI policies, causing innovation systems to underperform. But after 2000 with STI policies adoption and stabilization, R&D activities showed outstanding success and the use of technologies from these activities by industries increased; this led to a noticeable change in the economic performance of the nation (Havas 2002). Appropriate policies can thus define the level of success for research and innovation in the economic transformation to a certain extent. From these perspectives, it is clear that the STI organizational setting and policy framework are at the base of interactions that promote the use of scientific knowledge for development. Then, effective STI policies can play an important role in economic development by facilitating these interactions leading to industrial transformative development that improves the technological capabilities of firms with knowledge at the center of operations (Dodgson and Bessant 1996). STI policies support to socio-economic development as a facilitating tool may vary from one country to another depending on economic structures and working environment at a specific place. This explains the interest in exploring the STI framework (policy and organization) as a point of departure for developing efficient research and innovation uptake frameworks that can accelerate the use of knowledge for development in Rwanda.

3 Methodology

This study focuses on the Rwandan STI framework as a means for exploring the research and innovation uptake landscape, considering the patterns of policies, institutions, capacity building and interactions. It uses mixed methods, including structured review of existing documents, survey and secondary data mining. The review included scientific articles, scientific reports, official reports, programs and policy documents. Whereas for the survey, research managers at universities and public agencies, researchers and entrepreneurs were consulted categories. Secondary data were acquired from different databases in offices in charge of STI matters in Rwanda.

The survey included two series, the first round was conducted in April 2017, it was based on a set of generic questions sent online to 10 top managers in public agencies and universities. Seven persons over 10 contacted responded to the questions. The questions mainly focused on enablers for research and innovation uptake, stakeholders' collaboration, synergies in research management and facilitation; and research infrastructures and capacity building, among others. Depending on the structure of each institution, I considered offices having technology transfer in their mandates. Respondents in government institutions and academic institutions were senior managers. For entrepreneurs, the Private Sector Federation was consulted as the overall umbrella for the business sector in Rwanda. Contacted institutions include the University of Rwanda (UR), University of Kibungo (UNIK), National Industrial Research Development Agency (NIRDA), Rwanda Agriculture Board (RAB), National Commission for Science and Technology (NCST) and the Department of Science, Technology and Research in the Ministry of Education (DSTR, MINEDUC). After the first round of April 2017, follow up discussions were conducted in December 2017 with a semi-structured interview based on the feedback provided in the initial online consultation and follow up questions were related to policy and institutional framework as well as well collaboration among stakeholders. Follow up interviews lasted for 30 min to 1 h and all the 10 initially contacted stakeholders were included.

To complement the information from the literature and the survey, available data from databases and reports of recently completed studies related to R&D and STI in Rwanda and Africa at large were used. Data on higher education matters were obtained from the Rwandan Higher Education Council. Whereas, data on research capacity and skills demand were acquired from the National Research and Development Survey of 2015 as well as the Africa Capacity Report of 2017.

Collected information was organized and analyzed systematically in order to analyze the main components of the Rwandan research and innovation landscape, which is the main objective of this chapter. Survey data were arranged based on key predefined parameters in order to be able to display information in the form of diagrams and info-charts. Predefined parameters included the category of actors, perception on the interaction among actors (synergy), identified challenges and perceived enablers. For quantitative data, cross-tabulation was done for producing summary tables. Analyzed variables were the trend in time for capacity building in higher education (estimated using the number of graduates per level of education over time).

4 Institutional and Policy Frameworks for Research and Innovation Management in Rwanda: A Systemic Review

Policies and institutions are among the potential components for setting organizational systems to support the production and use of knowledge for society development. In the case of Rwanda, as a landlocked developing country with limited resources, more comprehensive policy and institutional frameworks that ensure synergies among actors for meeting the common development goals are imperative. However, the establishment of such frameworks requires a good understanding of the system setting as a point of departure. This section of the chapter elaborates on the STI policies setting and institutional arrangement in Rwanda as mean of highlighting what exists and what would be the best recommendations to be considered in developing/adapting the needed comprehensive frameworks.

4.1 Research, Science, Technology and Innovation Policy Setting in Rwanda

Efforts have been invested in establishing STI policies and their instruments that are inspired by the government plans and programs in order to ensure that policy goals lead to the expected socio-economic development. The initial National Education Sector Policy of 1998 was a point of departure in reviving the Rwandan education sector after the tragedy of the Genocide against Tutsi of 1994 (UNESCO 2015). This policy paved the way for other policies that followed as a way of taking a wide sector approach. In 2003, a new education sector policy was developed with considerations for developing other specialized subsector policies for enhancing the production and use of scientific knowledge (MoESTSR 2003). The National Science, Technology and Innovation Policy of 2006 is among the developed policy in order to provide avenues for STI promotion in Rwanda (Murenzi and Hughes 2006). The efforts in developing policies were accompanied by the development of policy instruments for ensuring their implementation. However, consulted stakeholders perceived the implementation of policies to be slow due to overlap in policy goals, lack of human capacity, lack of financial means, low collaboration among actors and lack of a comprehensive institutional framework for coordination.

In relation to the low implementation of policies, stakeholders highlighted concerns on the policymaking process, which is seen as a top-down with limited consultation with concerned stakeholders. The use of international consultants with less knowledge of the Rwandan context is also seen as among the factors that slow the implementation process. Because most of the policies consider less the realities of the local context. They are formulated in a normative way based on what succeeded in other countries that have made considerable progress in STI. This, in turn, affects the implementation because the policy custodians in Rwanda in most of the cases fail to produce policy instruments that respond to the policy goals. To address this, Rwanda has started to build its internal capacities and encouraged the collaboration of international consultants with local consultants who understand the context. The policy-making process now is taking a more comprehensive approach with an emphasis on consultation with stakeholders in different forms and at different stages.

> As the Ministry of Education, we did a lot in the past in developing the STI policy but still, the clear research policy is in need and there is still a challenging issue linked to research and innovation strategic plans, they have been developed but not yet released, M&E mechanisms and clear policies implementation mechanisms. Much effort should be put in strategic consultation frameworks so that people can exchange experiences and lessons learned from other places (inside and outside the country). The national dialogue "Umushyikirano" can be a good example of a consultation framework were policy recommendations can emerge. If it can be possible to have sector-based consultation frameworks, it can contribute a lot in policy implementation, especially research and innovation oriented policies as they deal with how to address real problems in the society (Senior STI Manager).

The STI policies are aligned with their supporting policies, policy instruments and their inspiring government plans and programs in order to increase chances for successful implementation and impact. Figure 1 provides details on the key STI policies and other aligned policy instruments and government plans. In addition to national policies, academic and research institutions also prioritized the development of research and technology transfer policies to ensure that conducted research is of high quality, and responds to community demand. In 2006, the former National University of Rwanda developed its first research policy and other Higher Learning Institutions (HLI) both public and private followed with their own research policies; about 91% of academic and research institutions in 2010 had research and technology transfer policies (Butera et al. 2012). In addition to Higher Learning Institutions,

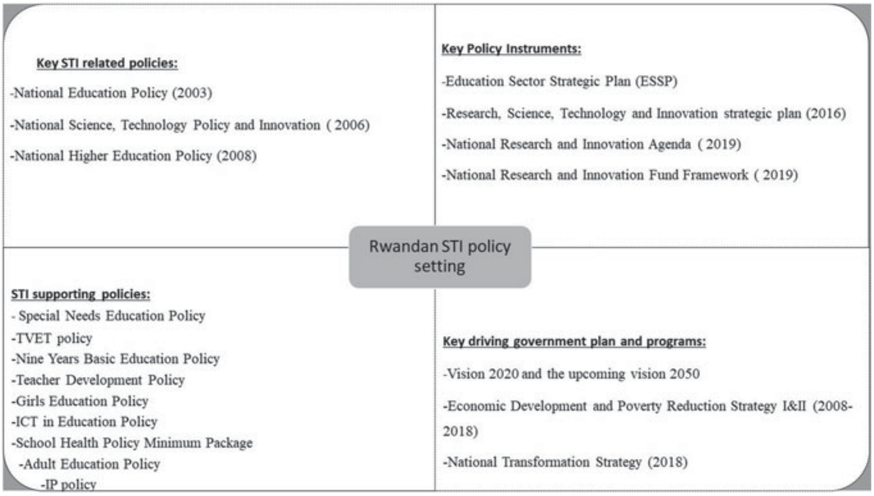


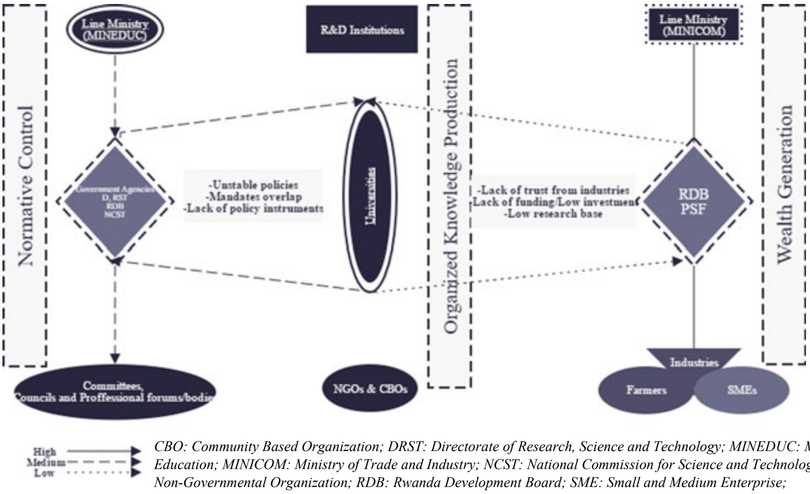
Fig. 1 STI policy setting in Rwanda *Source* Author's' own compilation based on policy documents and reports

other research institutions have moved on with developing their research policies and technology transfer policies as a way of strengthening the production of scientific knowledge and its use for solving the societal problems. Supporting policies in strengthening the education sector as a mean of increasing the capacity for knowledge creation and acquisition were also developed. To allow the facilitation of the use of produced knowledge, policies on intellectual property rights and commercialization were put in place as well. Although, their awareness remains very low among the stakeholders.

4.2 Institutional Frameworks for Research and Innovation Management in Rwanda

To ensure the coordination of STI activities in Rwanda, structures have been established to facilitate the interactions and smooth implementation of activities responding to the overall goal of producing and using knowledge for development. These structures as in other environments in the initiation phases faced a series of review and restructuring for the sake of achieving stable and delivering structures. Over a long period, all activities related to STI were overseen by the Ministry of Education (MINEDUC) until in 2017 where the National Council for Science and Technology (NCST) was given the overall mandate to coordinate national Research, Science, Technology and Innovation activities. As a way of supporting this national coordination organ, there are sector-specific entities that are in charge of promoting STI in specific sectors. Those include the National Research and Industrial Development Agency, the Rwanda Agriculture Board, the Rwanda Biomedical Center and the Rwanda Standard Board, among the major. The Rwanda Development Board has the overall mandate for facilitating Intellectual Property Management in collaboration with the Ministry of Trade and Industries. However, it is not clear to stakeholders how these organs collaborate and complement each other. Consulted stakeholders expressed their views on a remarkable duplication of efforts among most of these institutions and lack of consultation and collaboration. Referring to studies on the performance of the National Innovational System that have proved that synergies among actors and effective organizational structures are imperative for knowledge dissemination and use (Lundvall 2007; Edquist 2008), it can be envisageable for Rwanda to rethink about its institutional organization and assignment of mandates.

The proper assignment of mandates might have a significant functional improvement in the current institutional framework. According to the normative function of institutions in the triple helix model, as described by Lawton Smith and Leydesdorff (2012), the current Rwandan institutional framework shows the arrangement of institutions according to their prescribed function but doesn't have strong expected linkage among the functions, which explains the lack of operationalization of the normative functions. This is also linked to unclear and duplicated mandates for some institutions. Institutions have their mandate stating what needs to be done but they



CBO: Community Based Organization; DRST: Directorate of Research, Science and Technology; MINEDUC: Ministry of Education; MINICOM: Ministry of Trade and Industry; NCST: National Commission for Science and Technology; NGO: Non-Governmental Organization; RDB: Rwanda Development Board; SME: Small and Medium Enterprise;

Fig. 2 Current Rwandan functional institutional framework for research and innovation management based on Lawton Smith and Leydesdorff, 2012 triple helix functions *Source* Authors own compilation based on policy documents and reports

are still missing clear strategies on how to do that. Figure 2 shows the status of the institutional framework for research and innovation management in Rwanda based on their predefined normative functions and the perceived level of interactions by stakeholders.

As highlighted in Fig. 2, knowledge institutions, which are universities, research and development institutions and other Non-Governmental Organizations (NGOs), including community-based organizations are expected to accomplish the organized production of knowledge. Knowledge production in this context focuses more on research-based knowledge. The contribution of these institutions may be through active direct involvement or indirect involvement. This production of knowledge is to some extent organized and managed in regulatory and administrative way under the control function umbrella accomplished mainly by the public agencies mandated for research, science, technology and innovation. Whereas the use of the produced knowledge is expected to be performed by the business sector through the valorization of IP (commercialization) and industrial development. The private sector and the line ministry in charge of commerce and industries and other aligned agencies like RDB facilitate this function of wealth generation through the use of knowledge. Small and Medium Enterprises are considered as basic operational units to accomplish that function. These three functions can be performed if there are strong operational links among the performers. There is a moderate link between the controllers/facilitators and the knowledge producers, whereas there is a low link between the knowledge producers and knowledge users for wealth generation. Several factors affect the levels of linkage, including unstable/unclear policies, mandate overlaps and lack of policy instruments for the needed efficient control. Whereas the lack of trust among stakeholders, low investment and low level of research production are among the factors slowing down the linkage between knowledge production and use for wealth generation.

- The level of synergy is still low. The interactions are based more on individual contacts, rather than institutional frameworks. There is a lot said about PPPs but there are no national mechanisms to drive them forward. For example, at the institutional level, it should be mandatory to have Advisory Committees as part of the regulations that are enforceable. At a national level, the PPPs and Triple Helix initiatives can be supported through Government subsidies and tax rebates (Research Manager at University).

- The level of synergies is still low even though things are getting better due to new strategies, which are being put in place (STI Manager in Public agency)

The above challenges are seen as common continental challenges in Africa. Generally, in regards to the development of STI policy and institutional frameworks, as highlighted in the African Capacity Report of 2017, there is promising progress in most of the African countries. However, STI related policies implementation was reported as a critical problem for most African countries, where about 84.4% of African countries have policies in place but only 40% have clear processes for policy implementation in place (ACBF 2017). This is the case also for Rwanda though it is not easy to quantify the pace of implementation of the various STI policies as they are subject to many reviews before they achieve the stage of impact and this explains the instabilities and overlap of institutional mandates as well.

5 Promotion of Higher Education System and Building Internal Capacities in Rwanda

The development of the higher education system is among the potential ways to build internal human capacity that can respond to the local development needs. This is part of the Rwandan strategic actions to make STI among the core drivers for development. The Rwandan education sector is increasing opportunities for higher learning institutions to operate in Rwanda and stimulate competitiveness among the graduate on the labor market. In the same line, about 30 private higher learning institutions were accredited to operate in the Rwandan academic sector and one public university (University of Rwanda) with six colleges in disciplines of Agriculture, Arts and social sciences, Business and Economics, Health Sciences, Education Sciences and Science and Technology was established in 2013 for efficiency and effectiveness (HEC 2019). To stimulate practical oriented training and the generation of technical skills responding to the community demand, the GoR established the Work Development Agency (WDA) in 2008 to coordinate and ensure the quality of practical training. This aims the production of employable graduates to specific labor market needs, responding to the technical skills needed for development. Under WDA, the Rwanda Polytechnic was established in 2017 with eight Integrated Polytechnic Regional Centers (IPRC) and 22 Technical Vocation Education and Training

Table 1 Awarded degrees from 2000 to 2015 in Rwanda

Academic year	Diploma	Bachelor's degree	Postgraduate degrees (PGD, M.Sc. & Ph.D.)	Total
2000–2002	780	1591	0	2371
2003–2005	1536	7340	41	8917
2006–2008	2639	16,666	362	19,667
2009–2011	7048	28,632	1551	37,231
2011–2015	4713	28,793	3347	36,853
Total	**16,716**	**83,022**	**5301**	**105,039**

Source Rwandan Higher Education Council (HEC) 2016

(TVET) certificate courses were designed, of which six are agriculture oriented as agriculture is among the main economic sectors of the country (WDA 2018).

In addition to the higher education system promotion, research capacity building has been prioritized as well, even though the base is still low. Table 1 shows the trend in degrees awarded in higher education in Rwanda over 15 years period (from 2000 to 2015). Despite this positive trend, the number of qualified and active researchers is still low. According to the research and development survey of 2015 with 2013–2014 as a year of reference, most active researchers in the higher education sector were MSc holders (51%). Whereas active staff to support research activities had a Bachelor's Degree in both government and private sector at a rate of 39% and 40% respectively (UNESCO 2015). The number of qualified staff for conducting research is still low across the country; for example, the University of Rwanda in 2014 had only about 19% of staff with PhDs (UR 2014) and the same situation is reported in the Agricultural Research and Development Indicators Factsheet, 2018 where only 21.9% of researchers in agriculture domains are PhD holders (Flaherty et al. 2018). To bridge this gap, a number of collaborations have been initiated for capacity building and training programs at advanced levels are being established.

Although the education system and human capacity are being developed in Rwanda, stakeholders expressed the need to consider the development of research infrastructure and funding capacity. This is among the core challenges for most of developing countries as they have a high dependence on external funding and donations for their research budgets and infrastructure development (Juma 2006; Göransson 2016; ACBF 2017). As a way of approaching the issue, African leaders, in their ordinary session of African Union Head of State and Government Summit of 2014, committed to investing at least 1% of the national GDP in Research and Development (R&D) and they emphasized on the importance of the integration of STI in all African development agendas. The commitment was a good start, however, the current effort in its implementation signals difficulties for many Africans countries. This can be explained by the continental average of 0.5% of the GDP invested in R&D, even some countries are not yet able to consider R&D in their national budget (ACBF 2017).

For Rwanda, the R&D investment was estimated at 0.2% of the national GDP in 2015 (UNESCO 2015), although the commitment is 1% by 2020 and 4% by 2050 (Gatare 2016). The current share of the GDP for R&D seems to be small compared to targets set and to the practice in developed countries where R&D made a progress. Thus, it would be in the interest of Rwanda to explore possibilities to meet such ambitious commitments in addition to the donor led research funding. The encouragement of industries to invest in R&D would be one of the options. This might be done through setting incentive schemes for industries that invest in R&D and give a level of autonomy to research institutions for the smooth running of joint research activities with industries. The established National Research and Innovation Fund might be a starting point to exit from donor led research funding and expand horizons for the Rwandan research funding by interesting industries to invest in research. This funding instrument will need to consider a more inclusive approach that stimulates long-term collaboration between the knowledge producers and knowledge users. It might be advisable to direct effort to transdisciplinary applied research and give less interest to blue-sky research. This might also be a way of valorizing considerable investments done for infrastructures to support applied research and innovation, including ICT infrastructures, the establishment of centers of excellence and scientific laboratories as well as innovation hubs and incubators.

6 Driving and Constraint Factors for Research and Innovation Uptake in Rwanda: Towards a Performing STI Framework

The organization of knowledge production and its use is context-specific as discussed by Lawton Smith and Leydesdorff (2012) and depends on available resources, actors and their interactions. For the case of Rwanda, consulted stakeholders had relatively similar perceptions on the major considerations for shaping research and innovation uptake in Rwanda, mainly in the view of driving and constraint factors to promote the use of research outputs for national development. Strong policy and institutional frameworks were among the factors perceived by stakeholders as important, followed by the researcher's capacity building through higher education and mentorship, and collaboration among stakeholders. Research funding and access to adequate infrastructure were also mentioned as main drivers to high quality research outputs that can have development impact and meet community needs. Both literature and survey results confirm that progress has been made in the areas of policy development and institutional structuring; however, gaps in policy implementation, stability and consistency are still observed.

Although there has been progress, some constraints to research and innovation uptake are still observed. Consulted stakeholders in the survey repeatedly mentioned the lack of trust among actors to be among the key constraints. It was highlighted from the academic side that there is concern about the protection of intellectual properties whereas industries are concerned about the research quality. The lack of trust and low research quality may be at the root of the lack of interest among industries to invest in research and limited interactions between industries and research institutions. This lack of interaction between industries and research institutions is a hampering factor for having a performing framework that allows the flow of knowledge among socio-economic actors in Rwanda. According to Lundvall (2007), interactions between firms and knowledge infrastructures (universities, research institutions) are among the indicators of a sustainable innovation system. If interactions are weak or non-existent, it may be hard to realize national economic growth resulting from knowledge dissemination and use. This seems to be the case for Rwanda where it is hard to see the contribution of scientific knowledge to national economic growth. This can be observed by looking at the commercialization of research outputs and the use of knowledge to solve the community problems, which is still very low.

> *The main issue is the quality of researchers and research output. The business side is interested in high quality research outputs that directly impact business performance such as increased sales, increase in production and productivity, loss reduction, risk mitigation. But most of the research outputs are unusable to the industry. What I am trying to say is that the reports are good but cannot benefit the end user practically* (*Research Manager at University*).

In addition to the need for trust, other considerations in support of the ultimate use of knowledge through the aspired research commercialization and general community use include policy and institutional framework. The latter can pave the way for the proper establishment of collaboration framework, research funding and capacity building, among other intermediate factors to driver research and innovation uptake in Rwanda. The proper collaboration frameworks may lead to the needed trust and appropriate Intellectual Property Right (IPR) use. Whereas, the research funding supports the infrastructure, general research activities and incentives for research. The capacity building in different forms, like formal training or continuous learning on job supports skills development. The interconnection among these factors is likely to lead to the high quality research, motivation of research and credibility and availability of credible data/information to end-users, which are among perceived key attributes for increasing the research uptake. Figure 3 illustrates the connection among the factors that may contribute to enhance the research and innovation uptake and their relationship as indicated by arrows.

7 Analytical Perspectives

The Rwandan context as analyzed demands for a more comprehensive systemic approach to organizing the creation, diffusion and use of knowledge. This poses an interest in major components of the system and interactions among these components for having a functional system. The described STI framework in terms of policies and institutions can be a point of departure in building such a system, like the National Innovation system as suggested by its pioneers (Nelson, Freeman and Lundvall).

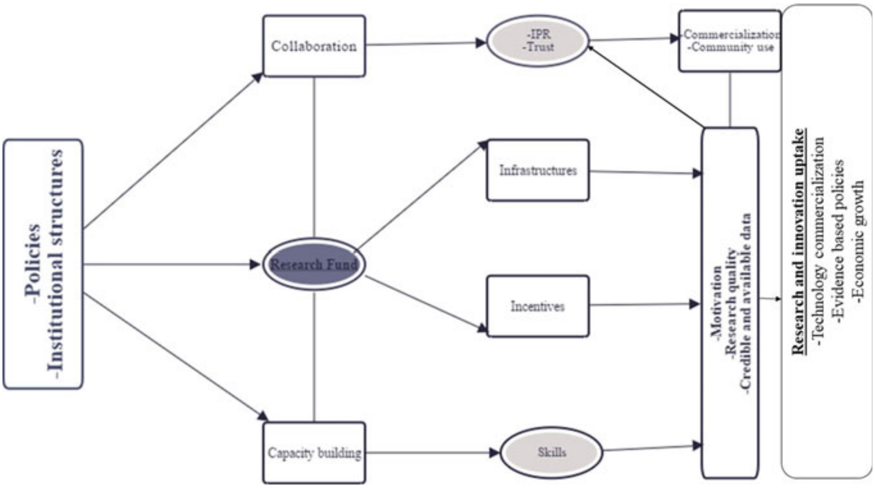


Fig. 3 Diagram of perceptions of drivers for research and innovation uptake in Rwanda *Sources* Survey by the author, 2017

According to Lundvall (1992), the National Innovation System is considered as a comprehensive framework that can facilitate the use of research, science, technology and innovation to support the society development. It considers knowledge as the main capital and learning as the core process. In this framework, economic structures and institutional settings shape the interactions that ensure the co-evolution of knowledge generation and diffusion among the knowledge producers and end-users (Freeman 1995; Lundvall 2007, 2010). The current institutional setting in Rwanda shows a remarkable disconnect to support interactions that are necessary for the use of produced knowledge for responding to the society problems related to industrial development and entrepreneurship. The observed disconnects reflect the non-existence of the needed comprehensive system; however, there is an expression of interest for that system. This can be confirmed by the government's commitment in different plans and programs that advocate for a knowledge-based economy.

Based on the institutional arrangement as described in Fig. 2, interactions among actors for accomplishing their roles as per their defined mandate might be supported by an operational tool that can help the organization of ways for actors' engagement. The Triple Helix Model is suggested as among such tools in the context of developing countries (Etzkowitz and Dzisah 2008). The Triple Helix Model (THM) is described as a tool to promote research uptake by ensuring the interaction between three clusters of actors including universities/research institutions, government/public institution and private/business institutions. It considers universities to play the central role in interactions for knowledge production and use as opposed to the NIS concept where firms are considered to play the central role in these interactions (Etzkowitz and

Leydesdorff 2000; Lundvall 2005). The two concepts have in common the consideration of interactions among actors and institutional capabilities, both creative and diffusion capabilities.

Considering the Rwandan context in terms of institutional setting, research capacity and the demand for skills to address the society as described in Fig. 2; it might not be realistic to confirm that the triple helix can work in the Rwandan context. However, it might be reasonable to take the triple helix model as a point of departure for developing a more contextualized tool for Rwanda. Nevertheless, some preconditions might need to be taken into account. Those include trust, capacities of actors and creation of avenues for interaction. Although, lack of trust among actors and low research quality were reflected as among the compelling factors for research and innovation uptake. This low level of trust among actors can be interpreted as a result of operating in silos, which precludes building mutual trust through a continuous learning process.

The interactive learning processes might be facilitated by the adoption of an education system that fosters exposure of students and university researchers to industries in a way that industrial practices and academic practices are harmonized and complementary with mutual responsiveness to problems. Lundvall (2005) expressed the same view in discussing National Innovation Systems in developing countries, emphasizing the importance of early interactions among firms and knowledge infrastructures with small initiatives that might result in significant outputs over time. This to some extent proposes a bit different approach to what many developing countries, including Rwanda, are trying to adopt. They are trying to invest in big infrastructures like "Science Parks" and "Monumental Innovation Hubs" without the fundamental grounds for running and sustaining those big investments; such investments may result in the waste of the little available resources. In the Rwandan context, a start with diversified incubation centers playing the intersection point between universities and industries might be a good option.

Whereas for the low research quality and limited resources, consultative approaches and experience sharing can enhance the relevance and the quality of research as well as the consolidation of efforts to maximize the limited resources. Etzkowitz and Dzisah (2008) puts this forward as one of the benefits of THM, considering the possibilities for resource circulation among the spheres of actors (Public-private sector-Universities). This also might be a way for ensuring the effective use of available human resources through the facilitation of human resources circulation at different levels (macro & micro) within and among institutions. Although, this can be seen as a short-term solution for progressing with building the needed capacity.

8 Conclusion

The Rwandan Research and Innovation uptake landscape is characterized by different patterns in terms of efforts that are being invested for establishing mechanisms that accelerate the use of knowledge for socio-economic transformation. The development of the STI policy framework and aligned institutional framework are among the major progress made. However, capacity building and collaboration are still among the priorities that need attention. The funding of research and innovation is still challenging, as it is more donor-driven. There is a hope that the establishment of the National Research and Innovation Fund (NRIF) will contribute significantly to addressing this issue. This NRIF can be a starting point for attracting local industries for investing in research. This is likely to happen if the NRIF targets research that is responsive to industrial problems.

Human resource capacity-building efforts have been invested, although there is still a high demand for qualified researchers. Specialized capacity building schemes can be among the ways to approach capacity building issues. Collaboration with other development partners is a potential solution, which can be sustained through the establishment of joint training programs and exchange programs that provide room for exposure to the Rwandan researchers and access to modern infrastructures that are not available in Rwanda currently. Establishment of centers of excellence and research laboratories, as well as innovation hubs and incubation centers, are good signs of internal capacity development that can ensure the possibilities for developing contextualized needed technologies that are responsive to the society problems.

Although there is investment in all these efforts, there is a need to put in place a comprehensive framework that facilitates the use of these resources and capacities for producing and using knowledge to address the development challenge that Rwanda is facing. The construction of an operational National Innovation System can be one of the options for organizing the creation, diffusion and use of knowledge for economic growth at the national level. This can facilitate the needed availability, accessibility and use of knowledge. Given the challenges for the facilitation at the national level, it is recommendable to organize the research uptake at a sectoral level based on specific socio-economic sectors in Rwanda. This can be a strategic and systemic move in operationalizing the NIS. However, this needs to be coupled with promising tools that help to organize linkages and collaboration among the actors. A contextualized triple helix model was identified as among the tools that have potentials based on the Rwandan context.

Overall, the research and innovation uptake landscape in Rwanda presents a mosaic of initiatives that need to be harmonized and arranged in a way that they are coherent and complementary. This can be achieved through integrated planning that considers the alignment of development goals and research efforts as well as set up platforms for stakeholders' interactions and consultations. The importance of joint efforts between universities, government and the private sector deserve particular attention.

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References

ACBF (2017) Africa capacity report 2017 building capacity in science, technology and innovation for Africa' S transformation
Adolph B, Herbert-jones S, Proctor F (2010) Learning lessons on research communication and uptake
Ahmed F (2016) Urbanizing deltas of the world : research uptake. Int Water Manag Inst, Vietnam
Amsden AH (2001) The rise of the rest: challenges to the west from late-industrializing economies. Oxford University Press
Bercovitz J, Feldmann M (2006) Entpreprenerial universities and technology transfer: a conceptual framework for understanding knowledge-based economic development. J Technol Transf 31:175–188
Butera V, Shyaka JG, Habimana D (2012) Essay of causes analysis of low level of scientific research in higher learning and research institutions in rwanda. East Afr J Sci Technol 2(1):54–82
Chaminade C, Lundvall BÅ, Haneef S (2018) Advanced introduction to national innovation systems
Clark N (2002) Innovation systems, institutional change and the new knowledge market: implications for third world agricultural development. Econom Innovat New Technol 11(4-5):353–368
Dodgson M, Bessant J (1997) Effective innovation policy: a new approach. Long Range Plann 30(1):143
Edquist C, Leif H (eds) (2008) Small country innovation systems: globalization, change and policy in Asia and Europe. Edward Elgar Publishing Limited, Edward Elgar Publishing, Inc.
Ergas H (1987) Does technology policy matter? In: Guile Bruce R, Brooks Harvey (eds) Technology and global industry: companies and nations in the world economy. National Academy Press Washington, D.C
Etzkowitz H, Dzisah J (2008) Rethinking development: circulation in the triple helix—triple helix in developing countries—issues and challenges. Technol Anal Strateg Manag 20(6):653–666
Etzkowitz H, Leydesdorff L (2000) The dynamics of innovation: from national systems and"Mode 2"to a Triple Helix of university-industry-government relations. Res Policy 29:109–123
Flaherty K, Beintema N, Gatete A (2018) Agricultural R&D indicators factsheet update rwanda. International Food Policy Research Institute and Rwanda Agriculture and Animal Resources Development Board
Freeman C (1995) The national system of innovation' in historical perspective. Cambridge J Econ 19(1):5–24
Gatare I (2016) Role of higher learning institutions in national research and innovation planning, Kigali
Göransson B (2016) 'Making research matter: a synthesis of survey findings' in innovation systems for development-making research and innovation in developping countries matter. Edward Elgar Publishing, UK, pp 276–296
Havas A (2002) Policy matter in a transition country ? the case of hungary. J Int Relat Dev
HEC, Higher Education Council (2019) List of accredited institutions. http://hec.gov.rw/index.php?id=16
Hobday M (1995) Innovation in East Asia. Edward Elgar, The Challenge to Japan, Cheltenham
Iizuka M, Mawoko P, Gault F (2015) Innovation for development in southern & eastern africa: challenges for promoting ST&I policy. UNU-MERIT Policy Brief 1:1–8
Jacobsson S, Bergek A (2006) A framework for guiding policy-makers intervening in emerging innovation systems in " catching-up" countries. Eur J Dev Res 18(4):687–707
Juma C (2005) Going for growth : science, technology and innovation in Africa. The Smith Institutte, pp 0–130
Juma C (2006) The 2006 hinton lecture. Int Aff
Juma C (2016) Education, research, and innovation in Africa forging strategic linkages for economic transformation. Belfer Center for Science and International Affairs-Harvard Kennedy School
Juma C, Yee-Cheong L (2005) Innovation: applying knowledge in development. UN Millennium Project Task Force on Science Technology and Innovation Earthscan 1

Lawton Smith H, Leydesdorff L (2012) The triple helix in the context of global change: dynamics and challenges. SSRN Electron J, pp–13
Leslie TF, hUallachain BO (2007) Rethinking the regional knowledge production function. J Econ Geogr 7:737–752
Lundvall B.-Å (2005) National innovation systems—analytical concept and development tool, DRUID tenth anniversary summer conference 2005 on dynamics of industry and innovation: organizations, networks and systems, (July 2011), p 43
Lundvall B.-Å (2007) Innovation system research and policy:where it came from and where it might go. CAS Seminar, p 50
Lundvall B (ed) (1992) National innovation systems: towards a theory of innovation and interactive learning. Pinter, London
Lundvall B.-Å (2010) National systems of innovation: toward a theory of innovation and interactive learning, Anthens Press, p 404
MINECOFIN (2013) Economic development and poverty reduction strategy(edprs 2). The Republic of Rwanda, Kigali
MINECOFIN (2017) 7 Years government programme : national strategy for transformation (NST 1):2017–2024, The Republic of Rwanda, Kigali
MoESTSR (2003) Education sector policy, The Republic of Rwanda, Kigali
Mueller P (2006) Exploring the knowledge filter: how entrepreneurship and university—industry relationships drive economic growth. Res Policy 35:1499–1508
Murenzi R, Hughes M (2006) Policy on science, technology and innovation, The Republic of Rwanda, Ministry in the President's Office
NCST (2015) Need for fostering demand-driven skills development: analysis of supply and demand of skills in the ICT sector, Republic of Rwanda
Nguyen D (2014) Research uptake: the value of effectively communicating research to your audience. Eur Sci J 18–7431
Republic of Rwanda (2012) Rwanda vision 2020. Revised in 2012, pp 1–40
University of Rwanda, UR (2014) Strategies for increasing research production and quality at the University of Rwanda, Kigali-Rwanda
UNESCO, United Nations Educational, Scientific and Cultural Organization (2015) Mapping research and innovation in the Republic of Rwanda. In: Lemarchand GA, Tash A (eds) GO-SPIN Country crofiles in science, technology and innovation policy, vol 4. United Nations Educational, Scientific and Cultural Organization, Paris
WDA, Work Development Agency (2018) Skills development strategieshttp://www.wda.gov.rw/

A Critical Review of Policy Instruments for Promoting Innovation in Manufacturing Small and Medium Enterprises (SMEs) in South Africa

John Ouma-Mugabe, Kai-Ying Chan, and Hendrik C. Marais

1 Introduction

Small and medium enterprises (SMEs) play critical roles in South Africa's manufacturing sector and in the socio-economic transformation of the country in general. They are sources of new products and processes, new employment opportunities, and exports to foreign markets. These enterprises are key actors in the country's national system of innovation, and some of them are active in research and development (R&D), product and/or process development, technology prospecting and acquisition, and the commercialization of new technologies.

Manufacturing accounts for a large share of the country's Gross Domestic Product (GDP). In 2016, it accounted for 13.4% of the economy and 10.7% of employment in the country (IDC 2017).[1] SMEs are key players in manufacturing, constituting about 60% of the sector (IDC 2017).[2] Manufacturing SMEs are involved in a variety of economic activities including agro-processing, automobiles, mining, pharmaceuticals, chemicals, textiles, defence, forestry, paper and pulp, information and communications technologies (ICTs), and electronics. Innovation—technological and organizational, including products, practices and processes—is a key determinant of the

[1] OECD (2000), 'Small and Medium-sized Enterprises: Local Strength, Global Research'. *OECD Observer Policy Brief* June 2000, p. 2. Organization for Economic Co-operation and Development, Paris.

[2] OECD (2000), 'Small and Medium-sized Enterprises: Local Strength, Global Research'. *OECD Observer Policy Brief* June 2000. Organization for Economic Co-operation and Development, Paris.

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economic dynamism and productivity of manufacturing SMEs. Indeed, innovation accounts for a large measure of SMEs manufacturing performance and economic competitiveness. Building innovation capabilities of manufacturing SMEs is thus a critical issue of public policy and academic research in contemporary South Africa.

The Government of South Africa has adopted a wide range of policy instruments to promote the emergence and growth of SMEs and small businesses in general. Some of the instruments aim at spurring innovation in manufacturing SMEs. The effectiveness of these instruments and specific barriers to innovation are largely unknown. Indeed, there are knowledge gaps and limited empirical research on the adequacy and effectiveness of existing policies in general, and on specific policy factors that influence innovation in manufacturing SMEs.

This chapter fills some of the knowledge gaps and lays ground for further empirical research on the topic. It is an output of a research project on 'Enabling Innovation and Productivity Growth in Low Income Countries'. The project was funded by the Department for International Development (DFID) of the United Kingdom (UK) through the University of Tilburg in the Netherlands. Undertaken in South Africa between 2014 and 2017, its overall aim was to generate empirical information on and build an understanding of innovation capabilities of manufacturing SMEs in the country. The project also identified and analysed policy instruments for and related barriers to innovation in manufacturing SMEs in South Africa.

The rest of the chapter is organised as follows. After a brief background on characteristics and economic contributions of manufacturing SMEs in South Africa in Sect. 2, we provide our research questions and methodological approach to the study in Sect. 3. Section 4 is a review literature on determinants of innovation and innovation policy instruments while Sect. 5 provides an overview of national innovation policy instruments in South Africa. Section 6 our empirical findings and analysis. The last section offers suggestions on how to improve policy effectiveness in order to spur innovation capabilities and performance of the manufacturing SMEs in the country.

2 Background

Small and medium enterprises (SMEs) are "non-subsidiary independent firms which employ fewer than a given number of employees" (OECD 2000, p. 2).[a] The upper limit of number of employees varies across different national jurisdictions. For example, in the United States of America (USA) SMEs are firms that employ less than 500 persons while in the European Union (EU) the most frequent upper limit is 250 employees (OECD 2000).[b] In some jurisdictions, financial assets, in addition to the number of employees, define SMEs.

In South Africa, a formal definition of SMEs is offered in the National Small Business Act 102 of 1996.214. The Act defines SMEs as businesses or enterprises that employ between 5 and 200 persons. Small enterprises employ up to (maximum of) 50 employees while medium ones employ a maximum of 100 employees, or 200 for the mining and manufacturing sectors (Republic of South Africa 1996).[c]

The Majority of South African SMEs employ less than 100 people on the average, with about 50% of them having 5–20 employees. According to the World Bank (2018. p. 35) “most jobs in South Africa are located in firms of less than 50 workers. However, the share of employment in SMEs declined from 72% in 2005 to 67% in 2015, mirroring weak net job creation in this segment in the last decade. Small businesses are nonetheless critical to reducing inequalities, providing an entry point for young people to enter the labor market …. While direct support to SMEs, including access to finance for start-ups, may help and could be improved.”[d]

Manufacturing SMEs occupy a significant part of South Africa’s economy, and are in almost all sectors of the economy. They are in sectors and activities such as mining (iron, steel and metal products), textiles, food and agro-processing, defence, automotives, telecommunications, pulp and paper, chemicals and petroleum products. SMEs in the manufacturing sector contribute to about 15% of the country’s GDP and provide at least 40% of formal employment (Statistics South Africa 2019).[e] Food and agro-processing, and chemicals and petroleum manufacturing SMEs employ the largest number of people.

However, over the past decade or so, South Africa’s manufacturing sector in general and manufacturing SMEs in particular have faced formidable challenges, and their productivity and economic performance have declined. According to various government reports and academic studies (for example Bureau for Economic Research 2016[f]; Statistic SA 2019, *op. cit.*; and Williams et al. 2014[g]) manufacturing production has declined and the sector experienced increased loss of jobs. Statistics SA (2019) shows that the number of people employed in the manufacturing industry has declined over the years, from about 1.5 million in 2005 to 1.2 million in 2015. The largest decline in employment was in textiles and mining. There has been very limited diversification of the manufacturing sector in the country over the past two decades.

Rodrik (2008, p. 772) argues, “the deeper cause of South African unemployment lies elsewhere, and it is intimately connected to the inability of the South African economy to generate much growth momentum in the past decade. High unemployment and low growth are both ultimately the result of the shrinkage of the non-mineral tradable sector since the early-1990s. The weakness in particular of export-oriented manufacturing has deprived South Africa from growth opportunities that other countries have been able to avail themselves of.”[h]

SMEs in general and manufacturing ones in particular have not performed well in the past two decades in a number of aspects. First, evidence shows there is a significant increase in mortality of SMEs in the country. Recent assessments, for example Bureau of Economic Research (BER) 2016, show that SMEs in South Africa becoming less entrepreneurial and there is a high mortality rate of enterprises. According to Willemse (2010) at least 75% of SMEs in South Africa do not become established businesses making the country to have the highest failure rate of SMEs in the world.[i] The 2017/2018 Global Entrepreneurship Monitor (GEB) shows that most SMEs in South Africa do not survive beyond 3.5 years.[j] Bushe (2019) identifies broader political, economic, social, technological, and legal factors that account for the high rates of SMEs failure.[k] Most of the studies focus on economic barriers, particularly access to credit, and intra-firm management or entrepreneurial capacity weaknesses to explain the performance of SMEs in South Africa.

Secondly, manufacturing SMEs in some of the sub-sectors such as textiles are under-utilizing their capacity. Willemse (2010) and the Bureau of Economic Research (2016) attribute this to factors such as the electricity crisis (or 'load-shedding') and weak economic incentives that undermine SMEs to engage in increased export-oriented manufacturing. Lekhanya (2015) makes passing reference to lack of innovation as the source of under-utilization of capacity of the enterprises.[l]

There is scant academic research on policies for innovation in manufacturing SMEs in South Africa. This is so despite the Government of South Africa's recognition that innovation is critical to the development and economic performance of SMEs. As Booyens (2011) asserts: "[t]he dynamics of innovation, entrepreneurship and small enterprises have, …, only received a little research attention in South Africa".[m] The government through institutions such as the Human Sciences Research Council (HSRC), Statistic South Africa (Stats SA) and the Department of Science and Technology (DST) have invested in national R&D and firm or enterprise-level innovation surveys. Most of these surveys have not been analysed and used to derive policy relevant options for promoting innovation in manufacturing SMEs.

3 Research Questions and Methodology

In this section, we outline the core research questions and methodology for this study. As stated earlier, the study is about the nature and effectiveness of policy instruments for promoting innovation in manufacturing SMEs in South Africa. It identifies specific policy instruments and critically analyses how well they promote innovation performance of manufacturing SMEs. Key questions addressed by the study are:

(a) What are the main barriers to innovation in manufacturing SMEs in South Africa?
(b) What are the explicit policy instruments that the Government of the Republic of South Africa has adopted (in the past two decades) to promote the development of and innovation in manufacturing SMEs?
(c) What factors influence the implementation and effectiveness of the policy instruments? and
(d) What policy reforms and institutional adjustments are needed to improve the effectiveness of the instruments in order to spur innovation in the enterprises?

Research design

The research was designed and undertaken through a series of interrelated activities. First, an initiation workshop was held in Pretoria in November 2013 to introduce the project to various stakeholders from departments of science and technology, trade and industry, small business development, private sector and research institutes. This workshop also helped to map out key policy issues and the institutional landscape of manufacturing SMEs in the country.

Survey

Second, a questionnaire was developed based on proceedings of the workshop and a review of prior innovation surveys conducted by the Human Sciences Research Council (HSRC) of South Africa and World Bank's surveys on SMEs. It contained questions on innovation activities, innovation inputs and innovation outputs of the enterprises, as well as the nature of government support and what policies either facilitate or hinder their innovation efforts. Specific questions on policy issues included the following: 'Has the firm received any government support for innovation activities over the past two years? 'If so, from which government department and what kind of support?' 'Any government policies, regulations, etc. that promote or facilitate innovation in that firm?' 'If so, identify such government policies, regulations, etc.'

A private company, Consulta, specializing in large surveys was contracted to administer the questionnaire. Consulta pre-tested the questionnaire on 10 manufacturing SMEs after which it was revised based on feedback from the respondents. Out of a list of 6000 firms that Consulta had access to a total 500 firms participated in the full survey between July and September 2014. The 500 firms were randomly selected by the research team. There was over-sampling of firms in the 21–50 employees range within an industry-region cell. The firms were from six manufacturing sectors (automotive, chemical, defence, food production, pharmaceutical and textile) and located in four provinces (Eastern Cape, Gauteng, KwaZulu-Natal and Western Cape) as they are the major provinces that contribute to the SA manufacturing industry according to Statistics South Africa.

The survey was subject to a few limitations, like most empirical studies. It could be argued that the non-inclusion of three provinces in the survey sample (Free State, North-West Province and Northern Cape) limits the generalisability of the findings. Although those three provinces contribute less than the other five to the SA manufacturing industry, they may show unique features with regard to manufacturing by SMEs. Secondly, the scope of this project did not provide for a comprehensive comparison of the findings with those of other comparable countries.

Qualitative research

To gather qualitative information on the nature and effectiveness of policy instruments for innovation, face-to-face interviews were conducted with representatives of selected manufacturing SMEs in Gauteng Province, officials from the departments of science and technology, trade and industry, public enterprises, national treasury, small business development, and representatives of the Industrial Development Corporation (IDC) and the Development Bank of Southern Africa (DBSA). A total 17 face-to-face interviews were conducted.

The qualitative and quantitative data were analysed, and a draft report prepared and submitted to the University of Tilburg and DFID. The report was presented at a validation workshop in which representatives of SMEs, government departments, researchers and IDC as well as DBSA participated. Based on inputs and comments from the workshop, the report was revised and the published on the DFID website. This chapter is largely a synthesis of the report, focusing on policy questions.

In the next section, we review the literature to define key concepts such as innovation, policy instruments and policy mixes, and outline a framework for analysing determinants of innovation in SMEs and related policy instruments.

4 Innovation Determinants and Innovation Policy Instruments for SMEs

There is a relatively large body of academic literature on the nature and determinants of firm or enterprise level innovation performance. Ebrahim et al. (2010)[n], Shefer and Frenkel (2005)[o], and Vermeulen et al. (2003)[p] provide rich reviews of some of the literature on innovation in SMEs and factors influencing innovation performance of such enterprises. Some of the literature (e.g. Ebrahim et al. 2010) focuses on organizational innovations and their impact on the productivity of firms while others (e.g. Vermeulen et al. 2003) deal with different forms of innovations—both technological and non-technological.

Innovation is a widely used concept and yet its meaning is subject to confusion. As Borras and Edquist (2019, p. 18) remarked, "there has been an inflation in the use of the innovation concept. Innovation has become a buzz word on the lips of scholars from various disciplines, policy-makers, consultants, etc. This tremendous attention has produced a large variation of understandings and meanings of innovation."[q] There is a tendency to equate innovation to related concepts of technology and entrepreneurship, and sometimes to reduce it to scientific research. This misleads public policy.

Eminent scholars of innovation (for example Lundvall 1988[r] and Borras and Edquist 2019) have provided conceptual clarity. Borras and Edquist (2019, p.19) define innovation as "[n]ew creations of economic significance, primarily carried out by firms, but not in isolation. They include product innovations as well as process innovations." It is about the introduction and diffusion of new (or significantly improved) products and processes as well as new organizational practices. This conceptual approach—the definition and typology of innovation—is largely based on or drawn from the Olso Manual (OECD 2018).[s] Two important aspects of the definition, 'newness' and 'diffusion' need elaboration. Firstly, newness in this context means that a product or process is new to the firm or the economy but maybe old to the rest of the world or old in other firms. Secondly, "new creations do not become innovations until they are actually commercialized or diffused (i.e. spread) to a considerable degree" (Borras and Edquist 2019, p. 17).

The relationship between innovation and enterprises (firms) has been the subject of academic inquiry for a long time. There is now extensive research on firm level innovation determinants, and how innovation (or its absence) influences the growth and survival of firms. For example, Shefer and Frenkel (2005) show that the innovation rate or propensity of a firm is related to determinants such as firm size, industrial sector, location or geography, firm's prior accumulated capabilities, the type(s) of innovation (whether product or process) that the firm focuses on, and investment in the production of new knowledge (R&D).

Audretsch and Belitski (2013)[t] have put emphasis on the importance of R&D as a source of knowledge spillovers, and the how small firms out-source knowledge and highly skilled labour to innovate. They demonstrate that large firms tend to invest more resources in R&D than small ones, and therefore linkages between these groups of firms are crucial. There are also studies (for example Asheim and Gertler 2005)[u] that show that R&D and innovation activities tend to be concentrated in large urban areas, and that geography is vital role in stimulating innovation particularly in small firms.

There is a paucity of academic literature on the role of public policy in promoting innovation in SMEs in developing countries. Most of the research and literature are on innovation policy instruments for SMEs in the industrialized world. Innovation policies for SMEs are, in general, in their infancy (Nauwelaers and Wintjes 2003, p. 193).[v] However, there is increasing attention paid to the design and implementation of innovation policies for SMEs in both developed and developing countries. This is because of the roles that innovation and SMEs play in the economic transformation of countries, and the uniqueness of these enterprises.

Nauwelaers and Wintjes (2003) provide rationales for having innovation policy dedicated to SMEs. They argue that these enterprises have unique characteristics, different from those of large firms. The characteristics include limited financial, knowledge and human resource assets, lower ability to influence the external environment, more informal nature of the enterprises and their unstable organizational management, and weak links to other actors in the national innovation system. These are systemic deficits of SMEs and require holistic innovation policy interventions (Borras and Edquist (2019); Nauwelaers and Wintjes (2003)). Considering the complex nature and unique characteristics of SMEs also enables one to eschew a conventional or orthodox linear approach to innovation. The linear approach is based on the assumption that innovation is an outcome of a sequential step-by-step, research to technology process. It ignores broader inter-related systemic institutional, social, economic and geographic barriers to innovation in SMEs, and focuses mainly on technological innovations.

The holistic innovation policy approach proposed by (Borras and Edquist 2019 and Nauwelaers and Wintjes 2003) emphasizes mixing different policy instruments in order to address systemic innovation challenges of firms. Borras and Edquist (2019, p. 215) draw on relatively established 'policy scholarship' to define a policy instrument as a set of techniques purposively chosen and used by governmental authorities to deliberately induce (or stop) change. The study of policy instruments has a long history, going back to the 1970s (see Bressers and O'Toole 1998 for historical origins of the concept of policy instrument).[w]

The notion of policy instrument is increasingly used in innovation policy studies. Borras and Edquist (2019) and Nauwelaers and Wintjes (2003) developed similar typologies of innovation policy instruments. Borras and Edquist (2019, p. 215–225) propose three categories or groups of instruments—regulations, economic transfer and soft instruments. The first category (regulations) include instruments such as intellectual property rights protection, competition law, and research ethics regulations while the second one (economic transfer instruments) include public funding of R&D, R&D tax relief, and public procurement. The third category (soft instruments) of innovation policy instruments include voluntary technical standards and public-private partnerships.

Nauwelaers and Wintjes (2003, p. 212 and p. 217) develop a typology that is specific for innovation policy instruments for SMEs in European countries. These are (a) firm-oriented input resources and behavioural change to promote learning; and (b) system-wide oriented innovation input resources and proactive support for systemic linkages and collective learning. The long list of instruments includes firm R&D subsidies and loans, risk capital, training subsidies, technology transfer centre, business incubators, support for firm networking, and subsidies for cooperative R&D projects.

5 Overview of Policy Instruments for Innovation in South Africa's SMEs

Based on and guided by the above conceptual outlook, this section is an overview of policy instruments for promoting innovation in SMEs in South Africa. Key policy instruments for innovation in manufacturing SMEs in the country are in a wide range of white papers, legislation and programmes. They include regulatory (intellectual property rights protection, mandatory product/process technical standards), economic and fiscal incentives (e.g. direct public funding for R&D and technology development, and R&D subsidies), training and incubation support (e.g. hospitality training levy), and soft innovation policy (e.g. Black Economic Empowerment BEE requirements) instruments. Below is a table (Table 1) of indicative key policy and legislative frameworks for SMEs with their specific instruments. It provides some general sense of the wide range of frameworks and instruments for promoting innovation in SMEs in the country.

The implementation of the policy frameworks and instruments is through or by a variety of institutional mechanisms, including government departments, State-Owned-Enterprises (SOEs) and Non-governmental organizations. The key institutional actors in the landscape include the Department of Small Business Development, the Department of Trade and Industry (The dti), the Small Enterprise Development Agency (SEDA), the Department of Science and Technology (DST,

Table 1 Overview of selected innovation policy instruments for SMEs

Framework	Innovation Policy Instrument Type
White paper on small, Micro and medium enterprises (1995)	• Economic and legal incentives for establishment of SMEs • Public loans and related guarantees to innovative SMEs
Companies act (Act No 71 of 2008)	• Financial support for SME registration
Public finance management act	• Economic incentives for R&D/knowledge production • Tax deductions on creation of SMEs • Tax exemptions for importation of new machinery that is not locally manufactured
Integrated small business development strategy	• Economic incentives for R&D/knowledge production • Tax deductions on creation of SMEs • Capacity (technical support) building to enable SMEs develop financial and management plans
Industrial policy framework (2007) and Industrial policy action plan	• R&D subsidies for SMEs • Training funding • Protection of intellectual property (legal incentives) • Support for linkages between SMEs and large firms • Financial support for SME procurement of knowledge from research institutions, including universities • Export promotion incentives
Preferential public procurement policy framework act no. 5 (PPPPFA) 2000	• Government agencies preferential treatment in procuring goods and services from SMEs
National small business act (Act 102 of 1996)	• Fast-track registration of SMEs • Technical support/capacity building of SMEs in project design and management • Tax deductions on investments in new SMEs • Tax deductions on profits from venture capital investments

(continued)

Table 1 (continued)

Framework	Innovation Policy Instrument Type
Broad-based black empowerment amendment act (Act No. 46 of 2013)	• Preferential treatment of SMEs with majority non-white employees in public procurement
Advanced manufacturing technology strategy (2006)	• Technology support centres • Financial incentives for university-SME partnerships
National intellectual property protection of inventions from publically funded research (2008)	• Establishment of technology transfer office and capacity building in technology acquisition and commercialization • SMEs' preferential access to knowledge generated through/by publically funded projects • Financial assistance to SMEs to secure intellectual property protection • Financial assistance to SMEs to commercialize their intellectual property
National development plan	• Improving policy environment for registration and growth of SMEs
White paper on science and technology (1996)—expired	• R&D subsidies to SMEs • Financial support for start-up technology commercialization
White paper on science, technology and innovation (2019)	• R&D subsidies for SMEs • Financial support (through the Technology Innovation Agency) for start-up or early stage technology commercialization • Incubation of technology-based SMEs

renamed Department of Science and Innovation in 2019), the Technology Innovation Agency (TIA), the Development Bank of Southern Africa (DBSA), and the Industrial Development Corporation (IDC).

The Small Enterprise Development Agency (SEDA) is one of the main agencies directly responsible for promoting innovation in and by manufacturing SMEs. It is an agency of the Department of Small Business Development. Established through the *National Small Business Amendment Act* (Act 29 of 2004), SEDA is mandated to assist small businesses in general and SMEs in particular to procure technologies and introduce them in their operations. One of its core activities is the SEDA Technology Programme (SEDA TP) that was launched in 2006 and aims at facilitating the acquisition, development and transfer of technology to SMEs, providing technical support to SMEs to engage in technological innovation, and support technology incubation (technology start-ups) and technology demonstration centres.

Other institutions dedicated to supporting manufacturing SMEs include the Small Enterprise Finance Agency (SEFA), the National Youth Development Agency (NYDA) and the Technology Innovation Agency (TIA). SEFA offers bridging finance to the enterprises and the NYDA assists young South Africans between the ages of 14–35 years to start small businesses. TIA is an agency established by DST to support commercialization of technologies. It provides seed funding to SMEs to advance research ideas into prototypes, and move beyond proof of concept phase in the development of new technologies.

Non-governmental and private sector institutions that support manufacturing include commercial banks such as the First National Bank (FNB), ABSA, Standard Bank and Investec as well as many NGOs. The private institutions focus on different sectors and offer different services to SMEs. The banks provide loans and technical support to manufacturing SMEs in all the sectors. FNB and ABSA offer technical support to SMEs in pharmaceuticals, agro-processing and mining sector to procure equipment.

Overall, there are many instruments and institutions for promoting innovation in manufacturing SMEs in the country. Many of the instruments have multiple goals and require different institutional arrangements for the realization. The success (or relative effectiveness) of the instruments in promoting innovation, or removing barriers to innovation is discussed in the next section.

6 Empirical Findings and Analysis

In the first part of this section, we present a synthesis of the data obtained through the survey and then an analysis to respond to specific research questions of this study. The study focused on product and process innovations, and respondents in the survey identified which type of innovation their firm or enterprise was generating. As shown in Table 2, enterprises in Gauteng Province introduced more product innovation as well as process innovation as compared to those from other provinces. Firms located

Table 2 Product and process innovation

Province	Product innovation (%)	Process innovation (%)	N
Eastern cape	7	8	15
Gauteng	44	27	233
KwaZulu-Natal	22	38	58
Western cape	25	17	191
Total	33	24	497

in Gauteng had the highest product innovation (44%) whereas firms from Western Cape had highest process innovation (38%).

On the level of novelty of product innovation, respondents were asked whether or not their firms/enterprises have introduced any goods and/or services to the market that are new to the firm, new to the local market or new to the world. The percentages of firms by province conducting product innovation with three levels of novelty are shown in Table 3 below. There are more firms from Gauteng that were introducing innovations that are new to firm (35%), new to local market (28%) and new to the world (11%) as compared to other provinces.

Three forms of process innovations were examined, namely:

- Methods of manufacturing products or offering services;
- Logistics, delivery, or distribution methods for inputs, products, or services;
- Supporting activity for processes, such as maintenance systems or operations for purchasing, accounting, or computing.

Table 4 below shows the percentage of firms by province that conduct the various process innovations. Majority of the firms conduct innovation in method of manufacturing (20.7%), followed by supporting activities (12.9%) and logistics, delivery or distribution methods (11.5%). Firms located in KwaZulu-Natal introduced highest innovation in manufacturing methods.

The study also aimed at identifying reasons why the firms/enterprises focused on the particular innovations—whether product or process—and if their innovation activities were influenced by any specific policy instruments. As Fig. 1 shows, the main objective for focusing on product innovation is to extend the range of products

Table 3 Novelty of product innovation by province (N is size of sample)

	New to the firm		New to the local market		New to the world	
Province	%	N	%	N	%	N
Eastern Cape	0	15	7	15	0	15
Gauteng	35	233	28	233	11	227
KwaZulu-Natal	19	57	13	54	7	54
Western Cape	18	190	18	190	7	188
Total	26	495	22	492	8	484

Table 4 Types of process innovaiton by province

Province	Manufacturing methods (%)	Logistics (%)	Supporting activities (%)	N
Eastern Cape	7	7	7	15
Gauteng	24	11	12	233
KwaZulu-Natal	31	7	12	58
Western Cape	14	14	14	187
Total	21	12	13	493

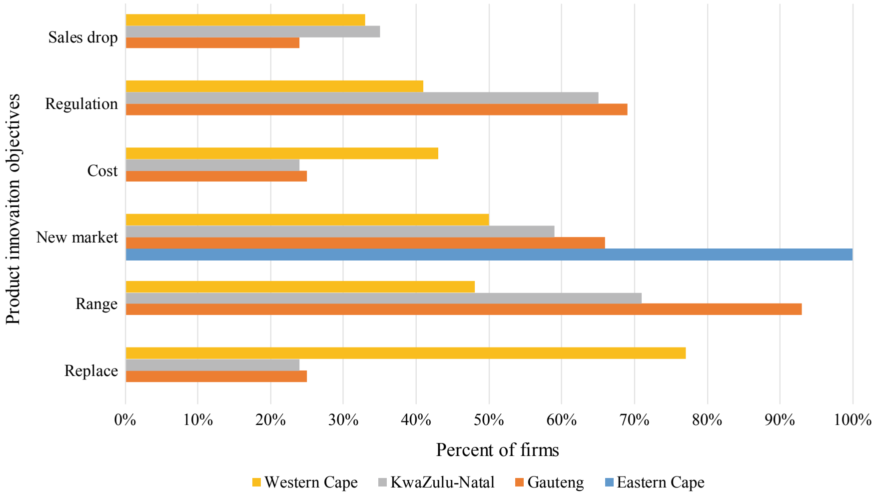

Fig. 1 Objectives of investing in product innovation

or service offered by firms in Gauteng province while for the firms in the Western Cape the main objective is to replace a product or service offered by them. The overall main objective is the range (78%), followed by open up new markets or increase market share (61%) and comply with regulations or standards (61%).

It is clear from Fig. 2 that the main objective of investing in process innovation is to increase the quality of products or services in all provinces. Overall, quality (92%) is the main objective, followed by increase the total production or amount of services offered (77%) and increase the flexibility of production or offering service (77%).

Another important aspect of the study was firms' sources of information and knowledge for innovation. The survey sought to identify whether the firms used internal or external sources of information or ideas for their innovation activities. Most firms rely on external sources of information as show in Fig. 3 below. Two of the main sources are customers' feedback and the Internet, especially used by

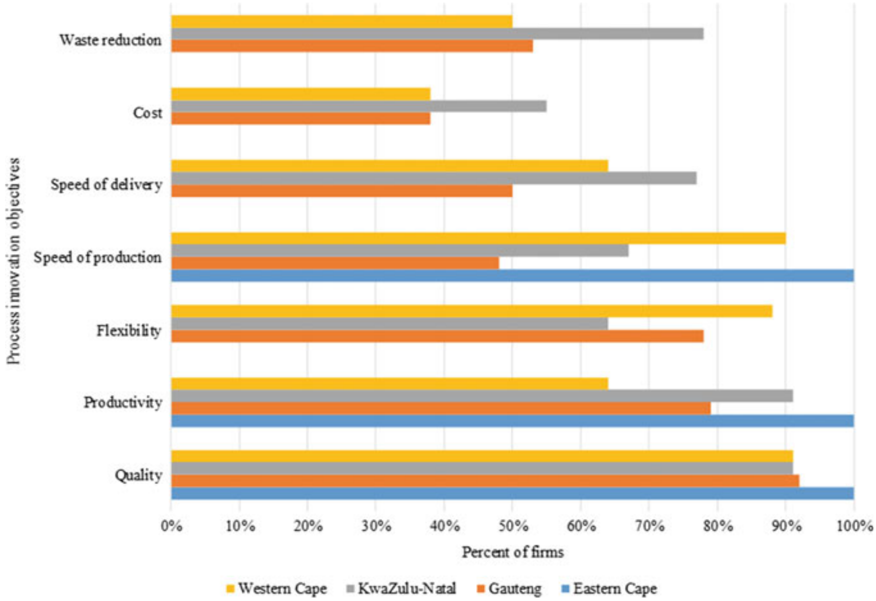

Fig. 2 Objectives of investing in process innovation

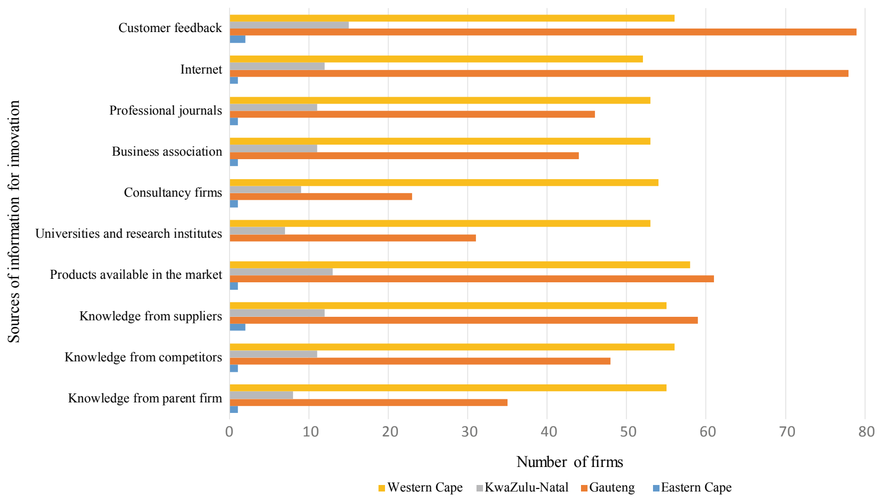

Fig. 3 Sources of information for innovation by province

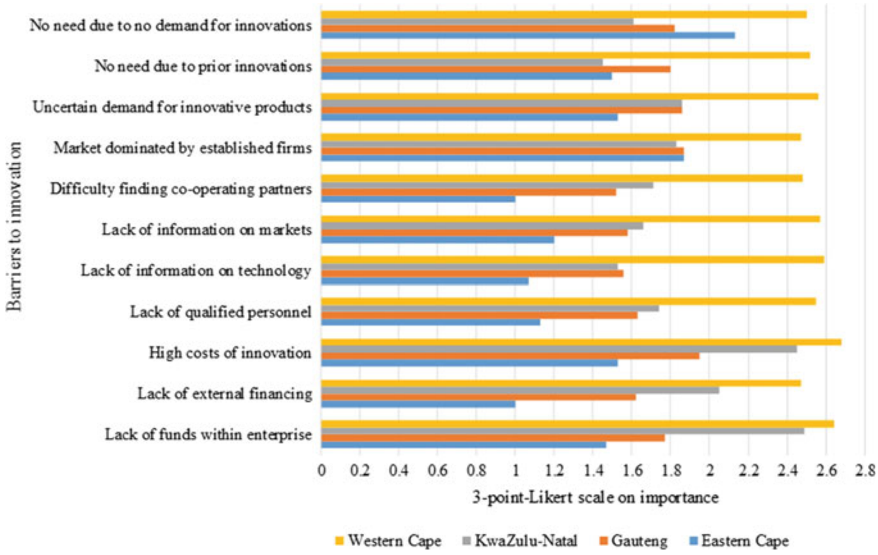

Fig. 4 Barriers to innovation by province

firms in the Gauteng Province. Some of the larger firms reported to have acquired information from professional journals.

Again, the two main sources are customers' feedback and internet. Besides these two sources, large firm also seek information from professional journals as their main source for innovation.

The last two clusters of issues that were covered in the survey are barriers to firms' innovation and factors that influence dynamic capabilities for innovation. On barriers to innovation, the survey gathered empirical information the factors that imped their innovation activities or influence their decision not to innovate. A 3-points Likert scale ranging from unimportant (1) to very important (3) was used in the survey. The descriptive statistics are shown in Fig. 4. High innovation costs (mean = 2.27) and lack of funding (mean = 2.17) are the two dominant barriers to innovation for the total sample of firms, followed by uncertain demands for innovative products (mean = 2.11) and market dominated by established firms (mean = 2.09). These barriers are associated with cost and market.

The notion of dynamic capabilities is applied in this study and particularly for the survey to refer to firms' abilities to identify sources of knowledge, select and acquire relevant knowledge, and then transform the knowledge into products that get commercialized. The 7-point Likert scale ranging from completely disagree (1) to completely agree (7) were used for measuring each constructs on dynamic capabilities. Specifically, 5 items are used for measuring the firms' ability for identifying and selecting knowledge, 3 items are used for measuring the firm's ability for acquiring knowledge, and 4 items are used for measuring both the ability of transforming knowledge and commercializing products. The average values of the items within each construct measuring dynamic capabilities are shown in Fig. 5.

Firms located in the Western Cape province score higher in all four construct as comapred to the other three provinces. Compared with firms located in Kwa-Zulu Natal, firms in Gauteng have higher average in all constructs, except ‘Identification & selection’. Overall, the constuct with the lowest average is ‘Identification & selection’ (mean = 3.9) and the highest average is ‘Acquisition’ (mean = 5.4).

The survey’s last sections covered the following research question: “What firm-level and regional-level factors (including size, ownership, market orientation, labour skills availability, gender, firm location, linkages between public/private sectors, role of intermediaries in the innovation process etc.) hinder or foster the engagement of firms in innovative activities?” As such, we seek to examine the firm-level and regional-level factors that are associated with firms engaging in network innovation activities. From these results we conclude that size of the firm is an important firm-level factor across all innovation activities. Furthermore, university education has positive effects on external R&D. Firms rely on credit for formal training and external R&D.

Qualitative findings and analysis

This sub-section offers a summary of a qualitative analysis of whether [and how] the different policy instruments outlined above in Table 1. The qualitative analysis is based on face-to-face interviews and group discussions at that validation workshop. Interviewees and participants were asked to identify specific policy frameworks and instruments and then give opinions on the effectiveness of the instruments in promoting or hindering innovation in specific manufacturing sector or firm(s). We defined policy effectiveness as outcomes of specific policy actions and/or policy inactions. It is whether a particular policy (course of action) has generated the desired

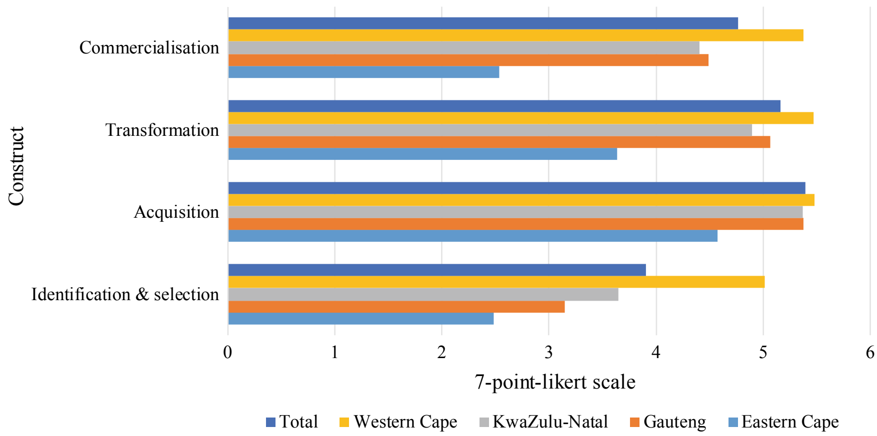

Fig. 5 Dynamic capabilities

consequence or change (impact). Measuring the effectiveness of policies for stimulating innovation in manufacturing SMEs is a relatively complex exercise for a range of reasons. First, it involves a mix of different policies in different policy frameworks and instruments that are interacting in non-deterministic ways. It is often difficult to attribute a particular outcome or consequence to one particular policy measure.

Secondly, conceptual frameworks and tools for measuring the effectiveness of innovation policy mixes are underdeveloped and not really tested, at least in a developing country context such as South Africa. It was difficult to undertake a comprehensive assessment of each of the many policy instruments identified by the study (see Table 1 above). However, from the 17 face-to-face interviews and workshop discussions, it was possible to draw or discern general points on policy relevance, policy quality, policy mix, policy coherence, and policy outcomes. Fourteen of the interviewees (85%) raised views or opinions indicating that many of the existing policy instruments are relevant or can be adjusted to be more relevant to address policy problems of poor innovation performance of the SMEs. The challenge is to sequence specific policy measures or a combination of policies to be able to address the systemic barriers to innovation.

Policy relevance: On policy relevance, many of the interviewees (85%) and workshop participants noted that some policy instruments (for example policy measures in the National Development Plan 2030) are general in nature. Policies are broad-based, framed around broad development goals, and not based on explicit determinants of innovation in the SMEs. For example, national policy instruments do not explicitly consider the role of geography or location as a determinant of innovation in SMEs. This is contrary to empirical evidence generated by this study. Broad-based policy instruments or measures are, generally, difficult to implement or at least to assess their effectiveness.

'Age': A related issue on policy relevance is the 'age' of some of the policy frameworks and instruments. A number of interviewees (at least 65% of the total of 17) noted that some of the policy frameworks were designed in the mid-1990s immediately after the country attained independence and are largely influenced by economic goals and institutional configurations of the Apartheid era. The White Paper on Small, Micro and Medium Enterprises (1995) was identified as one of the relatively old frameworks with policy measures that may not be well aligned to current the national system of innovation. Some interviewees noted that such as a framework and its specific measures tend to focus on supply-side factors of innovation. They recommended that such a framework needs to be reviewed and reformed to integrate holistic innovation policy measures.

Policy coherence: The extent to which different policy frameworks and instruments 'speak to each other' or articulate with each other was identified as another critical factor influencing the effectiveness of innovation policy instruments for manufacturing SMEs. Some of the interviewees (at least 50%) and during discussions at the validation workshop identified the Industrial Policy Framework (2007) and Industrial Policy Action Plan and being in conflict with some of the provisions of the Broad-Based Black Economic Empowerment Amendment Act (Act No. 46 of 2013). The Broad-Based Black Economic Empowerment Amendment Act (Act No.

46 of 2013), according to some of the interviewees, deny innovative SMEs flexibility to procure highly skilled persons. Some of the stakeholders at the workshop stated that some SMEs are often stranded with unproductive staff because the laws restrict the laying off of poorly or unskilled workers.

Policy uncertainty: Related to the issue of coherence is policy uncertainty. Representatives (at least 50% of those participating in the survey and three that were engaged through face-to-face interviews) of SMEs in pharmaceuticals raised concern that there is policy uncertainty regarding intellectual property protection and regulatory approval of new medicines (pharmaceutical products). The main issues raised are that the country's intellectual property protection legislation has been amended in a piecemeal version the past two decades and the enactment of the 2008 *National Intellectual Property Protection of Inventions from Publically Funded Research* are sources of confusion. Secondly, the approval of new medicines tends to take too long because of institutional weakness in the medicines control agency and a related weak policy framework.

Policy literacy: Knowledge or understanding of specific policy instruments and measures among government officials, managers at SMEs and the public in general is generally low in the sense that many government officials and the general public have limited understanding of specific policy measures. About 75% of respondents in the survey indicated that they did not know of specific policy measures for promoting innovation in manufacturing SMEs. A small number of respondents had information on or were aware of measures such as fiscal incentives (the R&D tax relief or incentives) provided (through or by DSI/DST) to industry (including SMEs) that invest in R&D and other innovation activities such as technology licensing.

Institutional coordination: Coordination in general and good linkages with and between government, between departments and private sector, and also between R&D institutes and SMEs in particular were identified as key to improving innovation policy effectiveness. A majority (at least 75%) of the respondents from SMEs that participated in the survey expressed concern that there is minimal dialogue between government departments and SMEs on a wide range of policy issues. SMEs are rarely consulted on policy issues and largely disengaged in policy processes on innovation. This may be starting to change as some of officials from dti, DST and SEDA indicated that government departments have established various platforms for policy dialogue with industry in general and SMEs in particular.

7 Conclusions and Recommendations

This study has reviewed national policies to determine whether they promote innovation in manufacturing SMEs in South Africa. It has shown that the country has a wide range of policy frameworks and instruments for innovation promotion. The quality and effectiveness of the instruments in promoting innovation are, to a large measure, influenced by factors such as age of the policy, public policy literacy, institutional linkages, and geographic or regional location of enterprises. Overall, policy incoherence, weak institutional coordination between government departments, weak policy focus on innovation determinants, and poor understanding of specific policy measures are the main factors that limit the effectiveness of existing national policy instruments. The study recommends that to improve the design and implementation of a mix of policy instruments that are sharply focused on removing systemic barriers to innovation in manufacturing SMEs, the following measures should be considered. First, a holistic national innovation policy framework for manufacturing SMEs should be developed by an inter-department or interagency comprising of all government departments, private sector and civil society. The rationale and objectives of the policy framework would be to unlock systemic barriers to innovation in the enterprises. Secondly, an inter-departmental or interagency institutional mechanism should be established to oversee the implementation of the proposed policy framework. Such a mechanism should be linked and accountable to the presidency to ensure that it has authority for coordinating cross-sectoral and cross-departmental interventions.

Notes

a. Industrial Development Corporation (IDC) *Economic Trends: Key trends in the South African economy*, 2017.
b. Industrial Development Corporation (IDC) *Economic Trends: Key trends in the South African economy*, 2017.
c. Other countries in which the project was implemented are in Ghana, Kenya, Tanzania, Bangladesh and Vietnam.
d. World Bank 2018. *South Africa Economic Update 11: Jobs and Inequality*, p 35. The World Bank, Washington DC.
e. Statistics SA, 2019. Manufacturing: Production and sales (Preliminary) November 2019. http://www.statssa.gov.za/publications/P30412/P30412November2019.pdf.
f. Bureau of Economic Research (BER) 2016. The Small, Medium and Micro-Enterprise Sector of South Africa, Research Note No. 1, 2016. Commissioned by the Small Enterprise Development Agency (SEDA).
g. Williams, G., Cunningham, S. and De Beer, D. 2014. Advanced Manufacturing and Jobs in South Africa: An Examination of Perceptions and Trends. Paper presented at the International Conference on Manufacturing-Led Growth for Employment and Equality. Johannesburg, 20 & 21 May 2014.
h. Rodrik, D., 2008. Understanding South Africa's economic puzzles, Economics of Transition Volume 16(4) 2008, 769–797. The European Bank for Reconstruction and Development.
i. Willemse, J. (2010). *The forum SA: SME failure statistics.* Retrieved on September 1st, 2016 from: http://www.theforumsa.co.za/forums/showthread.php?t=7808.
j. Global Report 2017/2018. *Global Entrepreneurship Monitor* (GEM), April 2018. http://gemconsortium.org/report/50012.

k. Bushe, B., 2019. 'The causes and impact of business failure among small to micro and medium enterprises in South Africa', *Africa's Public Service Delivery and Performance Review* 7(1), a210, https://doi.org/10.4102/apdpr.v7il.210.
l. Lekhanya, L.M., 2015. Public Outlook on Small and Medium Enterprises as a Strategic Tool for Economic Growth and Job Creation in South Africa. *Journal of Governance and Regulation*, Volume 4, Issue 4, 2015, p. 412–418. Virtus Interpress.
m. Booyens, I., 2011. Are small, medium- and micro-sized enterprises engines of innovation? The reality in South Africa, p. 67 in *Science and Public Policy*, 38(1), February 2011, pages 67–78 https://doi.org/10.3152/030234211x12834251302445; http://www.ingentaconnect.com/content/beech/spp.
n. Ebrahim, N., Ahmed, S., and Taha, Z., (2010). SMEs; Virtual research and development (R&D) teams and new product development: A literature review. International Journal of the Physical Sciences Vol. 5(7), pp. 916–930, July 2010. Available online at http://www.academicjournals.org/IJPS ISSN 1992–1950
o. Shefer, D. and Frenkel, A. (2005), R&D, firm size and innovation: an empirical analysis. *Technovation* 25 (2005) 25–32. www.elsevier.com/locate/technovation.
p. Vermeulen, P., O'Shaughnessy, K.C., and de Jong, J. (2003) Innovation in SMEs: An Empirical Investigation of the Input-Throughput-Output-Performance Model. https://www.researchgate.net/publication/5012662 accessed January 27, 2020.
q. Borras, S. and Edquist, C. (2019), *Holistic Innovation Policy: Theoretical Foundations, Policy Problems, and Instrument Choices*. Oxford University Press, UK.
r. Lundvall, B.-Å. (1988), "Innovation as an interactive process: From user-producer interaction to the National Innovation Systems", in Dosi, G., Freeman, C., Nelson, R.R., Silverberg, G. and Soete, L.(eds.), *Technology and economic theory*, London, Pinter Publishers.
s. OECD (2005), *The Measurement of Scientific and Technological Activities, Oslo Manual: The Guidelines for Collecting and Interpreting Innovation Data*, Third Edition. Organization for Economic Cooperation and Development (OECD), Paris.
t. Audretsch, D. B., & Belitski, M. (2013). The missing pillar: the creativity theory of knowledge spillover entrepreneurship. *Small Business Economics*, 41(4), 819–836.
u. Asheim, B., and Gertler, M. (2005), The Geography of Innovation, p. 291–317 in Fagerberg, J., Mowery, D., and Nelson, R. (eds.) (2005), *The Oxford Handbook of Innovation*. Oxford University Press, Oxford UK.
v. Nauwelaers,C., and Wintjes, R. (2003), Towards a new paradigm for innovation policy?, p. 193–221 in Asheim, B., Isaksen, A., Nauwelaers, C., and Todtling, F. (eds.) (2003), *Regional Innovation Policy for Small-Medium Enterprises*. Edward Elgar, UK and USA.
w. Bressers, J.Th.A. and O'Toole, L.J. (1998), The Selection of Policy Instruments: A Network-based Perspective, *Journal of Public Policy* 18(3):213-239.

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References

Asheim B, Gertler M (2005) The geography of innovation. In: Fagerberg J, Mowery D, Nelson R (eds) 2005. The Oxford Handbook of Innovation. Oxford University Press, Oxford UK, pp 291–317

Audretsch DB, Belitski M (2013) The missing pillar: the creativity theory of knowledge spillover entrepreneurship. Small Bus Econ 41(4):819–836

Booyens I (February 2011) Are small, medium- and micro-sized enterprises engines of innovation? The reality in South Africa, p. 67 in Science and Public Policy, 38(1):7–78 https://doi.org/10.3152/030234211x12834251302445; http://www.ingentaconnect.com/content/beech/spp

Borras S, Edquist C (2019) Holistic innovation policy: theoretical foundations, policy problems, and instrument choices. Oxford University Press, UK

Bureau of Economic Research (BER) (2016) The small, medium and micro-enterprise sector of South Africa, Research note No. 1, 2016. Commissioned by the small enterprise development agency (SEDA)

Bushe B (2019) The causes and impact of business failure among small to micro and medium enterprises in South Africa. Afr Publ Serv Deliv Perform Rev 7(1):210. https://doi.org/10.4102/apdpr.v7il.210

Ebrahim N, Ahmed S, Taha Z, (July 2010) SMEs; Virtual research and development (R&D) teams and new product development: A literature review. Int J Phys Sci 5(7):916–930. Available online at http://www.academicjournals.org/IJPS ISSN 1992–1950

IDC (2017) Economic trends: key trends in the South African economy. Industrial Development Corporation, Johannesburg

Lekhanya LM (2015) Public outlook on small and medium enterprises as a strategic tool for economic growth and job creation in South Africa. J Gov Regul 4(4):412–418. Virtus Interpress

Lundvall B-Å (1988) Innovation as an interactive process: from user-producer interaction to the national innovation systems. In: Dosi G, Freeman C, Nelson RR, Silverberg G, Soete L (eds) Technology and economic theory. Pinter Publishers, London

Nauwelaers,C., and Wintjes, R., (2003), Towards a new paradigm for innovation policy? In Bressers JThA, O'Toole LJ (1998) The selection of policy instruments: A network-based perspective. J Publ Policy 18(3):213–239

Republic of South Africa (1996) National small business act. Government Printer, Pretoria

Rodrik D (2008) Understanding South Africa's economic puzzles. Econ Trans 16(4):769–797. The European bank for reconstruction and development

Shefer D, Frenkel A (2005) R&D, firm size and innovation: an empirical analysis. Technovation 25(2005):25–32. www.elsevier.com/locate/technovation

Statistics South Africa (2019) Manufacturing: production and sales (Preliminary) November 2019. http://www.statssa.gov.za/publications/P30412/P30412November2019.pdf

Vermeulen P, O'Shaughnessy KC, de Jong J (2003) Innovation in SMEs: an empirical investigation of the input-throughput-output-performance model. https://www.researchgate.net/publication/5012662 accessed January 27, 2020

Willemse J (2010) The forum SA: SME failure statistics. Retrieved on 1 Sep 2016 from: http://www.theforumsa.co.za/forums/showthread.php?t=7808

Williams G, Cunningham S, De Beer D (2014) Advanced manufacturing and jobs in South Africa: an examination of perceptions and trends. Paper presented at the International conference on manufacturing-led growth for employment and equality. Johannesburg, 20, 21 May 2014

World Bank (2018) South Africa economic update 11: jobs and inequality, p 35. The World Bank, Washington DC

Challenges and Constraints for Government Agencies Supporting Firm Level Innovation: Some Reflections from South Africa

David Kaplan

1 Introduction

Support for technology-based start-ups, often termed new technology-based firms, (NTBs), initially seen solely as a concern for developed countries, is currently spreading very rapidly in developing countries. Even least developed countries, including a significant number of countries in Africa, are currently active in establishing new supports and institutions. NGOs, the private sector, donors and philanthropies and more recently governments have all entered this field giving rise to panoply of support measures and institutions. Institutions that directly support the development of firm level capacities to innovate by providing funding are now widely accepted as integral to the National System of Innovation (NSI).

The first part of this chapter explores the importance of technology-based firms within the NSI and the very significant contribution that these firms potentially make to the enhancing technological and innovative capacities and to the achievement of developmental goals more broadly. However, in seeking to support such firms, governments need to exercise considerable caution. This is the focus of the second part of this chapter.

There are very significant challenges in identifying and selecting the firms that require support in order to expand and develop. Moreover, there are issues as to the appropriate form of support. While NTBs rely on innovation and accordingly the expansion of their technological competencies to develop and grow, it does not necessarily follow that government support for such firms is necessarily best targeted at enhancing the capacities of these firms to innovate. Finally, there is the question of governmental capacities: does government have the capacities to select the firms that require support, to determine the form of support that is appropriate and to

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deliver that support effectively? These are all issues that need to be considered prior to establishing the appropriate institutional mechanism to deliver support to NTBs.

The third part of the chapter, and the chapter's main focus, is an examination of one possible institutional support for NTBs; namely support provided directly by a governmental agency. The chapter draws largely from the "lived experience" of one such institution—namely the Technology Innovation Agency (TIA) in South Africa. TIA is a government agency and TIA's role is to take forward the knowledge that is the outcome of research into application—particularly commercial application. To this end, TIA is engaged in funding and supporting new knowledge-based innovative firms. It is this engagement that is the focus of this part of the paper.

It needs to be stressed; this chapter is not an evaluation of TIA. Rather, this chapter draws on the experiences of TIA in order to highlight some of the real-world complexities and constraints that are likely to be faced by other developing country governments that attempt to develop technology-based firms through providing direct funding and support for innovation to such firms through the mechanism of a government agency.

2 NTBs, Economic Development and the National System of Innovation (NSI)

NTBs are young firms, typically less than ten years old, which have the potential for rapid rates of expansion. NTBs are innovative—they employ new production technologies and/or introduce new products to the market. These two characteristics are interdependent: the firm's potential for expansion grows directly from its capacity for innovation.

Start-ups have the potential to bring many benefits:

On average, new firm entrants have higher growth rates and they create far more jobs than do well-established firms. However, the higher growth in output and employment results from the rapid growth of a small minority of firms. The defining characteristic of these firms is that they have significant technological and innovative competencies (Ayyagari et al. 2011). As a result, employment opportunities created by these firms tend to be both skill intensive and high productivity. High productivity, in turn, has the potential for significantly higher earnings.

These firms disproportionately engage the young. Both the entrepreneurs and the employees tend to be both skilled and young. Start-ups facilitate early entry of young people into the economy. This has significant concomitant social benefits. These firms, by definition, and by contrast with the vast majority of new firms which are routine in product and in process, introduce something new. For countries that are seeking to diversify away from traditional activities—for developing countries these are usually primary based activities—the introduction of new knowledge-intensive products and services are particularly critical. Indeed, the need to diversify the economy away from a dependency on primary products has been a very important factor in the increasing attention that developing countries are currently according policy to enhance NTBs. Saudi Arabia, seeking to reduce its dependency on oil, and South Africa, seeking to reduce its dependency on minerals, are just two current examples.

Firms that enter new markets, more particularly if the products entailed are new, but even if the products are well established, will require some level of innovation and the development of new competencies in order to meet the demands of the new market. First time movers in exporting are pioneers. Other domestic firms can learn from their experiences with exporting so significantly reducing the costs and enhancing the returns for other domestic firms to follow suit (Hausmann and Rodrik 2003). Exports have an important impact on growth. The composition of exports is also important. Countries with more diversified and more knowledge based exports enjoy faster rates of economic growth (Hausmann et al. 2007). The development of NTBs is critical to enhancing exports in general, but more particularly to enhancing the diversification of exports towards more high value knowledge products and services, thus enhancing development prospects.

The innovative content of many start-ups consists of bringing new technology and solutions to the specific problems and challenges that the country confronts. Start-ups are generally characterised by experimentation with new solutions to address the challenges that a country faces. These firms demonstrate routes to growth through innovation and enhancing technological competencies. They enhance a climate of enquiry and innovation more broadly and as such are a critical component of the ecology of the NSI. While NTBs do tend to agglomerate in large already well-developed urban areas, they can be the spur to growth in neglected regions or areas of the country—Medellin in Colombia, for example; or the reinvigoration of depressed areas—Detroit in the United States is an obvious example.

Finally, NTBs provide an important route to empower those who have hitherto been denied opportunities. Thus, government support programmes and policies can target previously disadvantaged groups. In South Africa, for example, government support for start-ups is graduated with greater levels of support being made available to black and female owned enterprises.

In an all of the different dimensions outlined above, NTBs make a significant contribution to economic and social growth and development (OECD 2016; Wu and Atkinson 2017). The social benefits of new technology-based firms significantly exceed the private returns. It is this gap between social and private benefit that provides the overall justification for government to engage directly in providing resources to support the development of technology based and innovative start-ups.

The social benefits associated with the growth of NTBs are not characteristic of new small firms in general. The vast majority of new small firms are designed and intended to remain small. Indeed, many of these firms have no intention of significantly expanding output or employment. These firms do not introduce new products. They utilise standard technologies and well-worn business practices, entail no new economic activities and give rise to no new approaches to economic and social problems. The number and success of such firms is, in large part, a reflection of general economic conditions—expanding and growing with the overall economy.

Therefore, while government will have policies to encourage entrepreneurship and small firm development in general, there are strong grounds for proposing that government policies and supports should be firmly on NTBs. These firms require different modalities of support from small firms and new entrants in general. Since enhancing innovative and technological competencies are critical for these firms, state support can focus on enhancing these capacities.

3 Supporting NTBs: A Cautionary Note

Identifying and selecting such firms is very difficult. Moreover, targeting government support at enhancing their innovative and technological competencies may not be the optimal route to supporting these firms at this particular stage of their development. Finally, there is the issue as to how firms are to be identified and selected and supported i.e. what is the appropriate institutional form for such selection and support?

3.1 Identifying and Selecting Firms for Support[1]

Heavily influenced by the example of California and Silicon Valley, assumptions are often made as to the characteristics of the firms that have significant prospects for strong and sustained growth. Such firms are assumed to be very recently established; small; in high technology fields; capable of growing continuously.

However, each of these assumptions turns out to be (largely) incorrect:

- High-growth firms do tend to be younger than the average firm, but most will have been in business for at least a couple of years before any growth spurt occurs.
- Many high growth firms are larger than the average firm at the beginning of a high-growth episode and are larger than the average firm after three years of growth.
- While high technology is the location for many high growth firms, such firms are located also in other sectors. Moreover, the sectoral locations of high growth firms differ as between countries.
- Rather than growing continuously, many firms are likely to exit the market soon after the growth spurt and very few firms are likely to repeat a growth spurt.[2]

[1]This section draws on a recent World Bank publication, Grover et al. (2019), Chap. "The Readiness of Innovation Systems for the Fourth Industrial Revolution (4IR) in Sub-Saharan Africa".

This study utilises longitudinal data sets of company performance from Brazil, Côte d'Ivoire, Ethiopia, Hungary, India, Indonesia, Mexico, South Africa, Thailand, Tunisia, and Turkey.

[2]Half the firms that experienced a high-growth event in the previous three years are likely to exit the market altogether in the following 3–6 years; less than 15% are likely to repeat a high-growth episode, Grover et al. (2019).

The heterogeneity of firms with high potential for growth regarding age, size, sectoral location and continuity of growth, makes it very difficult to identify the appropriate targets. The right firm must be selected and it has to be selected at the right time—as with music the right note has to be struck at the right time to produce the desired sound. Moreover, the firms selected should be those which have the potential to expand because they have the fundamentals in place to support high growth as opposed to those firms who have the potential to expand due to some other factor such as an exogenous shift in demand. What criteria are available to those making the selection so as to determine the firms' prospects for growth derive from the fundamentals?

None of the criteria available such as past record, business plans etc. has much predictive capacity. Indeed, it may well be that the better endowed firms are more likely to score higher in any of these assessment criteria, resulting in public funds being made available to them and so enhancing inequities (Grover et al. 2019: 118).

3.2 Should Government Support for NTBs Be Targeted at Enhancing Their Technological and Innovation Capacities?[3]

Governmental measures designed to enhance the capacities of NTBs to innovate were initiated in the developed countries. In the developed countries governmental support for these firms is now universal and invariably directed at enhancing their capacities to innovate. Such policies and institutions are seen as an integral component of the NSI and contributing to development of knowledge-based economy.

However, in order to realise a return on its investments in innovation, firms require a series of complementary inputs. In this regard, the context, the broader environment, in which NTBs are embedded, differs markedly as between developing and developed countries. To take just a few examples:

(a) Innovation may require new skills—but firms may face very considerable skill shortages.
(b) Innovation may require reorganisation of the company's workforce—but firms may confront political or labour market impediments.
(c) Innovation may require new investments in selling and supporting new products—but firms may confront barriers in raising the capital for risky ventures where returns are uncertain.
(d) Innovation may require the importation of new machinery—but access to new capital equipment may be inhibited by trade or tariff barriers.

The above is merely an illustrative list of some of the factors that will influence the returns that NTBs are likely to make from their investments in innovation. These and other factors are complementary to innovation. Where these complementary

[3]This section of the paper draws on Cirera and Maloney (2017).

factors are absent, or constrained, the firm's returns to innovation will accordingly be similarly absent or constrained.

While such complementary factors may be present in the developed countries—abundance of the requisite skills, easy and low tariff access to imports, export market access and well-functioning capital markets—the same does not hold for the developing countries. As a general observation, the less developed the country, the more firms in that country are likely to lack access to the complementary factors required to ensure positive returns to innovation.

Where access to complementary factors is absent or limited, government support for innovation in NTBs will elicit limited additional firm level investments in innovation. Rather than providing support to firms to enhance their capacities to innovate, government should focus on enhancing these firms' access to the complementary factors that currently most constrain the returns that they obtain from investing in innovation.

Further factors that limit the ability of the firm to innovate, and therefore reduce the returns to innovation, are internal to the firm. A firm's capacity to innovate is not a given. A firm may begin by assimilating technologies that are readily available. Firms gradually develop the capacity to make minor adaptations. This may require hiring of technicians or engineers. As the firm engages in further incremental innovation, it requires more skills, some internal organisation and enhanced efficiencies. As the firm moves closer to the technological frontier, the firm's skill requirements, plant and equipment, work organisation and management practices all change. Formal R&D departments and deep collaborations with technology providers are likely to be required as a firm reaches closer to the technology frontier. Firms develop their internal capacities to innovate only over time and only with considerable internal effort and commitment of resources. Where these in-firm capabilities for innovation are lacking, government supply of finance or other supports for firm level innovation, will not find partners who have the requisite competencies to innovate and to yield sufficiently high returns from their investments in innovation.

A recent World Bank report drawing on the World Management Surveys has shown that

> …developing country firms are… lagging in a wide range of capabilities that are critical to the Schumpeterian catch-up process: few managers in developing countries can take a long-term view, have sophisticated project evaluation skills, or have a human resource policy that would staff research and development (R&D) projects. (Cirera and Maloney 2017: 65)

A critical first step in determining the support that governments provide to NTBs is to assess (a) what are the factors that are external to the firm and (b) what are the factors that are internal to the management of the firm that are most constraining the firms from innovating. Identification of the binding external and internal constraints will determine what forms of state support are likely to be most effective. As countries develop, we would expect that the external factors constraining innovation would diminish and change and similarly, as firms develop the factors internal to the firm that are constraining innovation would also diminish and change.

However, identifying these constraining factors, both the factors in the external environment within which firms operate and the factors that are internal to the firm, is a non-trivial task. Obtaining information from firms is a complex and time consuming business. Business associations may represent some firms, usually the well-established, and not others. Firms have bounded vision and they often do not themselves understand the constraints that they face either in the external environment or internal to the firm (Rodrik 2004). Of most importance is that these firms are by definition "entering into new territory"—new markets, new products, new production processes and new organisational forms. Of concern are not merely the constraints that firms face currently but the constraints that they are likely to face in the future. Of their current constraints and even more of the future constraints that firms will face, the firms themselves have only a very limited knowledge.

Despite these difficulties in obtaining the necessary information, before establishing policies and institutions focused on enhancing the capacities of firms to innovate, it is critical for government, to determine whether this is indeed what the firms require most. There can be no automatic assumption, particularly in developing countries where, to reiterate, firms are likely to face a very large number of constraints that are external to as well as constraints that are internal to the firm, that support for innovation is what would be most effective to enhancing the growth of these firms. Indeed, it is only a very small number of firms in the developing context which will benefit from support targeted at enhancing their capacities for innovation.

Nevertheless, there are likely to be some firms that have the internal capacity to undertake complex innovation and to obtain the necessary complementary inputs to innovation. The issue to which we now turn is the institutional form that support for such firms takes in developing countries.

3.3 Government Agencies to Implement Innovation Support for NTBs

The difficulties of identifying and selecting firms for support combined with the widespread absence of complementary inputs, both external and internal to the firm, make the challenge for government agencies tasked with implementing innovation policies very challenging. These challenges are particularly daunting in a developing country setting. Moreover, in the developing country context, governmental capacities will be more limited.

Developed countries have developed a number of institutional forms or agencies to support NTBs. There has been considerable variation in the performance of these different agencies. Best practice institutional models include Singapore, Israel and Finland. But, government agencies in other developed countries have had much less success. In brief, "…there is no single "successful" model for an innovation agency (Glennie and Bound 2016: 6)." Success is heavily context dependent.[4]

The establishment of governmental support for start-ups in the developing countries is of very recent vintage. In Latin America, for example, several countries have introduced supports for start-ups only within the last decade. Support is now widespread, including large and small countries, including Brazil, Argentina, Mexico, Colombia, Peru and Paraguay (OECD 2013, 2016).

Support for start-ups in Africa has lagged momentarily but is increasing rapidly.[5] Few African governments are currently actively engaged in directly funding start-ups. In most African countries, funding and support for start-ups is provided by a variety of non-governmental actors. In Kenya, Nigeria and Rwanda governments are playing a more direct role and have specifically 'targeted' the support of start-ups in the ICT sector (Bright 2016; Elebeke 2017; Mulligan 2015). Governments in Africa and elsewhere in the developing world are likely to significantly expand their support for start-ups in the near future.

What institutional form should support for NTBs take in a developing country context? Since they have only been recently established, and since the impact of supports may only be evident over a long term, systematic reviews of the performance of different institutional forms of support are lacking.

In South Africa, government direct support for technology-based start-ups has increased very significantly in the last decade. The institutional form that this support has taken is that of a government agency. What can be learnt from the South African experience?

4 The South African Technology Innovation Agency (TIA)

TIA was established by the Department of Science and Technology (DST) in terms of the TIA Act of 2008. South Africa has a well-developed NSI with multiple publicly funded research institutions and universities a dedicated ministry in government. It has a strong and well-established business sector, but with limited entry of new firms. While South Africa produces considerable research output, technology and commercial outputs, notably in respect of new technology based start-ups, has been

[4]There has been a tendency for policy makers to identify best-practice institutions based in countries such as Israel, Singapore and Finland and then attempt to emulate them. While the experiences of these countries are valuable, their contexts are radically different: in the broader environment within which the firms operate, in the capacities, that firms have to innovate and, most importantly, in governmental capacities.

[5]Supports programmes are increasingly available and have spread to most African countries (Disrupt Africa 2017). These include even a number of the poorer and smaller countries. 159 African tech start-ups are said to have raised funding in excess of US$195 million in 2017. While this is still a small number, the rate of growth is impressive—a 51% increase on the previous year (Disrupt Africa 2017). The top three countries were South Africa, Nigeria and Kenya. Ghana and Egypt were also significant. In terms of sectors, finance received the most funding and e-commerce had the most significant growth (Disrupt Africa 2017).

far more limited. The South African NSI was accordingly regarded as characterised by a deep and widening "innovation chasm" between research and development and commercialisation. There were a number of disparate entities engaged in bridging this chasm and the view was that a single agency could perform this function more effectively. Seven entities that had previously engaged in supporting innovation were accordingly merged into a single agency—TIA.

To this end, TIA is not engaged in supporting research but rather in facilitating and encouraging the translation of research into technological and particularly commercial outputs. TIA defines its mission as facilitating the translation of South Africa's knowledge resource into sustainable socio-economic opportunities. TIA's main goal is to help create new knowledge-based economic activities and industries so as to grow and diversify the economy, TIA's focus is thus on technology and commercial development. To this end, TIA is engaged with firms from proof of concept to the point where commercial partners and investors for the further development of the technology can be accessed. To achieve this, TIA established the following funds: the Seed Fund, the Technology Development Fund and the Commercialisation Support Fund. These funds provide financial support to applicants on a competitive basis. In addition to finance, TIA's Innovation Skills Development (ISD) unit provides managerial, business and mentoring support in the areas of business and entrepreneur development.

TIA also supports and manages a number of technology stations and platforms whereby SMMEs get access to technical, engineering and testing services. But, the focus of the following discussion is the direct financial support that TIA provides to enhance the innovative activities of technology-based firms.

4.1 A First Question—Two Different Approaches to Funding

There are broadly two approaches that government agencies can adopt in order to support NTBs. The first approach is for government to initiate a fund which then injects monies directly into one or more recognised private Venture Capital (VC) funds. The rationale for this approach is that private VC funds are not sufficiently profitable, and the available investments are too risky to attract private investors. Direct government financial support for private VCs is usually quite limited and is structured so as to somewhat reduce the risk without taking away the upside gain of a successful investment. Management and decision making is generally left entirely in the hands of the VC management with government essentially playing the role of a passive investor.

The distinct advantage of private VC as a funder and manager is that incentives are well aligned. There is significant downside risk and upside gain for private funders who have every incentive to allocate their funds effectively and to add additional resources that they command—management, networking, market information—that can play a major role in determining that the investments ultimately succeed.

If structured correctly, this fund-of-funds approach, retains the considerable downside risk and particularly the upside gain to private VCs that are the recipients of state funding. As a result, much of the incentive alignment is in place. In societies, where there are other far safer traditional avenues for investment, it will be difficult for private VCs, in the absence of some form of direct funding support from government, to operate. On the other hand, if the deal flow is low—there are few bankable projects—providing subsidies to private VCs will be likely to lead to otherwise unworthy projects receiving funding.

The second approach is for government to own and manage its own fund which then directly funds NTBs. There are two major concerns with this approach. Firstly, incentives are misaligned. Those who dispense public funds are only indirectly rewarded for good performance, or (less often), punished for poor performance. As a result, projects supported by government owned funds are likely to be less well screened and less well supported in terms of other factors such as management, networking and market knowledge than is the case with private VC.[6] The second concern is that where private and public funds coexist, the latter might crowd out the former, leading to less rather than more funding support for start-ups.

On the other hand, direct government funding allows for the pursuit of social objectives, such as reducing inequality. It also allows for funding allocation to be in alignment with other aspects of government policy, notably industrial policies that favour particular sectors, activities or localities. Privately funded and managed VCs are not able to effectively take account of such government objectives.

The South African context is one of pronounced inequality, particularly persistent racial inequality. South Africa also has an active industrial policy which favours particular sectors/regions/activities. The decision to allocate funding directly reflected government concerns to overcome racial inequalities and to steer the economy in certain directions. As a result, TIA has a wide range of objectives—well beyond the objectives that could be accommodated by a partnership with a privately funded and managed VC.

Of particular salience are racial inequalities. One of the key performance indicators (KPs) by which TIA is assessed is the number of PDIs (previously disadvantaged individuals) receiving support and the percentage share of successful PDI applicants. Severe skills shortages, few black graduates and strong incentives in terms of government policies to promote black economic empowerment combine to provide many employment opportunities for skilled black graduates in already well-established firms. As a result, there are very few black owned start-ups. Most start-ups are white owned, resulting in a pronounced racial division at the level of entrepreneurship. However, giving preference to black owned start-ups in a situation where there are

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[6] There is some evidence that government-owned funds are less effective in providing capital to start-up than are government-supported venture capital funds—the funds-of-funds approach. "There are significant differences between government ownership and government support of venture capital firms, broadly suggesting that support outperforms ownership" (Brander et al. 2010: 13). Interestingly, a modest amount of government support for a private fund may result in such a fund performing better than a private VC. Significant support has the opposite effect (Brander et al. 2010: 12).

very few, does not address the problem. Rather this is likely to lead to the funding of firms that have fewer prospects of success and so result in a misallocation of resources.

4.2 Ensuring Simplicity and Speed of Application

In order for support to innovative firms to be effective, such support must be rendered rapidly. For a firm introducing novelty, time is of the essence. Innovations frequently fail not for any inherent deficiency but simply because they take too long to be implemented and to come to market. It is not sufficient for the right supports to be in place. The right supports must be provided timeously if they are to be rendered effective.

A related problem is the time, but also the effort and the expense that an applicant is required to spend in order to access the support. Management time and firm resources spent on accessing the support materially detract from the value of that support. Where ensuring access is difficult, firms may resort to hiring outside professionals to prepare and present their applications. The transactions costs and the time involved in working with intermediaries are likely to be very significant.

Grant funding schemes, such as that operated by TIA, follow a common basic structure. The granting agency prepares and publicises a request for firms to apply for funding support. This request or call for applications outlines the qualification criteria i.e. which firms qualify, but also which projects; what categories of activities; levels of funding; and the terms of funding such as duration and pay-back provisions.

One of the key performance indicators to assess the efficacy of governmental agencies in their support for innovating firms is accordingly the turnaround time; this is the time of receipt of application to the notification of success and the first receipt of monies. As agencies develop and establish their procedures, turnaround times should reduce. However, streamlining procedures is a complicated and difficult task and requires time. In the case of TIA, turnaround times were as high as 6–8 months. Over time, this was significantly reduced. The 2016–17 annual report states that the turnaround time at 3 months and 2 days (TIA, Annual report 2016–17: 35).

Of course, in principle, the request for funding should be clear and the application procedures should be as light and as simple as possible, so reducing the turnaround time. But, this is by no means common in the practices of government agencies. "Too often…application procedures require excessive documentation or cumbersome application forms, which imply significant costs for applicants and act as a deterrent to apply for government support. Thus, in some countries consultants have specialized in filling applications, which can result in these programs being captured by those same firms that have developed a good understanding of the application processes or that have hired these consultants. Avoiding this capture and reaching out to the main policy beneficiaries require light application processes, with clear and transparent requirements that are evaluated by externally qualified evaluators with previously designed appeal mechanisms" (Cirera and Maloney 2017: 125–126).

However, light and simple processes, while generally desirable, have the disadvantage of encouraging all and sundry to apply. Since "free" or "cheap" monies are on offer, firms that may not be suitable may well take the chance and make an application. Where applications are very easy and light, this can result in agency spending considerable time and resources processing non-suitable applications.

Of more import is that as a government agency, TIA is dispensing public monies. Expenditures of public monies necessarily require controls and reporting procedures. In South Africa, the Public Finance Management Act (PFMA) 1991 requires that TIA itself and the granting of financial support to firms are subject to stringent processes of governance, accounting, reporting and auditing requirements. This has certainly served to ensure accountability and limit corruption, but it has also decreased the agility and rapidity with which TIA can support applicants that are assessed as worthy of support. Accordingly, there is something of a trade-off as between speed required for efficiency and procedures of reporting and accountability that are designed to limit arbitrariness, capture and possibly corrupt practices.

4.3 Safeguarding Against Corruption and Capture

In essence agencies providing financial support for innovating firms are distributing public monies to private clients. As with all activities entailing the provision of public monies, the provision of financial support for these firms runs the very considerable risk of corruption and capture. In this instance, the problem is compounded in that once monies are handed over, it is very difficult to undertake surveillance such that the agency is able to ensure that the monies allocated have indeed been utilised as applied for and as granted.

One way in which this can be—at least partially—mitigated, is by utilising matching grants. Accordingly, matching grants are very widely used globally. It is estimated, utilising public expenditure reviews, that matching grants make up 80% of support across 140 innovation instruments in Latin America (Cirera and Maloney 2017: 123). Under the system of matching grants, the granting agency requires that the applicant match (the percentage provided by the firm is variable) any grant advanced by the agency. These can range from one-off funding allocations to more complex and long-term private public partnerships. However, the once-off matching grant is most often utilised. To provide further security to the use of public funds by private beneficiaries, grants are often made in tranches, requiring that certain goals are achieved, including expenditures by the recipient firm of their own resources, before further tranches are granted.

Internal to the agency, a strong internal and external audit function answerable to the Board and not to the management are critical to ensure that resources are allocated effectively and in accordance with well-established procedures. An independent Board with declaratory safeguards to ensure that no employees of the agency derive any personal benefit from any of the agency's operations is a further essential constraint on state capture and corruption.

These are all safeguards—and there are others—that can and should be utilised to curtail state capture and corruption. However, none of these safeguards provides any form of guarantee. The potential will always exist whereby an agency and its employees distribute monies that are not theirs; a classic principal agent problem. The problem is likely to be particularly significant in the early stages of an agencies operation. Before systems are in place, internal and external auditors and the board well established and conversant with the operations of the agency, the agency is more prone to these sorts of problems.

TIA has all these safeguards in place. However, a large part of the senior management that were initially appointed when the organisation commenced were found to be responsible for corrupt practices and were dismissed. It took some considerable steering on the part of the Board to turn the organisation around, to acquire new management and to put in place more effective systems to safeguard against corruption and capture.

4.4 Reducing Costs

Government agencies are costly to run and administer. By far the most significant costs relate to wages and remuneration. A very high proportion of the requisite employees of a government agency are skilled—many highly skilled. Wages and remuneration are commensurately high. Particularly in a situation of a shortage of skills, as is the case in South Africa, in order to attract and to retain such skilled workers, a government agency will be required to pay a significant premium. Moreover, the shortage of skills is likely to ensure that labour turnover rates are high raising costs still further. In the three years 2014/5–2016/7, wage costs represented two-thirds of TIAs total cost. Wage costs were twice as much as all the other administrative costs combined (TIA, Annual Reports 2014/15–2016/17).

One key measure of an agency's operational efficiency is the cost of administering the agency as a share of the overall budget. In brief: what share of the agency's budget is spent internally and what share of the agency's budget is finally allocated to the recipients of support, the firms themselves? This is often termed the efficiency ratio. Particularly in times where the agency receives less overall funding, in order to safeguard the core activity of the agency, indeed the entre raison d'etre of the agency, the agency will need to improve its efficiency ratio.

This is what occurred in the case of TIA. The agency received a sudden reduction in its budget allocation in 2016. As a result, in a process overseen by the Board, TIA was forced to improve its efficiency ratio. "To enhance operational efficiency and ensure maximum budget allocation to projects, the Board set specific targets to regulate the ratio of administration costs as a percentage of the total budget. This is demonstrated by the efficiency ratio. The significantly improved ratio of 22% for FY2016/17 indicated that, for every rand received from the fiscus, R0.78 is utilised for investment and project funding, and R0.22 utilised for administrative and salary costs. Maintaining and improving on this ratio will remain a challenge as organisational growth and development initiatives must always be balanced against the efficiency ratio. Our target efficiency ratio remains 30/70 (TIA 2016–17: 21).

At one stage, TIA's efficiency ratio stood at 38%. In the three year period 2014/15–2016/17, the efficiency ratio averaged 26% (TIA, Annual Reports). By contrast, the percentage spent on operational overheads by Tekes of Finland, widely acknowledged as a best practice agency globally, was reported to be of the order of 5% (data supplied by McKinsey).

With only a little over 60% of the budget being allocated to the firms that the agency was established to support, the very raison d'etre of the agency was in question. But as the above quotation makes clear, enhancing the efficiency ratio has to be balanced against the agency having sufficient resources to perform its functions effectively. As noted above, the major component of administrative costs is labour—notably highly skilled and therefore high cost labour is essential to the effective functioning of the organisation.

4.5 Acquiring the Necessary Skills and Competencies

One of the key reasons for government to establish an agency structure to support start-ups rather than for support to start-ups being merely an additional function added on to an existent government department is that such an agency is not bound by the human resource procedures and policies that characterise government employment. Generally, agencies will be endowed with considerable freedom to establish procedures and policies so as to be able to attract and retain skilled workers.

Indeed, almost certainly, the most difficult challenge facing a government agency seeking to support start-ups is acquiring and retaining the requisite skills to perform this function effectively. While the severity varies, almost every developing county has a shortage of skills. Moreover, the skills that are almost certainly the most difficult to source, are precisely those that an agency will most require—in particular, scientific, engineering, technical and managerial skills. The wider the agency spreads its supports, the wider the array of technical and other skills that the agency will require.

The situation in this regard in TIA is summarised in the Annual Report.

> It is worth noting that the requisite skills to fulfil the TIA mandate are quite scarce. These include Workout and Restructuring Portfolio Managers, Intellectual Property Legal Advisors, Portfolio Managers with commercialisation background and Investment and Internal Auditors with Quality Assurance experience. TIA struggles to attract and retain talent with such skills….This poses an operational risk to the organisation. (TIA, Annual Report 2016–17)

Moreover, personnel who have both sets of skills, technical and managerial, are optimal. However, in a situation where development has been constrained and few people have experience of management in the business sector, such skill sets are unlikely to be forthcoming.

In this context, in-house training within the agency plays an important role.

> The nature of TIA business requires highly technical skills from engineering and science backgrounds combined with commercial and skills. This is to ensure a comprehensive approach to sourcing, assessment and management of investments. Due to the vast economic sectors where the Agency operates, it is imperative that the required skills are sourced and utilised to achieve the TIA objectives. In sourcing the skills, it became apparent that in some cases, the technical skills are not always coupled with the relevant leadership skills necessary to manage the projects and the people. Several efforts are made to develop these skills which include training on performance management, industrial relations and project management to name a few (TIA, Annual Report 2016–17: 72)

A number of specialist skills cannot be supplied in-house and must therefore be sourced from the private sector. As one example—Intellectual property (IP) law capacity is of the most critical resources, and one of the most costly. TIA has frequently to resort to the private sector to acquire such expertise. In South Africa, IP law is relatively well-developed, and the requisite skills are available locally. In other developing countries, governmental agencies may well have to resort to acquiring such expertise from outside of the country with, of course, implications for both the budget and for the turnaround time for applicants.

As outlined earlier, the major barrier to effective innovation at the firm will often rest less in the limited resources for innovation that are available to the firms, and more in the lack of firm level competencies particularly management capabilities that severely constrain the returns to innovation. Financial grants to firms to support innovation will only be effective if the firms have the managerial capacities to design and implement good innovation projects and to develop the firm but lack the necessary finance. But, as outlined earlier, start-ups frequently lack these internal management skills. Moreover, every company goes through a life cycle with each stage requiring a different set of management skills. The person who starts the business is seldom the person who can grow it, and that person is seldom the one who can lead a much larger company. Private VCs provide financial and managerial skills attuned to the different stages of a firm's development. These financial and business skills make an important contribution to the company's eventual success (Zider 1998).

However, skill shortages, combined with budget constraints, are likely to result in governmental agencies focusing almost exclusively on the tasks of allocating financial support to applicants. An agency, in a situation where management skills are in short supply, is unlikely to be in the position to offer significant non-financial support to applicants. This is the case in TIA where managerial and non-financial support provided to successful applicants is very limited. Successful applicants are required to report on progress, but other than reviewing progress of applicants and informal engagement, TIA is not able to offer significant management or other non-financial support.

4.6 Ensuring Secure Long-Term Funding

Financial support to firms for innovation is very rarely a once-off grant. Invariably, grants are multi-year, with payments made in tranches once milestones are met. At any point in time therefore, the granting agency has long-term funding commitments that it must, of necessity, meet. If funding is reduced, the agency will have to ensure that its existent commitments are met and accordingly severely curtail any new lending.

Curtailing new lending is however also very difficult. Support programs have been announced and applicants have been invited to submit. It is both difficult and inequitable to reduce access to funding for firms whose applications are in process. If good firms go without funding, the credibility of the agency suffers. It is clear that in order to enable smooth and efficient operations, and to ensure the legitimacy of the agency in the eyes of those whom it supports, the agency will ideally require a high level of certainty as to the availability of future funding.

Of course, this may be difficult for government, particularly when economic times are difficult and have not been planned for. In the case of TIA, despite a three year budget horizon in terms of the government's Medium Term Expenditure Framework (MTEF), when the economy stagnated and governmental revenues declined, budgetary allocations fell—sometimes precipitously. In 2013/14, TIAs parliamentary grant declined from R481 million to R338.4 million—and only rose slowly thereafter so that three years later the parliamentary grant was still some 20% lower than it had been earlier (TIA, Annual Reports). The organisation was also forced to make major savings in its operations in order to meet its funding commitments and to stabilise its project funding disbursements. It is clear that governments contemplating establishing an agency to provide financial support for the innovation activities of firms will need to be able to ensure that such funding is secure and dependable.

4.7 Monitoring and Evaluation

Governments everywhere are experimenting with new policies and new institutional arrangements to support start-ups. Particularly because policies and institutions are so new and indeed experimental, it is important to monitor and evaluate policies designed to support firm level innovation and the institutions that implement these policies. Performance will need to be evaluated and policies and institutions held accountable to clearly stipulated ex ante performance indicators, Policies and institutions can then be moderated or altered dependent on performance.

Innovative firms are situated in very fast changing markets and environments—most often global markets which are subject to strong competition and threats of new entrants. To be effective, governmental support and governmental institutions will need to be agile, making adaptations rapidly as the requirements for innovation change. The need for this agility, lends an added weight to the requirement for ongoing monitoring and evaluation.

TIA employs a number of Key Performance Indicators (KPI). In respect of TIA's support for firm level innovation, the most obvious set of KPIs relate to the effective commercialisation of projects that TIA has supported. Thus, TIA annual reports provide the number of firms that that, since its inception, have managed to penetrate the market. However, this measure begs a number of questions. Most obviously, how should "penetrate" be assessed—in terms of output or employment, for example? More significantly, over what time period is it valid to make this assessment—some projects may realise only very short term gains, but others gains occur only over a long period. Finally, can such success be attributed to TIA funding? In the absence of TIA, might successful firms have found support elsewhere? In other terms, is TIA crowding out private support for innovative companies?

A further KPI is designed to address this last question in TIA—namely the outside funding that TIA projects and applicants were able to secure. This KPI relates firstly to the outside funding that TIA itself is able to attract into its own programmes viz. the amount of funding attracted into the TIA portfolio. And secondly to the outside funding secured on the part of those firms receiving TIA funding viz the number of knowledge innovation products produced by TIA supported projects receiving third party funding.

Without entering a considerable discussion on the merits and limitations of these KPIs, it is clear that, as with the KPIs in relation to commercialisation, the KPIs relating to the crowding out or crowding in of private funding support for innovation, are far from definitive. This is not uniquely a TIA problem. KPIs to assess performance are difficult to design and are, in any event, open to interpretation. To this end, regular KPIs should be supplemented by periodic external in-depth institutional reviews.

Before an agency to support funding of firm level innovation is established, it will be critical for government to establish clear performance indicators for that agency, particularly in respect of commercialisation and the crowding in/crowding out of private funding support for innovation. However, this is very rarely done. "A final important weakness in these countries is the lack of appropriate M&E frameworks and impact evaluations. Many innovation programs lack a well-defined, logical framework that could inform M&E efforts. In addition, impact evaluation in innovation programs is in a very early stage, with only a handful of evaluations available for the whole Latin American region" (Cirera and Maloney 2017: 122).

5 Conclusion

Governments are currently experimenting with various policies and institutional forms to support firm level innovation. At this stage, no definite conclusions can be drawn. There is no innovation policy that is universally successful. Nor is there any single successful model for an innovation agency (Glennie and Bound 2016).

Context is all important. Context, including critically, governmental capacities must be carefully considered in weighing up what policies and particularly what intuitional design is appropriate.

As the earlier section of this chapter has stressed, before even deciding on providing direct support for firm level innovation, government needs to have clearly identified that this support addresses the most binding constraints on the further development of the firm. If this is indeed the case, the next step is for government to examine what institutional form would best deliver that support. A government agency is one such possibility but, of course, there are other institutional forms.

This chapter does not seek to evaluate TIA but, drawing from the experience of South Africa and TIA, outlines some of the major challenges and constraints that a government agency located in a developing country is likely to experience. A major recent World Bank review of innovation, singles out the difficulties that governments face in establishing institutions to support innovation, particularly in developing countries which are far from the technology frontier and where government capabilities are likely to be very limited, as one of the most pressing and yet one of the most unacknowledged gaps in our understanding of innovation and policy.

> Academic and policy discussions about innovation policy often omit the question of who actually implements it. The role public servants, ministries, and agencies play in ensuring or undermining the effectiveness of policy instruments is rarely considered. This is a critical part of the resolution of the innovation paradox: as the complexity and scope of the interventions necessary to resolve the failures that impede exploiting the gains from technological catch-up increase with distance from the frontier, the capabilities of governments to design and implement the interventions tend to diminish. Overall, the issue of capabilities in innovation policy making and how to improve them is probably one of the most pressing, yet unacknowledged agendas in innovation policy in developing countries (Cirera and Maloney 2017: 138)

This chapter attempts a very modest contribution to this agenda; drawing on the experience of South Africa to examine some of the difficulties and complexities that government agencies are likely to experience in funding the development of technology based start-ups.

References

Ayyagari M, Demirguc-Kunt A, Maksimovic V (2011) Small vs. young firms across the world: contribution to employment, job creation and growth. Policy Research Working Paper no. 5631. World Bank, Washington, D.C.

Brander J, Du Q, Hellmann T (2010) The effects of government-sponsored venture capital: international evidence. National Bureau of Economic Research (NBER), Working Paper 16521. NBER, Cambridge, Mass

Bright J (2016) Rwanda's tech initiatives prove African governments can catalyse innovation. Techcrunch. Accessed at https://beta.techcrunch.com/2016/10/31/rwandas-tech-initiatives-prove-african-governments-can-catalyze-innovation/

Cirera X, Maloney WF (2017) The innovation paradox. The World Bank Group, Washington, D.C.

Disrupt Africa (2016, 2017) African Tech Startups Funding, 2017

Elebeke E (2017) Nigeria spends $70 bn to support start-ups. Vanguard (15 November 2017). Accessed at https://www.vanguardngr.com/2017/11/innovation-nigeria-spends-70bn-support-start-ups/

Glennie A, Bound K (2016) How innovation agencies work; International lessons to inspire and inform national strategies. Nesta, London

Grover A, Medvedev D, Olafsen E (2019) High-growth firms. Facts, fiction, and policy options for emerging economies. World Bank Group, Washington, D.C.

Hausmann R, Hwang J, Rodrik D (2007) What you export matters. J Econ Growth 12(1):1–25

Hausmann R, Rodrik D (2003) Economic development as self-discovery. J Dev Econ, Elsevier 72(2):603–633

Mulligan G (2015) Kenya: a sartup nation? New African. (12 August 2015). Accessed at Newafricanmagazine.com/kenya-a-startup-nation/

OECD (2013) Start-up Latin America: promoting innovation in the region, Development Centre Studies. OECD Publishing, Paris

OECD (2016) Start-up Latin America 2016. Building an innovative future. Development Centre Studies. OECD Publishing, Paris

Rodrik D (2004) Industrial policy for the twenty-first century. John F. Kennedy School of Government, Harvard University, Cambridge, MA

The Technology Innovation Agency (2015, 2016, 2017) Annual Reports. https://www.tia.org.za/press-and-media/#1513848005440-fde0dadf-479d

Wu J, Atkinson RD (2017) How technology-based start-ups support U.S. economic growth. Information Technology and Innovation Foundation. (November 28, 2017). https://www2.itif.org/2017-technology-based-start-ups.pdf

Zider B (1998) How venture capital works. Harvard Bus Rev. November–December. https://hbr.org/1998/11/how-venture-capital-works

Mapping the Potentials for Transformative Innovation Policies in Africa: Evidence from Cote d'Ivoire and Nigeria

Chux Daniels and Mafini Dosso

1 Introduction: Public Policies and Transformation Agenda in Africa

The ongoing initiatives in Africa's policy arena indicate that Science, Technology and Innovation (STI), likewise entrepreneurship and digital technologies, are considered as essential factors in the transformation of industries, systems, and societies across the continent. Expectations that STI policies (henceforth used interchangeably with Innovation Policies), will help drive STI towards the realisation of sustainable development have led to the sharp rise in the (re)formulation of STI policies, strategies, and plans. These changes occur at different pace at the national (MESRS 2018; AOSTI 2013; FMST 2012), regional (see for example, ECOWAS' ECOPOST)[1] and continental levels (see for example, Consolidated Plan of Action, STISA 2024: STI Strategy for Africa 2014–2024, AUC 2014). To this end, there has been a steady increase in the number of STI policies across the continent. Relatedly funding for STI activities is progressively on the rise, while more actors continue to enter the STI ecosystem in Africa (Chataway et al. 2017, 2019).

Alongside the progress in the area of STI policies, various development topics have arisen in relation to STI processes and policymaking. These topics for example include entrepreneurship, technology and technology commercialisation, and innovation (AUDA-NEPAD 2019; Daniels 2017; AUC 2014), the role of innovation in development, sustainability and industrialisation (Dosso 2019; Daniels et al. 2017), and capabilities and skills for STI and STI policies (ACBF 2017; Daniels 2015). Other subjects include the role of mobile and digital technologies, and digital

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policies (AUC 2020; Daniels and Tilmes 2020; Dosso et al. 2020a; Bayen 2019), international research and innovation partnerships (Dosso et al. 2017), innovation policy for transformation (Daniels et al. 2020; Daniels and Ting 2019), indicators and evaluation tools (Daniels et al. 2018) and research excellence (Chataway and Daniels 2020). Moreover, the topics of STI and STI policies are also at the centre of Africa's transformation agenda as articulated in the continental Agenda 2063 (AUC 2015).

Despite the heightened interests and the rise in number of funding sources and actors, STI policies in Africa, (i) continue to be formulated on the backdrop of weak evidence; (ii) face acute implementation challenges; (iii) experience major difficulties to align with strategic development priorities at various levels—*local, sectoral, national, regional, and continental*—and contextual factors such as high proportion of informal economy actors; (iv) underperform in their ability address pressing social, environmental and development challenges; and finally, (v) fail at producing the desired level of impacts and transformative change expected in African societies and transition to the anticipated knowledge economy (AUC 2020; Daniels et al. 2020; UNECA 2016; AUC 2014).

In this chapter we acknowledge these shortcomings and discuss innovation policy gaps from a dual policy perspective. The first perspective focuses on the evidence for innovation policy exploiting two countries as cases studies: Côte d'Ivoire and Nigeria, which belong to the top three economic powerhouses of West Africa. These economic performances hide important structural bottlenecks in their innovation systems, thus preventing them from tapping fully into their STI resources for pressing and sometimes basic societal needs. The second perspective is conceptual and explorative. It intends to stimulate the debate on the place-based and transformative dimensions of innovation policies in Africa.

Place-based (or place-specific) innovation policies puts forward the importance to design economic transformation agenda, which build upon the territorial—national, regional or urban—features such as economic and industrial activities, business and knowledge clusters, traditions and culture, STI capabilities, networks and outcomes (Dosso et al. 2020b; Grillitsch and Asheim 2018; Foray 2012). Transformative innovation/STI policies, on the other hand refers to policies that go beyond the focus of economic gains and also addresses social and environmental concerns as articulated in the Sustainable Development Goals (SDGs) (Daniels et al. 2020; Schot and Steinmueller 2018). Building on these definitions, we focus on two objectives, encapsulated in two research questions. To what extent can:

I. Available evidence help inform place-based and transformative STI policies in Africa?
II. STI policies be geared towards the transformation of African economies and societies in line with the UN Agenda 2030 (SDGs)?

The case studies of Côte d'Ivoire and Nigeria shed light on the context-specific gaps in innovation policies and evidence base with a view to determining their distance to transformative change or potentials for application in place-based policymaking approach. The rest of the chapter is organised as follows. In Sect. 2, we provide the conceptual background and review relevant literature and guiding frameworks. Section 3 gives an overview of the available and important missing 'pieces of evidence' to inform place-based and transformative innovation policies in both countries. This mapping helps to highlight some of the critical gaps that currently exist. These observations lead to the discussion of key insights from the emerging findings, in Sect. 4. Section 5 concludes.

2 Conceptual Underpinnings and Review of Literature

2.1 Towards Place-Based and Transformative Innovation Policies in Africa

The growing awareness about the importance of innovation as a means towards the transformation of African societies and industries has led to the adoption of several frameworks and strategies at the national and continental African levels (UNECA 2015). At the level of the African Union, this shift in policy thinking has been marked by the adoption of the Africa's Science and Technology Consolidated Plan of Action[2] (CPA) by the African Ministerial Council on Science and Technology (AMCOST) in 2005. Drawing lessons from the CPA, the Heads of States and governments of the African Union (AU) member countries have adopted the Science, Technology and Innovation Strategy for Africa—2024[3] (STISA-2024) in 2014. A few progresses are also visible at the levels of Regional Economic Communities (RECs) with the adoption of strategies and the creation of novel institutions and programmes. These initiatives aim at fostering innovation policy capabilities and the integration of African national STI systems (for instance, ECOWAS Policy on Science and Technology (ECOPOST 2011); and the establishment of the East African Science and Technology Commission (EASTECO) as a semi-autonomous institution of the East African Community (EAC) in 2007).

Moreover, many countries such as Côte d'Ivoire, Nigeria, Rwanda, Sierra Leone or South Africa have announced or have established national STI policies or dedicated innovation funds. Some of the innovation policies or funds have been formulated (for policies) or set up (for funds) by the countries alone while others have been formulated/set up in partnership with—or with assistance from—international or continental institutions such as the African Development Bank (AfDB), World Bank, UNCTAD or UNICEF's Innovation venture funds.

Côte d'Ivoire does not have a traditional of innovation policy per se, yet the government and private sector have undertaken a number of programmes or local initiatives to strengthen research and innovation capabilities over the last decade. The country has a national plan that frames the development of higher education and scientific research, the PDESRS (Plan de Développement de l'Enseignement Supérieur et de la Recherche Scientifique)[4] for the period 2016–2025. The Ministry of higher education and scientific research promotes the PDESRS consistently with the objectives defined in the national development agenda (MESRS 2018). Since the end of 2016, Côte d'Ivoire has set up dedicated funds for research and innovation, the FONARI[5]. The FONARI integrates three programs: the President's special prize, the funds for the promotion of woman in science and science education, and the funds for research, development and innovation. These programmes complement the PASRES, the Strategic Support to Scientific Research in Côte d'Ivoire set up in mid-2007 with the funding of the Ivoiro-Swiss Funds for Economic and Social Development (FISDES). In addition to reaching the 1% threshold of R&D, these STI reforms target the improvements in the exploitation of research outcomes, research governance and management and research capabilities building.

Nigeria, on the other hand reviewed its S&T policy and in 2012 launched the revised policy with the objective of strengthening the focus on innovation. The launch of the 2012 STI policy has been followed by efforts in setting up the National Research and Innovation Fund (NRIF). The goal is to, through the NRIF, reach the minimum of 1% of GDP expenditure on STI. NRIF aims to source at least 5% of the funds from multiple sources—government, international development partners and private sectors.[6] The funding will be dedicated to the implementation the 2012 STI policy, which as in many other Africa countries, public policies suffer from implementation failures and less than optimum impact on development.

Lastly, South Africa with an existing National Research Foundation (NRF) that funds research and innovation, in 2019 launched her most recent White Paper on STI[7]. The 2019 White Paper on STI seeks to foster transformation through innovation while addressing environmental, sustainability and social concerns such inequality and exclusion.

In order to investigate the issues raised in this Chapter and address the research questions, we draw from two approaches—the Transformative Innovation Policy (TIP) or Innovation Policy for Transformative Change[8] (Daniels et al. 2020; Schot and Steinmueller 2018); and Research and Innovation Smart Specialisation Strategies (S3) (see Dosso et al. 2020b for a reflection on Sub-Saharan Africa; UNCTAD 2018; Foray 2012, 2016). TIP, as an emerging innovation policy paradigm, argues for a shift to innovation (or STI) policies and policymaking that goes beyond Research and Development (R&D) and National Systems of Innovation (NSI) (referred to as first and second frames respectively) of innovation policies; to a third frame of innovation policies and policymaking that better responds to environmental and social challenges, while also addressing economic objectives (Schot and Steinmueller 2018).

Smart Specialisation Strategies (S3) on the other hand are economic transformation agendas. As a type of TIP, S3 guide territories in the identification and selection of research and innovation priority domains and projects in order to tackle socio-economic and industrial development challenges. S3 approach to transformative innovation policymaking thus advocates that territories should prioritise innovation investments consistently with the business, knowledge and financial resources, human capital and innovation infrastructure available to the territory. Through the promotion of inclusive dialogues around innovation, S3 thus enable territories to nurture unique competitive advantages and to take new paths for structural change

Table 1 Challenges and opportunities of innovation policies in African context

Challenges	Opportunities
– Narrow conceptualisation of innovation – STI policies often focus on "S&T" component, with "I" either missing or very poorly addressed – Weak evidence for policymaking and impact assessment (or MER—Monitoring, Evaluation and Reporting) – Lack of/weak implementation mechanisms, MER, and governance frameworks – Mis/Alignment with development/local/societal challenges (access to energy, water, food security, etc.) – Gaps in capabilities, and low promotion of local STI and research – Low research funding and weak infrastructure – Weak support for commercialisation of technology/research	– Increased awareness of the role of STI in national development by policymakers and other key actors – Youth (dividend) – Peaks of entrepreneurial activities – Diversity of human/land/natural resources – Increased innovation and entrepreneurial funding from International donors, private foundations, venture capital, etc. – Uptake of digital technologies/spaces – Agricultural potential for food security – Indigenous knowledge (farming & industrial techniques, etc.) – Human resources and prospects for capability enhancements – Improvements in research excellence

Notes S&T = Science and Technology; I = Innovation
Sources Authors' elaborations (drawing on AfDB 2020; Daniels et al. 2020; Daniels and Tilmes 2020; AUDA-NEPAD 2019; Daniels 2017; AUC 2016, 2015a, b, 2014)

(modernisation, transition or radical change of the industrial and economic structures) in the local economies. Table 1 presents a summary of some of the main challenges and opportunities for innovation policy, if they are to be more impactful in the African context.

2.2 *Transformative Innovation Policies and Smart Specialisation Strategies*

Transformative Innovation Policies

To reiterate, the transformative innovation policy (TIP) approach focuses on mobilising innovation to address societal challenges such as inequality, unemployment and climate change, alongside economic growth. TIP emphasises policies for reorientating social and technical (i.e. sociotechnical) systems into desirable directions that embed processes of change in society. TIP goes beyond R&D and national systems innovation (NSI) policy approaches, and puts forward innovation as a response to environmental, social as well as economic challenges. In this sense, innovation is for transformation. In the TIP approach, there are six factors (or criteria) that help to determine to what extent an innovation policy is transformative or can lead to transformative change. The factors are: directionality, which relates to what extent an innovation policy focus on societal goals; impact at system level, learning and

Table 2 Key principles of transformative innovation policy and smart specialisation policy

Six criteria for transformative innovation policies (Daniels et al. 2020; Schot and Steinmueller 2018)	Six dimensions of for smart specialisation strategies (Dosso et al. 2020b; Foray 2012)
• Focus on achieving societal goals (economic, social and environmental) through the changing of sociotechnical systems[a] • Directionality—ensuring that other trajectories or pathways are explored in determining the choice of technology. • Ensuring impact at system level, that is, over and beyond individual sectors • Focus on second-order (or deep) learning and reflexivity • Inclusiveness of a wide range of actors • Conflict and consensus—ability to encourage conflicts, revolve them and reach a consensus in policy processses	• Localisation of diagnostics based on quantitative, qualitative and experts-based evidence • Prioritisation of a few innovation domains in line with business and societal challenges (not sectors per se) • Building critical masses in research and innovation activities and human capital • Mobilisation for participatory decision-making (triple or quadruple-helix actors) • Customisation of innovation policy mixes and policy instruments to support pilot transformative activities • Regular impact assessments, monitoring and strategy review
http://tipconsortium.net	http://s3platform.jrc.ec.europa.eu

Source Authors' elaborations (based on Daniels et al. 2020; Daniels and Ting 2019; Dosso et al. 2020b; Kleibrink and Mateos 2018; Foray 2012; Schot and Steinmueller 2018)

[a]Socio-technical systems refer to norms, routines, and standards (regimes) embedded for example in technologies, institutions, markets or societal functions

reflexivity, conflict vs consensus, and inclusion of more stakeholders in innovation policy processes. The six criteria are summarised in Table 2 below, alongside the criteria for S3.

The conceptual framework that guides the TIP approach is presented in Fig. 1 below. As the framework shows, the focus of TIP is to use R&D and innovation to target pressing societal challenges—such as inequality, or environmental degradation—which then leads to (the desired type of) economic growth, while achieving public welfare objectives in the process. This is a radical shift from current approaches to STI policies and policymaking. The current approaches focus R&D (or science/research) on innovation (products innovation in particular), with the assumption that economic growth (alongside other outcomes such as public welfare and clean environment) will be realised in the process. This approach is based on the linear model to innovation, which assumes that investments in R&D (or science/research) leads to economic gains. And that the economic gains will trickle down and be distributed across societies, resulting in for example, jobs and employment. Evidence shows that this is not the case, as inequality, social exclusion, and poverty continue to rise in some segments of societies, despite economic growth, some of which emanate from R&D, science and research.

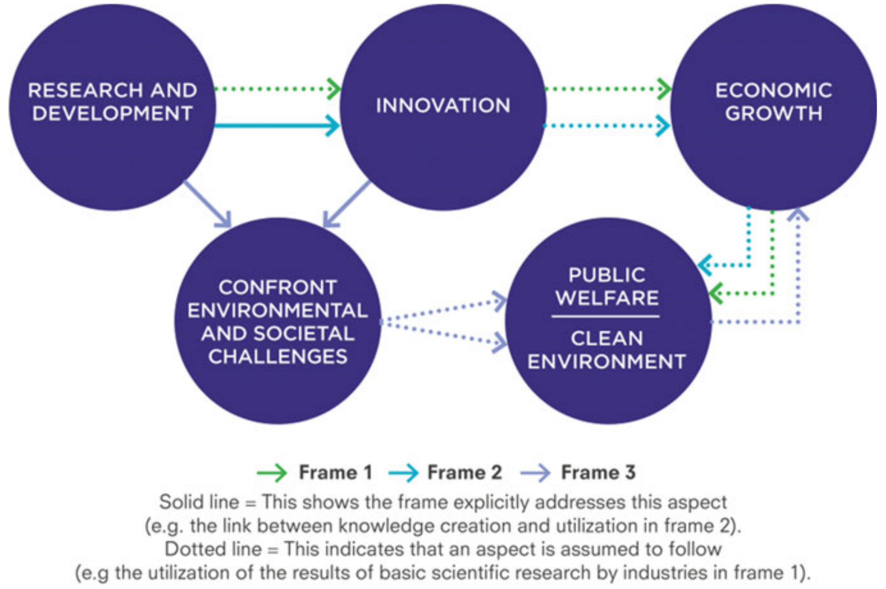

Fig. 1 The conceptual framework for the transformative innovation policy. *Source* TIPC (see also http://www.tipconsortium.net/about/; Daniels et al. 2020; Schot and Steinmueller 2018)

Smart Specialisation Strategies

In Smart Specialisation Strategies (S3), the focus is primarily on improving the exploitation of STI resources in order to generate long term economic returns and societal welfare. S3 has been developed in the frame of the regional or cohesion policy of the European Union with the aim to tackle the deficiencies identified in territorial innovation policies and growing development inequalities. To this date more than 120 S3 initiatives have been launched in European regions (subnational level). In addition, S3 cooperation and pilots are currently taking place for instance with Australia, Latin America, Western Balkans countries and northern Africa (see S3P, the official S3 monitoring and guidance platform, Table 2).

Early evidence indicate that smart specialisation is indeed a type of transformative innovation policy, as also illustrated by the similarities between the criteria for S3 and the six criteria of TIP (see Table 2). Besides the strong territorial component, S3 rely on evidence-based diagnostic (quantitative, qualitative and experts knowledge) and participatory governance mechanisms, which are operationalised through S3 *entrepreneurial discovery processes or EDPs*. In practice, designing a smart specialisation strategy entails six related steps (Fig. 2):

i. Analyse the specific strengths and weaknesses of the region (evidence, SWOT type);
ii. Design a smart specialisation dedicated governance structure;
iii. Develop a shared vision for the future of the territory (country, region or urban);[9]

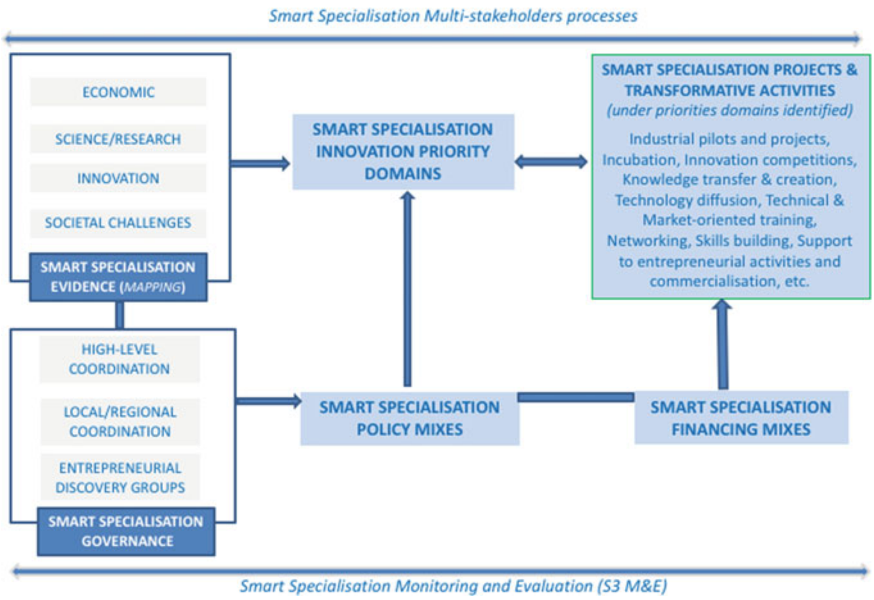

Fig. 2 Building blocks of smart specialisation strategies (S3). *Source* Dosso et al. (2020b)

iv. Select innovation priority domains that will direct the targeting of transformative activities and projects;
v. Design policy mixes and financing tools to support the selected innovation activities;
vi. Establish a sound Monitoring and Evaluation (M&E) scheme;[10]

In the smart specialisation approach, the innovation priority domains (and the subsequent transformative activities) should be consistent with the local resources and capabilities on the one hand, and in line with solving societal challenges, on the other hand (two dimensions of 'place-based'). Table 2 provides an overview of the key principles of Transformative Innovation Policy and Smart Specialisation Strategy, as two different but related approaches to innovation policy and policymaking.

With the two underpinning approaches briefly discussed above, we explore the basic evidence that would be required in order to map the potentials for place-based and transformative innovation policy in Africa. The case studies of top West African economies, Côte d'Ivoire and Nigeria, provide an illustrative basis to highlight relevant gaps in data and comparable macroeconomic statistics. The mapping also underlines key gaps that innovation policymakers should address in order to improve the evidence base for policymaking and the impacts of the current innovation policies, plans and strategies on development targets. The section takes inspiration from the S3 statistical mapping approach and integrates key indicators from the broader TIP perspective.

3 Mapping Innovation Policies in Africa Using S3 and TIP: Evidence and Gaps

This section looks at some key macro socio-economic and STI-related indicators of Côte d'Ivoire and Nigeria that illustrate some untapped potentials and gaps in evidence. It is important to underline that official statistics generally reflect the formal part of the economy (i.e. formal sectors); leaving out non-registered and non-monitored businesses (labelled by some people as informal economy[11]). From a mapping perspective, an important implication is that significant economic and innovative potential of territories remain statistically 'invisible' and eventually untapped. This share of under-reported and often-untapped segments of economic activities sometimes constitute a substantial share of economic activities and non-agricultural employment in Sub-Saharan African economies (see for example, Medina et al. (2017) for estimations of the share of informal economy and WIPO (2013)).

According to ILO (2018[12]), "In Africa, 85.8 per cent of employment is informal". With agriculture sector included, the percentage rises to 90%, and over, in the majority of West African countries (see Fig. 5, page 13, ILO 2018).

In the tables below, we provide a summary of socio-economic statistics (Table 3). Tables 4 and 5 provide indicators related to the national science and innovation potentials. It is useful to note that we rely mainly on international databases as sources of information in order to facilitate cross-country comparison. In practice, both S3 and TIP encourage the use and improvement of national data and sources in line with continental or international guiding policy frameworks. The evidence presented in the tables highlight important potentials for improvements but also gaps or pressing societal challenges in the two countries (youth opportunities, research and innovation capabilities, agricultural potentials, etc.). Moreover and in spite of the partial statistical picture, even so for the science and innovation potentials, many of these basic indicators are often inaccessible in updated and comparable formats. Some important implications for evidence collection are further discussed in Sect. 4, exploiting both the S3 and TIP perspectives.

Economic potential

Table 3 Key socio-economic indicators

	CÔTE D'IVOIRE (3rd ECOWAS economy)	NIGERIA (1st ECOWAS economy)
Population, *million in 2018*	25.1	195.9
GDP per capita, *current US$ in 2018*	1715.53	2028.18
GDP growth, *annual percent*	7.43	1.93
Poverty headcount ratio at national poverty lines, *% of population*	46.5 (2015)	46 (2009)
Population ages 0-14, *% of total population, in 2018*	42%	44%
Youth not in employment, education or training	34.2% (2017)	21.4% (2016)
Urban population, *% of population in 2018*	50.8%	50.3%
Agricultural land, *% of land area*	64.8% (2016)	77.7% (2016)
Access to electricity, *% of population in 2018*	70% (Rural: 32.9; urban: 100%)	56.5% (Rural: 31%; urban: 81%)
Mortality rate attributed to unsafe water, unsafe sanitation and lack of hygiene, *per 100,000 population*	47.2% (2016)	68.6% (2016)
% VA in Agriculture (*)	21.2	21.2
% of Employment in Agriculture (*)	48	30"
% VA in Industry *(incl. manufacturing)* (*)	33.4 (15.2)	18.5 (8.8)
% of employment in Industry *(incl. manufacturing)* (*)	–	–
% VA in Services (*)	45.3	60.4
% of employment in Services (*)	46	55
Shares range of "informal" economy (**) *2010 to 2014 average as a share of GDP*	30–40%	50–65%
Share of informal employment (*range excluding agriculture*)(***)	75–89%	75–89%

Source WDI: World Development Indicators of World Bank (access May 2020); (*) Iizuka et al. (2018) (latest available data as in 2018). (**) Medina et al. 2017; (***) ILO (2018)

Notes The youth not in employment, education or training are persons between the ages of 15 and 24 years who are unemployed and out of the education system. Data provided conveys the share of this category of youth as a percent of total youth. In practice, some countries define different age band in identifying youth

On innovation and the informal economy, see Kraemer-Mbula and Konté (2016) for a reflection on the innovation dimension of policies targeting the informal sector and suggestions of concrete avenues to integrate innovation and informal economy considerations in policy interventions in Africa

Science and Innovation potential

Table 4 Main research and innovation indicators

	CÔTE D'IVOIRE	NIGERIA
Tertiary education—gross enrolment ratio (1)	9.34% (2017)	10.2 (2011)
Enrolment in technical and vocational education and training, *% of the total enrolment in 2nd education in 2018* (1)	11.7%	*na.*
Gross Expenditures on Research and Development over GDP (GERD/GDP) (*)	0.36%	0.22%
Number of scientific and technical journal articles (2018), WDI	248	5602
Internet penetration *in January 2020* (**)	47%	42%
Number of Digital Tech Hubs (2016–2019, Africa 618 hubs)	5–22	23–85
STI policy	No full STI policy yet, but a national plan for scientific research 2016–2025 and adopted ECOPOST	STI policy 2012 and adopted ECOPOST

Sources (1) UIS stat, WDI: World Development Indicators of World Bank (access May 2020), (*) Iizuka 2018 (latest available data as communicated in 2018); (**) Internet penetration from datareportal.com and tech hubs from GSMA
Notes Scientific and technical journal articles refer to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences
GSMA monitors "tech hubs" operating across Africa, including incubators, accelerators, co-working spaces, fab labs, makerspaces, hackerspaces, and other innovation centres. ()

4 Analysis of Innovation Policies in Africa Using S3 and TIP Approaches: Insights from the Findings

In this section, we build on data presented in Sect. 3 above (as summarised in Tables 3, 4 and 5) and discuss S3 and TIP together. The analysis is based on the six criteria (for TIP) and six principles (for S3) presented in Table 2 above. The objective is to explain the implication of the current gaps and highlight some of the key strengths, similarities and differences; and how the two approaches complement each other. The main question that this section attempts to address is what do available evidence—as presented in Tables 3, 4 and 5 for example—tell us with respect to Côte d'Ivoire's and Nigeria's readiness for S3 and TIP type of policies?

Table 5 Findings from innovation surveys

Indicator–world bank enterprise survey	CÔTE D'IVOIRE (361 firms)	NIGERIA (2676 firms)	Sub-Saharan Africa (equivalent % for the region)
% of firms using technology licensed from foreign companies*	3.4	6.5	15.2
% of firms having their own Web site	18.1	22.3	30.5
% of firms using e-mail to interact with clients/suppliers	53.7	23.5	58.6
% of firms that introduced a new product/service	40.1	52.7	43.9
% of firms whose new product/service is also new to the main market	70.3	68.6	71.9
% of firms that introduced a process innovation	15.9	62.9	41.7
% of firms that spend on R&D	6.8	13.8	17.6

Source World Bank's statistics—Enterprise surveys
http://www.enterprisesurveys.org/data/exploreeconomies/2014/nigeria
http://www.enterprisesurveys.org/data/exploreeconomies/2016/c%C3%B4te-divoire
Notes Details on country survey dataset is available at https://www.enterprisesurveys.org/en/survey-datasets
Côte d'Ivoire: Business owners and top managers in 361 firms (263 in Abidjan and more 60 SMEs between 5–19 employees) were interviewed from July 2016 through February 2017. Nigeria: Business owners & top managers in 2676 firms were interviewed on April 2014-February 2015
The surveys are administered to a representative sample of firms in the non-agricultural, formal, private economy

4.1 S3 Approach to Innovation Policies in Côte D'Ivoire and Nigeria

S3 is a step-based approach to territorial or place-based innovation policy. Although each S3 is specific to the territory/place—country, either region or city—important common principles matter for the design and implementation of a successful strategy (see Table 2). S3 pilots are currently taking place for instance between the European Union and Australia, Mexico, Serbia, Tunisia and Rwanda (exploratory activity). The ongoing cooperation confirm that S3 is being adopted as a place-based transformative innovation policy and that the six principles matter. These principles include evidence-based innovation policy decisions, prioritisation of innovation domains, mobilisation of public and private stakeholders, customisation of innovation policy mixes, monitoring and review.

The sections following discuss key implications of adopting such principles of innovation governance in the contexts of Côte d'Ivoire and Nigeria. The objective here is not to provide an exhaustive analysis, but rather an exploration of avenues to help contextualise S3 locally. A conceptual discussion for Sub-Saharan Africa and more in-depth macroeconomic mapping for Côte d'Ivoire can be found in Dosso et al. (2020b).

In line with the first S3 principle, each territory should localise or contextualise its diagnostics of territorial potentials along three principles: economic potentials, research/scientific potentials, and innovation potentials (Dosso et al. 2020b; Matusiak and Kleibrink (*ed.*) 2018). This means that efforts are focused on fostering the education, statistical apparatus and capabilities for the monitoring of STI capabilities and performances—for instance, being able to assess the progresses in terms of R&D and innovation investments from both the public and private sectors and launching training programs on innovation statistics. In the case of Côte d'Ivoire and Nigeria, these countries may not need to start from scratch. This is because international and continental capabilities and joint efforts already exist. In addition to national commitments, one way forward can consist in joining the recent initiatives of the African Innovation Outlook (AIO, see the latest edition in AUDA-NEPAD 2019) and the African Observatory of STI, which provide for several countries a wealth of information and practices on collection and interpretation of R&D and innovation data in African contexts. Côte d'Ivoire has not yet participated AIO exercise, while Nigeria has performed the exercise only for R&D and for the two first editions in 2010 and 2014. Continuity and comparability in collection of evidence also matter for sound S3, in which review and monitoring frameworks are essential (sixth principle) for both adaptations and review of the innovation domains and transformative innovation activities.

Another important criteria, which is also a key feature of S3 relates to the mobilisation of stakeholders in view of enabling more inclusive dialogues around innovation and its relevance for solving business and societal needs. In the drafting or revision processes of their innovation policies, the two countries should consider the integration (and capacity building) of a broader base of stakeholders from the business sector, the civil society, the government and the research and education institutions. Such approach will facilitate the alignment around shared visions for sustainable development and transformation, while it can significantly attenuate 'ex-ante picking-the-winners' strategies. In the S3 approach, these processes of participatory and bottom-up decision-making is referred to as "entrepreneurial discovery process" (EDP). EDP deals with the systematic discovery and pursuit of emerging STI investment priorities by actors, typically within a socio-economic system territorially bounded.[13] Furthermore, because of this strong territorial or local dimension in S3, investigations should also inform the appropriate level for designing and implementing S3 (and therefore of collection of evidence); this might not be neither the national level for Côte d'Ivoire, nor even the state level in Nigeria.

Furthermore, prioritisation in the S3 approach relates to the selection a few innovation priority domains in line with the context-specific development and transformation goals. Therefore, the attention should be put on areas where STI can effectively contribute to addressing pressing societal and business needs (including the provision of social safety nets, or increasing access to quality electricity and internet, food and health security), and at the same time, better tapping into local potential (youth, land, or capability mixes, see Tables 3 4 and 5). In many cases both for Côte d'Ivoire and Nigeria, this also entails to customise the innovation mixes and funding instruments for transformative STI activities in order to reach critical masses of funding, skilled human capital and infrastructure and ensure that STI efforts deliver on their promises to enable the achievement of sustainable development goals.

4.2 TIP Approach to Innovation Policies in Côte D'Ivoire and Nigeria

Similar to the S3 approach, the mapping on TIP builds on the evidence provided in Tables 3, 4 and 5 above, in line with the six criteria outlined above in the analytical framework (Table 2). The TIP approach, currently being applied in various countries across the world, including in four countries in Africa (Ghana, Kenya, Senegal and South Africa (see Daniels and Ting 2019)) argues that for innovation policy to produce transformative change, six criteria are important (Daniels et al. 2020). To reiterate, these six transformative change criteria that underpin TIP are directionality, focus on societal goals, impact at system level, learning and reflexivity, conflict vs consensus, and inclusion of more stakeholders in innovation policy processes (Schot and Steinmueller 2018).

A brief explanation of the criteria outlined above helps in developing a common understanding of some of the concepts that guide the TIP approach (Daniels et al. 2020; Schot et al. 2017). Thereafter, from the six criteria—directionality, focus on societal goals, impact at system level, learning and reflexivity, conflict vs consensus, and inclusion of more stakeholders in innovation policy processes—we use the first three criteria for the analysis that follow. The first criteria, directionality, examines the notion of whether a policy supposes the non-neutrality of technology by exploring a wide range of options, that is, plurality in the choice of technological solutions. In this view, the development of STI policy (or strategy, programme or project), for example in the case of Côte d'Ivoire, which currently does not have an explicit STIP policy, it is important to question if social and environmental issues were considered in current innovation strategies, programmes or projects. The evidence on economic potential (Table 3) shows that the percentage of poverty in both countries stand at about 46%. In formulating a new STI policy, in the case of Côte d'Ivoire, or revising the existing STI policy in the case of Nigeria; it is therefore imperative that while the need to focus on economic growth takes precedence, addressing social and environmental concerns must be factored into the policy process and policymaking.

The second criteria, societal goal, examines whether the policy focused or focuses on the pressing societal challenges, in this case, related to Côte d'Ivoire or Nigeria, but more broadly, challenges articulated in the United Nations' SDGs. Some of the societal challenges from evidence presented above (Tables 3 and 4) include high number of youth not in employment, education or training in both countries, high percentage of urban population, a high informal economy (reflected in the high level of informal employment in both countries), low enrolments in tertiary education and low R&D expenditures (0.36% for Côte d'Ivoire, and 0.22% for Nigeria). A key question to therefore ask in the TIP approach is how would STI policy address these societal challenges and lead to transformative change? TIP argues that increasing R&D and regulations (Frame 1) and strengthening NSI (Frame 2) will be insufficient to produce the desired level of transformative change. Addressing the underlying sociotechnical systems (i.e. Frame 3 and TIP approach) architecture, which form the bedrock of these challenges, is necessary to achieve the desired level of change envisaged.

The third criteria, systems-level impact, questions if the policy addresses or has the potential to address change at sociotechnical systems level. And if the impact of the resultant changes will be at systems level, that is, wide enough to cut across many sectors. In the example provided above, a transformative change impact at systems level as prescribed in the TIP approach will for instance cover many sectors—education, youth, employment, and informal economy; as opposed to focusing just on one of these sectors. The remaining criteria—fourth, learning and reflexivity, does the policy allow for second order or deep learning; fifth, conflict versus consensus, the need to encouraged and welcome differences in opinion between stakeholders; and sixth, inclusiveness, whether civil society actors and/or end-users are included in the policy process or not, and why—are vital to the TIP approach.

Put together, these six criteria, according to the TIP approach, are essential to ensuring that innovation policies foster transformative change. In the case of Nigeria, which has an explicit STI policy (FSMT 2012), we find that the policy is weak in terms of directionality but stronger on its focus on societal goals. With respect to impact at system level and learning and reflexivity, the policy makes considerable efforts in these regards. Nevertheless, the outcome of the implementation, M&E will determine to what extent this criteria is achieved. Conflict versus consensus, which in this case is related to the inclusion of more stakeholders in STI policy formulation, implementation and M&E processes, remain significantly weak. Some of evidence for these gaps are provided in the STI policy (FMST 2012) while others are contained in the main research and innovation indicators and findings from innovation surveys (Table 5), which for example shows the percentage of firms that spend on R&D, are lower in Côte d'Ivoire and Nigeria than the SSA average.

4.3 Similarities and Complementarities of S3 and TIP: Building Bridges to Inform Innovation Policies in Africa

Importantly, there are core similarities between TIP and S3. We discuss a few of the similarities here, and provide examples that help to illustrate the point and improve clarity. First similarity is the focus on the transformative outcomes/impacts of innovation/STI policies. Second similarity is the adoption of a broad definition of innovation that includes technological, organisational, marketing, business model, radical, incremental and social types of innovations. Third similarity is the emphasis on societal and place-based challenges. As a result of these similarities both approaches can be used to map innovation policies and a related range of outcomes, thereby helping us to deepen our understanding of how innovation policies can be geared towards the transformation of African economies and societies. By juxtaposing S3 with TIP, we adopt a methodology based on the mapping of national and territorial potentials for evidence-informed innovation policies in Africa.

The international experience show that S3 are largely adopted at the sub-national or regional level and or at the country level. For instance, in the ongoing S3 pilots in Tunisia, country-level reflection and strategies can also precede or take place alongside subnational pilots. In this sense, the territorial component of S3 can well complement the TIP approach to policymaking (typically deployed at national levels) through for instance finer contextualisation and formulation of transformative innovation activities that lead to transformative outcomes (Daniels et al. 2020; Schot et al. 2019; Schot and Steinmueller. 2018). Moreover, with its initial focus on structural change, a flourishing literature has further elaborated on S3 as place-based innovation policy for industrial diversification (see for instance Dosso et al. 2020b; Dosso 2020; Dosso 2019 for early reflections and steps in African contexts; and Grillitsch and Asheim 2018; Foray 2015). S3, together with their wealth of information on firms, value chains dynamics and diversification strategies, are now considered as the biggest industrial and innovation policy experience in the world. In practice, S3 could thus inform a better integration of firms and value chains perspectives and the micro-macroeconomic links in the elaboration of transformative innovation policies in Africa.

Furthermore, the two approaches integrate learning processes for both policy formulation, implementation and monitoring. In the S3 approach, capacity building, (transnational) peer learning and exchanges are encouraged not only for policy-makers, but also for broader circles of representative stakeholders in the society and for different S3 steps, practical and conceptual aspects (for instance Governance, Entrepreneurial Discovery Processes or EDP and Monitoring, see Guzzo and Perianez-Forte 2019). In the case of TIP, the focus is on second-order (or deep) learning, alongside emphasis on policy learning and mutual learning involving researchers and policymakers from across different project teams spread across the world. Capacity building is also central to the TIP approach, bearing in mind that individuals are key agents for transformative change (Daniels et al. 2020; Schot and Steinmueller 2018). In order to ensure that this mutual learning takes place is adequately embedded, it is essential to develop a share understanding of TIP among the actors and stakeholders involved (Schot et al. 2017).

Finally yet importantly, the two approaches can enrich each other on the monitoring and evaluation (M&E) dimension in order to foster local capability and knowledge pools for policymaking. Especially in the case of countries with limited innovation resources, efficiency-seeking and transparency in innovation policy governance is essential to ensure that choices are carefully made (based on the best available evidence). And that resources are efficiently utilised in ways that allow resources to reach key segments of the population. M&E in S3 focus on the developments related to policy interventions in the realm of the target S3 priority areas (see Gianelle and Kleibrink 2015; Gianelle et al. 2019 for conceptual and practical considerations on S3 M&E mechanisms). TIP approach on the other hand adopts a formative evaluation approach to M&E (Boni et al. 2019). In the TIP approach formative evaluation of innovation policies, projects or programmes are closely connected to the notion of policy experimentation and transformative outcomes (Schot et al. 2019).

5 Concluding Remarks: Towards Tranformative Innovation Policies in Africa

Côte d'Ivoire and Nigeria have adopted the ECOWAS's Policy on Science and Technology (ECOPOST) and have enjoyed (or enjoying) high economic growth rates. However, evidence indicate that they remain lowly diversified economies with low productivity in agriculture and with heavy reliance on commodity exports—*cocoa and cashew nuts in Côte d'Ivoire and crude oil in Nigeria*[14]. In addition, both countries have failed to translate economic growth into significant improvements in the living conditions of the majority of their populations (IMF 2016, 2017; Oyelaran-Oyeyinka 2014). Furthermore, empirical evidence indicate that the gains in economic growth in both countries have not gone far enough in helping to reduce environmental and social challenges such as inequality and exclusion, while establishing pathways towards sustainability transitions. The TIP and S3 approaches to policy formulation, implementation, evaluation and governance discussed in this chapter offer alternative pathways to address these innovation, economic, environmental and social challenges.

The low availability of data for a proper monitoring of innovation performances and for better evidence-informed innovation policy decisions relate both to the irregularity of data collection exercises and the lack of national and sub-national insights - regional (sub-national) or states' levels specific challenges and potential. These gaps need to be addressed in order to improve and monitor the impacts of research and innovation investments in the different 'places' within Côte d'Ivoire and Nigeria, and in Sub-Saharan African economies in general.

From a practical perspective, key initial indicators should allow us to better characterize the industrial productive structure (firms and size, share of start-ups companies, value-added and employment disaggregated data) as well as the innovation potential in agriculture. Besides, more knowledge is needed on the formation of innovation capabilities and models of small and micro-firms in African economies, on their innovation ecosystems and spaces, as well as the particular processes of innovation activities in the informal sector. With regard to the informal sector, the prior experiences of South Africa and Rwanda could serve as relevant examples for future domestic surveys. Similarly, a traceability of public funds for research is required for the evaluation of their outputs/outcomes. Furthermore, the two countries lack systematic monitoring of their R&D personal and innovation potential in terms of students or graduates in the different knowledge fields or domains. Such evidence is needed if Côte d'Ivoire and Nigeria are to achieve measurable economic transformation and ensure adequate responses to national and sub-national societal challenges through innovation and technology absorption and diffusion.

We expect that the mapping will, among other possible outcomes: a) provide an up-to-date assessment of the economic, scientific and innovation potentials in view of informing innovation policymaking in Côte d'Ivoire and Nigeria; b) identify opportunities for innovation policy learning or limitations, for instance, in terms of data or capabilities, related to the usefulness or application of TIP and S3 in African contexts; c) inform research agenda needed to underpin transformative innovation policies and policymaking in Africa, for example in terms of innovation policy formulation, implementation, monitoring, evaluation, reporting and learning (MERL), and governance of STI policies across the continent; and d) support efforts towards increased transparency of R&D, innovation policy funds management, and the setting up of research/working groups for continent-wide mapping exercises in African countries.

Notes

1. http://www.esc.comm.ecowas.int/a-propos-de-la-cedeao/division-of-science-2/?lang=fr.
2. The CPA are to enable Africa to harness and apply science, technology and related innovations to eradicate poverty and achieve sustainable development, and to ensure a contribution of Africa to the global pool of scientific knowledge and technological innovations. The CPA relies on five flagship research and development programmes to be implemented between 2006 and 2010: biodiversity, biotechnology and indigenous knowledge; energy, water and desertification; material sciences, manufacturing, laser and post-harvest technologies;

mathematical sciences; and information, communication and space science technologies.
Prior initiatives include the 1980 Lagos Plan of Action (1982), which states the need for Africa to invest at least 1% of its GDP in R&D and the Abuja Declaration (1987) which underlines the need to institutionalize and exploit African research and for a more effective exploitation of local scientific and technical competences.

3. STISA-2024 is part of the 50-years AU's plan—AU Agenda 2063—which supports the vision for the development of the continent and for the African integration and unity. STISA-2024 designed as a first 10-years plan, articulates six (6) priority areas which are: Eradication of Hunger and Achieving Food Security; Prevention and Control of Diseases; Communication (Physical and Intellectual Mobility); Protection of our Space; Live Together- Build the Society; and Wealth Creation.
4. PDESRS - Plan de Développement de l'Enseignement Supérieur et de la Recherche Scientifique (Higher Education and Scientific Research Development Plan).
5. FONDS D'APPUI À LA RECHERCHE ET À L'INNOVATION (FONARI)—Innovation Fund.
6. "Government Allocations, Public and Private Partnership, International R&D Funds, and Venture Capital" (source: https://www.gov.uk/world/organisations/uk-science-innovation-network-in-nigeria). See also for example: Emeka JohnKingsley, 22 February 2012. Nigeria's new science fund takes US as its model. Available at: https://www.nature.com/news/nigeria-s-new-science-fund-takes-us-as-its-model-1.10086. (accessed 10 Feb 2020)Ewa, I.O.B, 2013. Implementation of the Nigerian Science, Tecnology and Innovation Policy for National Development. Presentation at the 16th Session of the Commission on Science and Technology for Development. Available at: https://unctad.org/meetings/en/Presentation/CSTD_2013_Ministerial_STI_Nigeria.pdf (accessed 10 Feb 2020).
7. DST (Department of Science and Technology), 2019. White Paper on Science, Technology and Innovation Policy. Available at: https://www.dst.gov.za/images/2019/White_paper_web_copyv1.pdf (accessed 10 Feb 2020).
8. TIP is an initiative by the Transformative Innovation Policy Consortium (TIPC), a group of countries from the Global North and Global South exploring new ways to harness the power of innovation for transformation by promoting the idea of TIPs through mutual policy learning. For more information see: http://www.tipconsortium.net/about/.
9. For instance "develop a circular economy model or a green economy" or "an inclusive and sustainable industrial economy for societal welfare", etc. (see Foray et al. 2012).
10. See also Daniels et al. 2018 for a discussion of the needs and rationales for STI policy evaluations in the African context.
11. Also called shadow, black and unreported economy.

12. https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_627189/lang--en/index.htm (based on ILO 2018).
13. See applications at https://s3platform.jrc.ec.europa.eu/entrepreneurial-discovery-process-cycle.
14. see the Atlas of Observatory of Economic Complexity: https://atlas.media.mit.edu/en/.

References

ACBF (2017) Africa capacity report 2017, building capacity in STI for Africa's transformation

AfDB (African Development Bank) (2020) African economic outlook 2020: developing Africas workforce for the future. AfDB. https://au.int/sites/default/files/documents/38116-doc-african_economic_outlook_2020_.pdf

AOSTI (African Observatory of Science, Technology and Innovation) (2013) Science, technology and innovation policy-making in Africa: an assessment of capacity needs and priorities, AOSTI, working papers no. 2

AUC (African Union Commission) (2014) AU strategy for science, technology and innovation for Africa 2024, STISA-2024. African Union, Addis Ababa

AUC (2015a) Agenda 2063, the Africa we want, popular version. AUC, Addis Ababa

AUC (2015b) Agenda 2063, first ten-year Implementation Plan 2014–2023—https://www.un.org/en/africa/osaa/pdf/au/agenda2063-first10yearimplementation.pdf

AUC (2016) Continental education strategy for Africa (CESA) 2016–2025. Addis Ababa, AUC

AUC (2020) The digital transformation strategy for Africa (2020–2030). Available at https://au.int/sites/default/files/documents/38507-doc-dts-english.pdf (Accessed May 2020)

AUDA-NEPAD (African Union Development Agency) (2019) African innovation outlook III. Johannesburg, South Africa: AUDA-NEPAD

Bayen A (2019) Akwaba to the côte d'Ivoire tech ecosystem! published by GSMA mobile for development. Available at: https://www.gsma.com/mobilefordevelopment/blog/akwaba-to-the-cote-divoire-tech-ecosystem/ (Accessed 10 February 2020)

Boni A, Giachi S, Molas-Gallart J (2019) Key principles for a formative evaluation of transformative innovation policy, TIPC policy brief issue 1, March 2019

Chataway J, Dobson C, Daniels C, Byrne R, Tigabu A, Hanlin R (2019) Science granting councils in sub-saharan Africa: trends and tensions. Sci Public Policy 46(4):620–631

Chataway J, Daniels C (2020) The republic of science meets the republics of somewhere: embedding scientific excellence in sub-saharan Africa. In: Kraemer-Mbula E, Tijssen R, Wallace ML, McLean R (eds) Transforming research excellence: new ideas from the global south. Cape town, South Africa: African minds. http://doi.org/10.5281/zenodo.3607326

Daniels CU (2015) Organisational capabilities for science, technology and innovation policy formulation in developing countries: the case of Nigeria's federal ministry of science and technology. Doctoral thesis (PhD), University of Sussex

Daniels C (2017) Science, Technology and Innovation in Africa: Conceptualisations, relevance and policy directions. In: Mavhunga C (ed) What do science, technology and innovation mean from Africa? Chicago. MIT Press, USA

Daniels C, Ustyuzhantseva O, Yao W (2017) Innovation for inclusive development, public policy support and triple helix: perspectives from BRICS. Afr J Sci Technol Innov Dev 9(5):513–527

Daniels C, Mawoko P, Konté A (2018) Evaluating public policies in Africa: insights from the science, technology, and innovation strategy for Africa 2024 (STISA-2024). Policy brief. Policy@Sussex. December

Daniels C, Ting B (2019) Transforming science, technology and innovation policies in Africa: insights from Ghana, Kenya. Senegal and South Africa, TIPC Policy Brief November, p 2019

Daniels C, Schot J, Chataway J, Ramirez M, Steinmueller E, Kanger L (2020) Transformative innovation policy: insights from Colombia, Finland, Norway, South Africa and Sweden. In: Cele MG, Luescher TM, Wilson Fadiji A (eds) Innovation policy: global debates and local experiences. HSRC Press: Cape Town, South Africa

Daniels CU, Tilmes K (2020, forthcoming) Leveraging innovation policies and digital strategies to drive transformative change in Africa, In: African transformation report 3. Accra: African centre for economic transformation (ACET)

Dosso M et al (2017) Research and innovation, in European commission, joint research centre, science for the AU-EU partnership: building knowledge for sustainable development. EU Publications, Luxembourg

Dosso M (2019) Industrie et innovation pour un changement structurel et un développement territorial durable en Afrique. Annales des mines, Réalités industrielles, CGE, Paris. http://annales.org/ri/2019/resumes/aout/04-ri-resum-FR-AN-aout-2019.html#04FR (Access May 2020)

Dosso M (2020) STI roadmaps for SDGs: smart specialisation for territorial and industrial development in Rwanda, JRC conference and workshop report, publications office of the European Union, Luxembourg. https://ec.europa.eu/jrc/en/publication/sti-roadmaps-sdgs-smart-specialisation-territorial-and-industrial-development-rwanda (Access May 2020)

Dosso M, Meite Braoule F, Ametepe G, Gbogou C, Guiella G, Oulaï D (2020a, this book) New entrepreneurial narratives in urban West Africa: case studies of five innovation hubs and communities—special chapter in Daniels, Dosso and Amadi-Echendu (2020, this book), Handbook of entrepreneurship, technology commercialisation, and innovation policy in Africa, Springer Nature

Dosso M, Kleibrink A, Matusiak M (2020b, forthcoming) Smart specialisation in sub-saharan Africa: opportunities, challenges and initial mapping for côte d'Ivoire. Afr J Sci, Technol, Innov Dev, South Africa

FMST (Federal Ministry of Science and Technology) (2012) National science, technology and innovation policy, 2012th edn. FMST, Abuja

Foray D et al (2012) Guide to research and innovation strategies for smart specialisation (RIS 3). European commission, available at http://s3platform.jrc.ec.europa.eu

Foray D (2015) Smart Specialisation. Opportunities and challenges for regional innovation policy, Routledge, Abingdon (UK) and New York (NY)

Foray D (2016) On the policy space of smart specialization strategies. Eur Plan Stud 24(8):1428–1437

ILO, International Labour Office (2018) Women and men in the informal economy: a statistical picture (third edition), Geneva, available at https://www.ilo.org/wcmsp5/groups/public/—dgreports/—dcomm/documents/publication/wcms_626831.pdf

Gianelle C, Kleibrink A (2015) Monitoring mechanisms for smart specialisation strategies, S3 policy brief series no. 13/2015

Gianelle C, Guzzo F, Marinelli E (2019) Smart specialisation evaluation: setting the scene, smart specialisation—JRC policy insights, JRC116110, March

Grillitsch M, Asheim B (2018) Place-based innovation policy for industrial diversification in regions. Eur Plan Stud 26(8):1638–1662

Guzzo F, Perianez-Forte I (2019) Smart specialisation at work: evidence from the peer and exchange and learning workshops, EUR 29993 EN, publications office of the European Union, Luxembourg, JRC118899

Iizuka et al (2018) Innovation for development in West Africa, UNU-MERIT policy brief

IMF (2016) Regional economic outlooks, sub-saharan Africa

IMF, International Monetary Fund (2017) Regional economic outlooks, sub-saharan Africa

Kleibrink A, Mateos J (2018) Searching for local economic development and innovation: a review of mapping methodologies to support policymaking. In: Huang B (ed) Comprehensive geographic information systems, vol 3. Elsevier, Oxford, pp 59–68

Kraemer-Mbula E, Konte A (2016) Innovation policy and the informal economy: toward a new policy framework. In: Kraemer-Mbula E, Wunsch-Vincent S (eds) The Informal economy in developing nations: hidden engine of innovation?. Cambridge University Press, Cambridge
Matusiak M, Kleibrink A (eds) (2018) Supporting an innovation agenda for the western balkans: tools and methodologies, publications office of the European Union, Luxembourg. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC111430/2018-04-24_western-balkans-report_online.pdf
Medina L, Jonelis A, Cangul M (2017) The informal economy in sub-saharan Africa: size and determinants, IMF Working Papers, WP/17/156. International monetary Funds. https://www.imf.org/en/Publications/WP/Issues/2017/07/10/The-Informal-Economy-in-Sub-Saharan-Africa-Size-and-Determinants-45017
MESRS, Ministère de l'Enseignement Supérieur et de La Recherche Scientifique de Côte d'Ivoire (Ministry of Higher Education and Scientific Research) (2018) Conférence de madame le ministre. Académie des sciences d'outre-mer 30 Mars 2018
Oyelaran-Oyeyinka B (2014) The state and innovation policy in Africa, African journal of science, technology. Innov Dev 6(5):481–496
Schot J, Daniels C, Torrens J, Bloomfield G (2017) Developing a shared understanding of transformative innovation policy TIPC research brief 2017–01
Schot J, Steinmueller WE (2018) Three frames for innovation policy: R&D, systems of innovation and transformative change. Res Policy 47(9):1554–1567
Schot J, Kivimaa P, Torrens J (2019) Transforming experimentation: experimental policy engagements and their transformative outcomes. TIPC research report March 2019
UNCTAD (2018) Technology and innovation report 2018. Harnessing frontier technologies for sustainable development. Switzerland: UN publications UNCTAD/TIR/2018 https://unctad.org/en/PublicationsLibrary/tir2018_en.pdf
UNECA (2016) Assessing regional integration in Africa: innovation. Competitiveness and Regional Integration, United Nations Economic Commission for Africa, Addis Ababa, Ethiopia
WIPO (2013) The informal economy, innovation and intellectual property—concepts, metrics and policy considerations. Economic research working paper no. 10. WIPO economics and statistics series. World intellectual property office

Main Data Sources

UNESCO Institute of Statistics: http://uis.unesco.org/en
World Development indicators: https://databank.worldbank.org/reports.aspx?source=world-development-indicators