Innovation and Scaling by Tech Hubs and Their Hosted Startups: Three South African Cases

Lucienne Abrahams

Working Paper 26
Published: 16 December 2021

LINK centre
UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
openAIR AFRICAN INNOVATION RESEARCH

Contents

Author

Lucienne Abrahams (PhD)
Director, LINK Centre, School of Literature, Language and Media (SLLM), University of the Witwatersrand (Wits), Johannesburg
Researcher, Open African Innovation Research (Open AIR)
luciennesa@gmail.com

The author will be grateful for inputs and feedback on the contents of this working paper. Please use the author's email address provided above.

Abstract

This working paper sets out a view of the nature of three South African tech hubs, their modes of knowledge enablement, their complex context of knowledge creation, their measures of success or failure, and their evolution. Based on case studies conducted in 2016-17 at the Bandwidth Barn Khayelitsha (Cape Town), Workshop 17 (Cape Town), and the Tshimologong Digital Innovation Precinct, this paper aims to understand tech hubs' distinctiveness as a formation emerging in the early 21st century, as well as the commonalities that lead to "scaling up" in tech hubs. The research found that the ingenuity of the tech community is a key ingredient in tech hub evolution, although this evolution is tempered by adversity encountered due to low-resourced environments and the challenges of soft processes. Values of sharing and communitarianism have the potential to lift the tech hub beyond its constraints. A sense of innovation entanglement resonates through the words of the respondents, showing a deep engagement with digital enablement as users and producers.

Keywords

tech hubs, startups, digital innovation, tech enablement, collaboration, knowledge creation, knowledge governance, complexity, entanglement, South Africa

Acknowledgements

The research and the preparation of this paper were carried out as part of the Wits LINK Centre's participation in the Open African Innovation Research (Open AIR) network, in partnership with the University of Cape Town, the University of Johannesburg, Strathmore University in Nairobi, the Nigerian Institute of Advanced Legal Studies, The American University in Cairo, and the University of Ottawa. The author acknowledges the support provided for this research by Open AIR, the Social Sciences and Humanities Research Council of Canada, the International Development Research Centre, and the UK Department for International Development. The views expressed in this work are those of the author and do not necessarily represent those of the research funders. The author extends her thanks for the contributions from all of the research respondents, and for the contribution by Wits LINK Centre Master's graduate Yolisa Kedama, who compiled information on the majority of South African tech hubs in operation at the time of the research. The LINK Centre is one of the founding institutions of one of the three hubs studied: the Tshimologong Digital Innovation Precinct. This working paper is the foundation document for the journal article published in 2020 (Abrahams, 2020).

I. Introduction

A. Digital Innovation and Tech Hubs in Africa

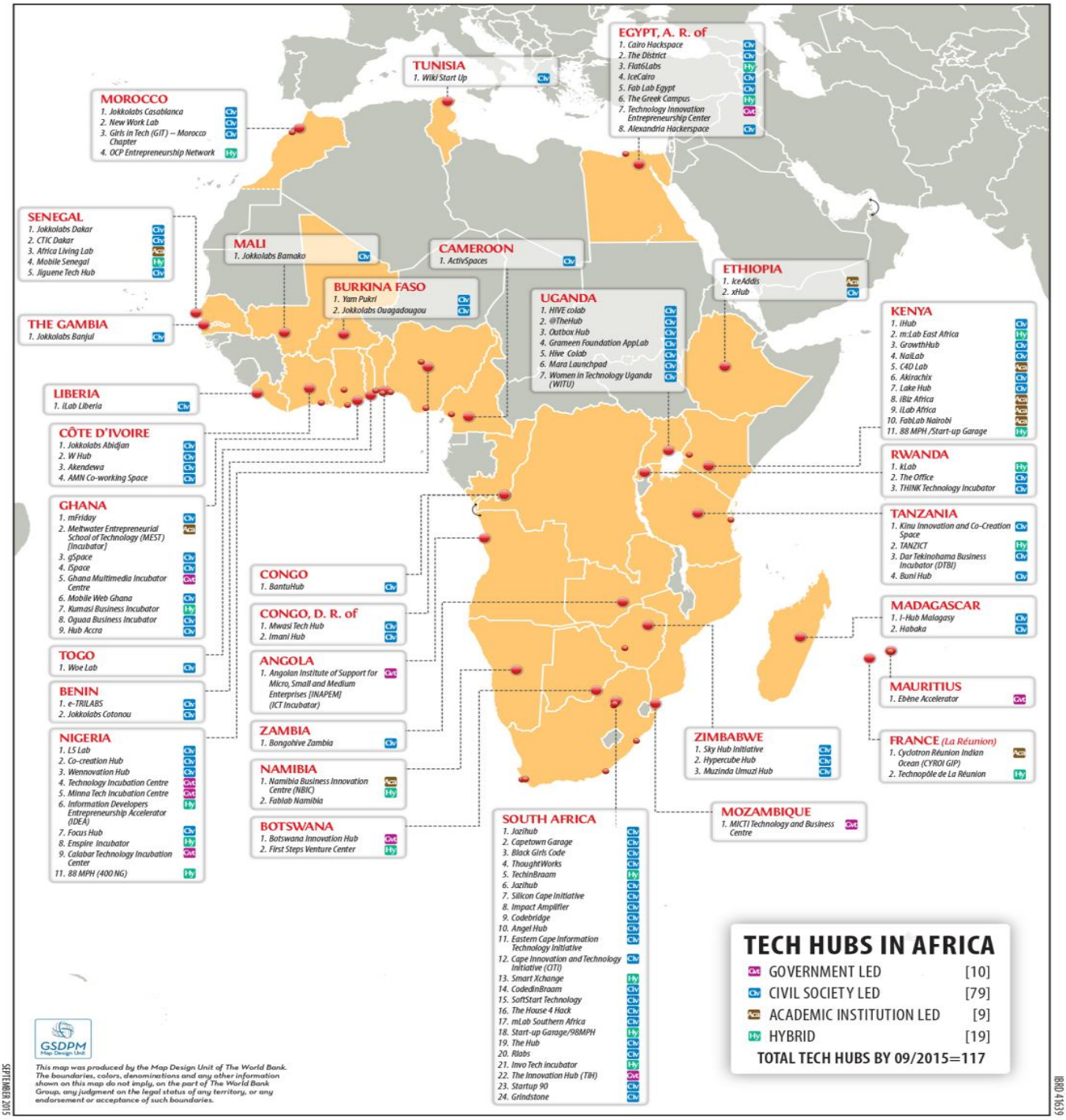
Digital innovation centres and technology hubs (hereafter "tech hubs") have evolved as a way of making broadband access available to innovator-entrepreneurs, fostering creativity, and providing supporting environments to technology startup companies. Tech hubs can be seen as "ecosystems" or communities that consist of researchers and software developers, digital makers, startups, small, medium and micro enterprises (SMMEs), and corporate clients and investors in innovation—brought together "to create the best conditions for long-term business success for all involved" (Zwegers & Sassen, 2015). Tech hubs are, generally, collaborative working spaces, and may include incubator and accelerator facilities. They focus on the information and communication technology (ICT) production and service sectors, as well as on digital technologies, as enablers in all industries and sectors—for example, the design of ICT applications for the aviation, education, energy, fashion, health, retail, and other sectors.

A common feature across tech hubs is that they are collaborative working spaces and competence-building centres, using digital technology to incubate business startups and/or to accelerate existing businesses. While broadband internet penetration is still relatively low on the African continent, the rapid growth in Wi-Fi hotspots, smartphones, and laptop devices has advanced internet penetration and access, creating demand for digital applications (apps), software-enabled platforms and systems integration, 3D-printing, data analytics, and digital solutions ranging from digital health to smart homes and smart cities.

Tech hubs have become spaces where young aspiring entrepreneurs can access resources such as Wi-Fi, office space, and meeting spaces; receive training, coaching, and mentorship; engage in networking and building partnerships; and get assistance with startup funding, venture capital funding, and other inputs. Most tech hubs in South Africa, as on the African continent in general, provide arenas for learning and practising software development and related skills, as well as the business and management skills required for a country's entrepreneurs, and the country as a whole, to participate in the global digital innovation ecosystem. Among the benefits of tech hubs and business incubators is the process of value creation for both for-profit and not-for-profit enterprises, and the advancing of business competitiveness in the markets in which they operate.

Critical reviews of digital tech hubs in Africa (see Comins & Kraemer-Mbula, 2016; De Beer et al., 2017; Desta, 2018; ElHoussamy et al., 2020; Friederici, 2019; Jiménez & Zheng, 2017; Nzomo et al., 2020) are essential to promoting sustainability and long-term success, as they promote deep insight into real-world institutions and innovation challenges. The World Bank, in its *World Development Report 2016: Digital Dividends*, identified 117 tech hubs operating in Africa (see Figure 1).

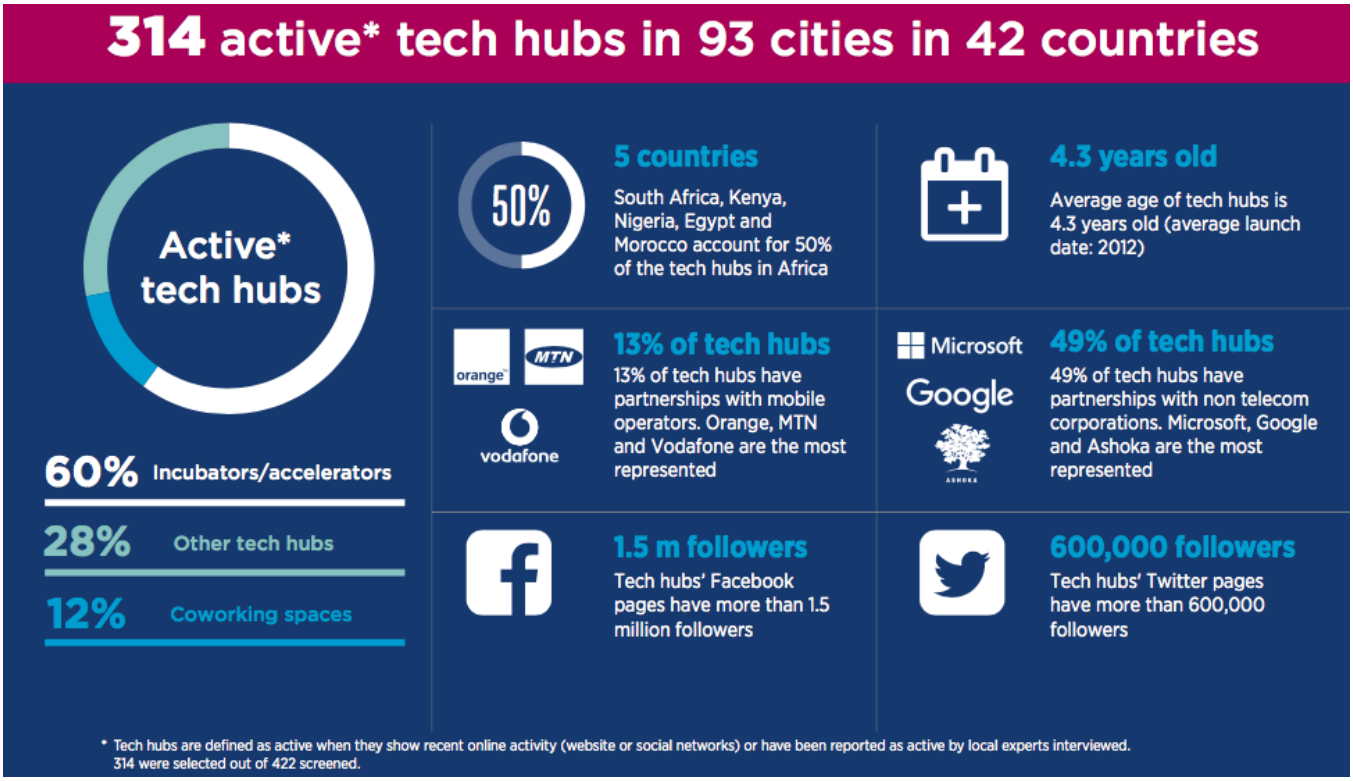
Figure 1: 117 African Tech Hubs (World Bank, 2016)



Source: World Bank (2016)

In 2017, the GSMA, using a broader definition of tech hub than that used by the World Bank, reported that there were 314 African tech hubs (GSMA, 2017) (see Figure 2).

Figure 2: 314 African Tech Hubs in 2017



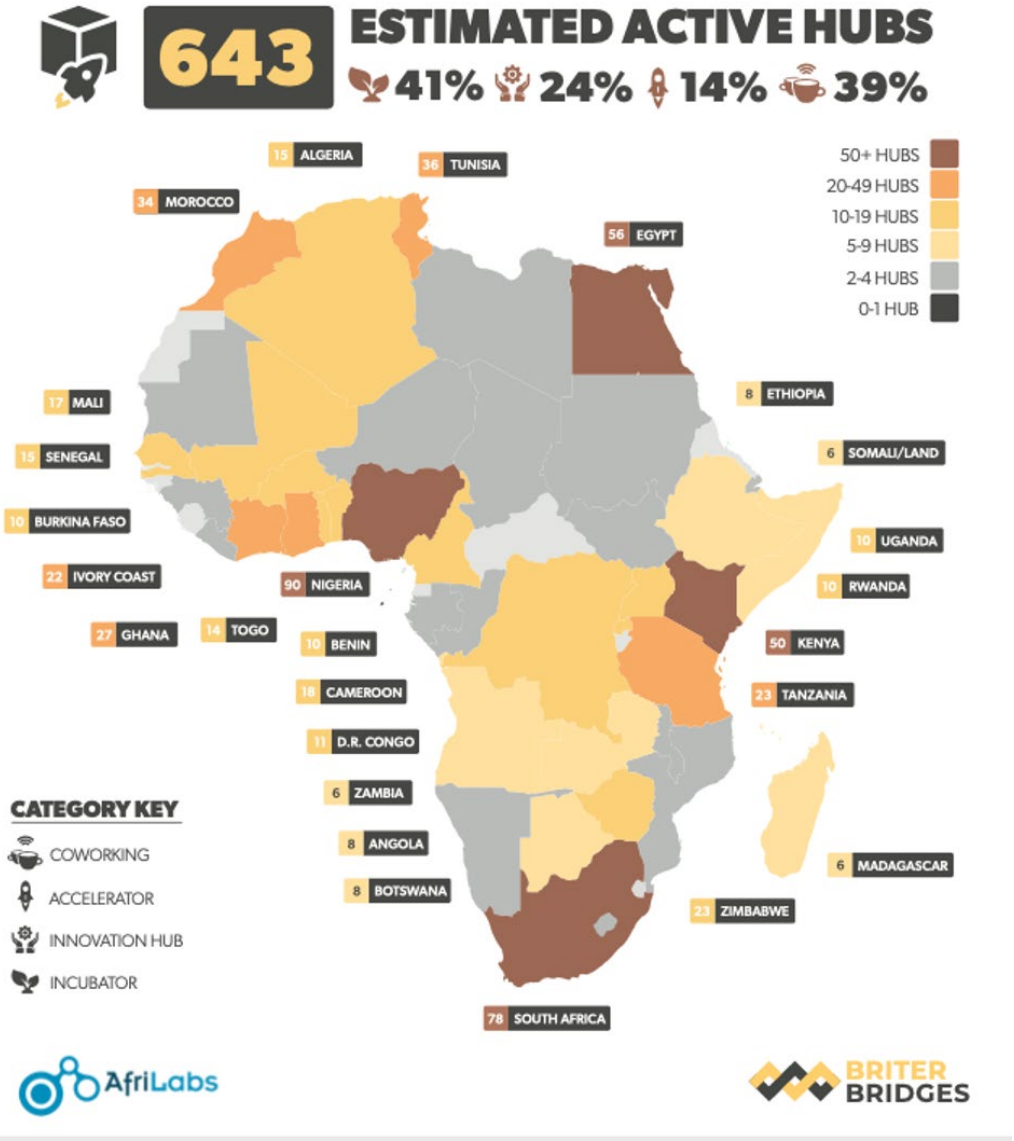
Source: GSMA (2017, p. 30)

A 2019 AfriLabs and Briter Bridges report pointed to evidence of 643 innovation hubs across Africa, including "coworking spaces, incubators, accelerators, and hybrid innovation hubs affiliated with government, universities, or corporates" (AfriLabs & Briter Bridges, 2019, p. 5). Citing GSMA statistics, the report stated that there were 314 hubs in Africa in 2016; 442 in 2018; 618 in early 2019; and 643 in October 2019 (see Figure 3).

AfriLabs and Briter Bridges qualified their reporting of these numbers by stating that

> around 25% [of the 643 hubs] do not seem to offer any type of support to companies other than providing physical, often shared facilities for entrepreneurs to work safely and hassle-free […] [O]ver 110 hubs […] have shut operations in the last few years due to bankruptcy, pivoting, or the expiration of their mandate. (2019, p. 5)

Figure 3: 643 African Tech Hubs (AfriLabs and Briter Bridges, 2019)



Source: AfriLabs and Briter Bridges (2019, p. 6)

Despite some attrition, tech hubs appear to have a resilient character, some having been in operation for over a decade; for example, the Wennovation tech hub and accelerator in Nigeria was founded in 2010.[1]

B. South African Digital Development and Tech Hubs

This section offers a high-level overview of key statistics, as the economic context in which tech hubs are forming, with data provided for the publication year. The 2021 mid-year estimate of the South African population was 60.14 million, of which 51% are female (StatsSA, 2021a), and 34.4% are unemployed (StatsSA, 2021b). The GDP at market prices for 2020 was recorded at ZAR4.2 trillion (StatsSA 2021c), with only 62% of households receiving an income from salaries and 16% of households receiving an income from operating a business, while 65% of households received income from social grants, remittances, and pensions (StatsSA, 2019), with some households receiving income from multiple sources. Public funding of

[1] See https://wennovationhub.org/about.html

research and development (R&D) was 0.75% of GDP in the 2018 financial year (the latest survey year) (NACI, 2021, p. 11). The National ICT R&D and Innovation Strategy acknowledges that incubators and science/technology parks are key institutions for innovation and aims to "support ICT start-ups to create a vibrant hi-tech ICT SMME sector" (RSA, 2007). Expenditure on ICT R&D is recorded as 9.9% of total R&D expenditure in 2018/19 (NACI, 2021, p. 85). The most recent ITU Digital Development Dashboard shows the following ICT indicators: 96% population coverage by a 4G network in 2020; 78% individual mobile ownership (though with limited smartphones) in 2019; 63% of households with internet access, but only 23% of households with a computer at home in 2019; and 111 active mobile broadband subscriptions per 100 inhabitants in 2020 (ITU, 2021).

Of South Africa's nine provinces, Gauteng, the Western Cape, and KwaZulu-Natal are the main provincial contributors to the country's GDP. At city level, the main economic contributions come from eight metropolitan municipalities in five provinces: Buffalo City, the City of Cape Town, the City of Johannesburg, the City of Tshwane, Ekurhuleni, eThekwini, Mangaung, and Nelson Mandela Bay. At the time of data collection for this study (2017), the city with the largest number of tech hubs was Cape Town, but it is apparent that tech hubs are being formed in many parts of South Africa, not only in the major urban centres. For example, a tech hub is currently being formed in rural Mamaila village in Limpopo Province, in the form of a living lab. The tech hub concept clearly fits well with this other key social innovation concept, namely the living lab, or virtual living lab.

The scope for this particular study of South African tech hubs was limited to selecting from among the existing hubs, incubators, and co-working spaces where digital innovation is the focus, or where digital technologies are used as an enabler for productive activity. At the time of the research, there were roughly 50 entities that met these criteria across four of South Africa's nine provinces: Gauteng, the Western Cape, KwaZulu-Natal and the Eastern Cape.[2] The aforementioned AfriLabs and Briter Bridges report documents 78 active tech hubs in South Africa (2019, p. 6), with that report's definition of tech hubs including, as mentioned above, co-working spaces, incubators, accelerators, and hybrid innovation hubs. Both our data collection and the AfriLabs and Briter Bridges (2019) data confirm that the two largest concentrations of tech hubs in South Africa are in the Western Cape Province and Gauteng Province, which are home, respectively, to South Africa's second largest and largest cities, Cape Town and Johannesburg. Accordingly, the three hubs identified for study (see "Research Design" section below) were two hubs in the greater Cape Town area and one in Johannesburg.

C. Research Problem

The research sought to understand the approaches to scaling present in the approaches and activities of tech hubs, and in the approaches and activities of enterprises making use of the hubs. This research problem was chosen because of its relevance to the frequent focus on scaling in existing tech innovation literature. It is necessary to investigate the key dimensions of scaling that require research attention and to establish data and analytical insights to enrich our understanding of scaling in tech hubs. The problem is investigated through three selected South African case study hubs.

[2] A listing of South African tech hubs identified in the course of this research is available at https://hdl.handle.net/10539/32329

D. Structure of this Working Paper

Section II explains the research design and provides some of the key characteristics of the three hubs studied. Sections III to VII provide findings and analysis organised into five thematic sections with the following foci:

- hub provision of infrastructure and services;
- hub provision of networking opportunities;
- hub provision of opportunities for collaboration;
- hub and startup approaches to knowledge governance; and
- hub and startup approaches to local appropriateness.

The concluding section VIII provides conclusions grounded in a consideration of the cross-cutting themes of scaling and sustainability.

II. Research Design

This study used a constructivist research methodology, building on the grounded theory approach used in my 2016 thesis on research entanglement (Abrahams, 2016). Grounded theory is a research design that relies on extracting themes for theory from data, without having adopted an initial analytical framework. Hence, the data is the foundation for the analysis.

A. Data Collection

Data collection was conducted at three tech hubs, selected due to the apparent differences in their features, their locations within their cities, and their phases of evolution:

- Bandwidth Barn Khayelitsha (connected to the Cape Innovation & Technology Initiative, CiTi, Cape Town);
- Workshop 17 (V&A Waterfront, Cape Town); and
- Tshimologong Digital Innovation Precinct (University of the Witwatersrand, Johannesburg).[3]

All three tech hubs remain active at the time of publication.

The data collection process comprised:

- (to inform design of the interview protocol) observation of business overview presentations from residents (innovator-entrepreneurs) at each of the hubs, and meetings with hub management;
- desktop review of background data on the broader range of tech hubs in South Africa;
- semi-structured interviews with 17 respondents at the three hubs (seven at Bandwidth Barn Khayelitsha, five at Workshop 17, and five at the Tshimologong Digital Innovation Precinct), with the respondents being a mix of (i) hub community managers; and (ii) key informants resident in the hubs as innovator-entrepreneurs engaged in incubating or accelerating tech or tech-enabled start-ups; and
- a six-person focus group at Bandwidth Barn Khayelitsha, with six women engaged in micro-businesses.

[3] The Wits LINK Centre, where the author of this paper serves as Head, is a founding member of the Tshimologong Precinct and has historically carried out many of its activities there.

Ethical clearance for the research was obtained from the Human Research Ethics Committee Non-Medical, University of the Witwatersrand, with Protocol Number H16/11/01.

B. Data Analysis

The data analysis was qualitative, consisting of identifying the core recurrent themes in the transcripts of the 17 interviews and the focus group discussion. In this working paper's reporting on the findings from the data, the respondent codes used are as follows:

- respondents BBK1 to BBK7 = the seven Bandwidth Barn Khayelitsha respondents;
- respondents W17.1 to W17.5 = the five Workshop 17 respondents;
- respondents T1 to T5 = the five Tshimologong Digital Innovation Precinct respondents; and
- BFG respondents = the Bandwidth Barn Khayelitsha focus group respondents.

C. The Three Hubs Studied

As stated above, the three hubs selected for study—Bandwidth Barn Khayelitsha and Workshop 17 in Cape Town, and the Tshimologong Digital Innovation Precinct in Johannesburg—were selected because of their apparent differences in terms of features, locations, and stages of evolution. However, the hubs do have several commonalities. All three have attractive, high-ceilinged, multi-use, flexible-use spaces for co-working and events, including shared tables, discussion nooks, working areas with couches and tables, whiteboards, and cubby holes for storage; a staffed front desk; a coffee shop; a strong youth focus; long opening hours; high speed Wi-Fi; and a dedicated community management team.

i. Bandwidth Barn Khayelitsha

Bandwidth Barn Khayelitsha is a tech hub for entrepreneurs in all fields. It is located at Lookout Hill, a tourism centre overlooking Khayelitsha, with a view of the mountains and the sea, in a community with some formal residential areas but with a preponderance of informal settlements. Khayelitsha, although part of greater Cape Town, is located far from the city's main production and service sectors. The community experiences high levels of unemployment, food insecurity, infrastructure shortcomings, and extreme poverty. In this socio-economic context (Beyond our Borders, 2017), the Bandwidth Barn Khayelitsha caters mainly for tech-enabled businesses, and also for some tech startups. The tech hub was, at the time of the research, offering free space to its resident businesses and startups, and it planned to later move to a rental model. All the businesses and non-profit organisations (NPOs) operating from the tech hub at the time of the research were incorporating tech usage into their operations: for registration of the company when it reaches the appropriate stage of business development, for digital marketing, and for doing background research for their business (Respondent BBK7; BFG respondent). The Bandwidth Barn is open from 09h00 to 17h00 on weekdays, with ad hoc events taking place as arranged, including some at weekends (CiTi, n.d.).

ii. Workshop 17

Workshop 17 is designed specifically as an innovation space, with tech serving as an enabler of innovation and often also as a key feature of innovation. It is located in central Cape Town's Waterfront district, the city's top destination for local and international tourism, which has had more than 24 million visitors and has generated ZAR335 billion (approx. USD20.6 billion) in revenue since 1990 (V&A Waterfront, 2020). Workshop 17's main hours of operation are 07h00 to 19h00 on weekdays, with community members able to use the venue after hours and with many events and tech talks taking place over weekends. Firms located at Workshop 17 at the time of the research were engaged in, inter alia, conceptual marketing, crowdsourcing of data for clients, building data models, building financial technologies (fintech), managing events and event

security, coding, creative design for digital branding and marketing for small businesses, app design, platform design, and 3D-printing. Workshop 17 now has four locations in South Africa but had only one at the time of data collection (Workshop 17, n.d.).

iii. Tshimologong Digital Innovation Precinct

The Tshimologong Digital Innovation Precinct is, formally, an entity of the University of the Witwatersrand (Wits) located in the Johannesburg inner city area of Braamfontein (Tshimologong, n.d.). The Precinct's environment is characterised by inner city businesses, historical buildings and railway yards, cultural precincts, proximity to two universities (Wits and the University of Johannesburg), and a view of the Witwatersrand gold mine dumps (Trangoš, 2015). Braamfontein has a resident tertiary student population of around 6,700 (Gregory & Rogerson, 2019), including students registered at Wits, the University of Johannesburg, and several technical and vocational training colleges located in and around Braamfontein. The tech hub operates within its own framework, but under the rules and procedures of the University. Tshimologong's standard operating hours are 07h00 to 22h00 weekdays (pre-pandemic), with ad hoc events and hackathons taking place after hours as arranged (including on weekends). The Fak'ugesi[4] African Digital Innovation Festival usually runs in September each year but went virtual during October to November 2020, as a result of the COVID-19 pandemic (Fak'ugesi, n.d.).

III. Hub Provision of Infrastructure and Services

One of the core themes that emerged from the qualitative analysis of the data was the theme of *hub provision of infrastructure and services*, i.e., provision of internet, office space, meeting rooms, events spaces, pre-incubation support, incubation support, and acceleration support.

Respondent BBK2 of Bandwidth Barn Khayelitsha spoke of being "here for the space", due to lack of privacy at home and the need for a suitable environment to meet with clients. Respondent BBK3's business, focused on financial literacy, was building a website with video tutorials in multiple local languages. According to this respondent, "With me, I really need access to internet because I always have to be online, [and it must be] fast enough" (Respondent BBK3).

Another necessary element commented on by respondents was flexibility of pricing. Tech hubs generally charge membership fees on a tiered basis, with the fee increasing according to the use of time, space, resources, activities. Respondent W17.1 at Workshop 17 favoured pricing that included a per-use element, e.g., a charge per hot desk, per-use, on the grounds that such pay-as-you-go models allowed members to "spend less or spend more; that's what these environments give us […]. Add on what you need as opposed to [a] pay-per-resource-bundle" (Respondent W17.1).

Though both Tshimologong and Workshop 17 were found to be offering access to their shared workspaces and services at prices that were substantially lower than those in the commercial market, some respondents at these hubs voiced concern that the prices were still unaffordable for many individuals and enterprises

[4] Can be translated as "plug it in", "switch it on", "light it up".

coming from low-income communities. Respondent W17.4 favoured a situation where membership in one tech hub location would also allow access to other locations, so as to:

> allow people to feel they are part of a greater physical space than the specific one they're using. So members can use any of the locations for the same member fee, can have access to and grow their business at multiple locations across the country. [This would be] valuable for both members and corporate clients.

According to one respondent, tech hubs need to offer both low overheads and attractive social environments, i.e., a hub must be a "location for young creative people; hip, cool, [with a] non-traditional 'desk' [providing the] capacity to have more fun". Respondents from enterprises making use of Barn Khayelitsha and Workshop 17 spoke of the attractiveness of being able to host their clients in a "trusted"

hub environment. A BFG respondent praised the hub as "a professional-looking space to take clients". And in the words of Respondent BBK1:

> […] people trust me more, because they believe I will give them a good service. They will say, "I can't give this guy business, because he doesn't have [an] office, he doesn't have a desk". [And] three years, five years from now, I would like to have a private room, not an open space.

Respondent W17.4 at Workshop 17 proposed numerous requirements that are essential for hub success, including location (e.g., proximity to transport nodes, availability of parking, being in a district that is neither plateauing nor declining in economic attractiveness); the physical space (e.g., heating, ventilation, air-conditioning, lighting, high ceilings, outside spaces); and human elements (well-trained, highly educated employees passionate about creating tech hub success). Respondent BBK7 at Bandwidth Barn Khayelitsha saw the four key elements needed by a successful tech hub as: (i) ensuring a flow of skills into and among the incubatees; (ii) providing an incubator service; (iii) connecting startups to industry partners and enterprise development opportunities; and (iv) having some industry partners operating from the hub.

One area where respondents pointed to a need for continual improvement was mentoring. Respondent T5 said that there was a "lack of [the] right type of tech mentors that realise the difference between good tech and smoke and mirrors." According to one of the Bandwidth Barn Khayelitsha focus group respondents, it "would be more helpful if a mentor was appointed to do follow-up after training. Most times it's like you [are] on your own, you just swim on your own" (BFG respondent). There was a general view among users of the three hubs that, in addition to more regular mentoring, there was a need for more workshops on growing a business—and "not just the basic stuff", as one respondent put it.

There was criticism, among respondents, of government support programmes being delivered through hubs. Respondent W17.2 argued that governmental enterprise development programmes tended to be poorly designed and bureaucratic, while another respondent argued that government support measures were unreliable. In the words of one of the Bandwidth Barn Khayelitsha focus group (BFG) respondents:

> As startups in our townships, we are struggling to access funding, more especially from [the] government side. When they [government representatives] present at *imbizo*s [meetings], you feel you qualify, but when you get there, there are many [types of] red tape, and, by the time you comply, they tell you the budget is finished. Age is also counting. We can't get funding, because we are over the age. But also the youth can't get funding. [There are] lots of boundaries that you can't cross.

The tech hub management respondents saw one key dimension of their hubs as being the fostering of synergies with partners—through, as one respondent put it, the "easy formula […]. Plug in the community events, be an enabler to host physical space, at low cost or for free, [and then] event organisers [market] the space". Hub manager respondents also reflected on the enormous challenges of providing the necessary support to individuals and startups using their premises and services.

In the words of a Workshop 17 respondent, knowledge creation for a high-impact end result requires a "high touch" approach to member engagement, i.e., "regular coffees and updates to know the customer" (Respondent W17.4). According to one tech hub manager respondent, a hub is ideally able to apply the principle of "one size doesn't fit all", with time spent with each startup in order to understand the startup's business, to offer advice, and to mentor. But the startups tend to need many hours of advice, particularly those coming from disadvantaged areas. Intensive individualised support for each startup is typically not sustainable for a hub, given that a mentor resource may cost ZAR500 per hour, or ZAR5,000 per month, or more, a cost higher than the monthly membership fee.

According to a Tshimologong hub management respondent, many incubatees do not have the foundational knowledge or technical ability to use the full range of digital innovation tools (e.g., IoT tools, block chain tools) to create novel solutions, and they tend to get stuck at the ideas stage of knowledge creation (Respondent T2). According to this respondent, while it may be tempting for hub management to seek to solve all problems, it is more realistic to strike a balance between, on the one hand, the hub providing support and solutions, and, on the other hand, requiring incubatees to go away and find external avenues for support and solutions. But realism can be fraught: it tends to be very challenging for incubatees to, on their own, find external learning resources, generate the necessary contacts, and navigate the complex worlds of business and government—which can easily lead to a mismatch of expectations between incubatees and hub management.

According to Tshimologong respondents, a successful tech hub requires a specific resource environment, including availability of software systems, engineering resources, production facilities for hosting the app or the platform, testing and stress-testing facilities, and funding to hire developers. At Tshimologong, at the time of the research, many of these resources were being provided by the community members themselves (Respondents T4, T5). This would be typical of a tech hub environment in its early stages of formation.

Respondent T1 said that at Tshimologong, process matters were continually being reviewed, reset, and advanced, based on evolving insights gained by hub management and by its startups. At the time of the research, Tshimologong's emerging process (stated in broad terms) was to review the business concept proposed by each incubatee, consider the technical viability of the idea, assess whether the incubatee's team had the capacity to deliver, and understand the potential speed to get to market. Parameters or criteria for assessment in the pre-incubation stage required the incubatee to: (i) create a business model identifying the target audience, stakeholders, and resource requirements; (ii) conduct some level of product-oriented research; (iii) make their pitch; and (iv) demonstrate progress. The hub had found that following these steps allowed incubatees to optimally unlock the opportunities provided by working with Tshimologong's startup facilitators, to focus on the technical aspects of getting the product to market (Respondent T1).

One specific programme being delivered by Tshimologong at the time of the research was a cohort programme for 20 startups per cohort working through a 13-week programme, including orientation elements such as creating a business model canvas. The business model canvas is a popular approach in the

incubator world, but not all participants in the cohort moved at the same pace, meaning that, in the words of Respondent T2, the approach was "great for management, but not for participants". After completion of the 13 intensive weeks, limited mentoring continued on a once-weekly basis for a maximum period of one more year. According to Respondent T5, the challenge is "coming with a question and leaving with an actual development".

Tshimologong also had a dedicated acceleration programme, for those who already had a business that was earning revenue and needed tailored support measures, such as consultant support on IP management or tax matters. According to Respondent T3, a participant in the accelerator programme:

> The accelerator programme […] was presented to us [as]: if we put in the work and we meet our milestones, then we get access to investors. So it's an incentive for me to do my best work. Hence we decided to […] concentrate on creating a product that people will be crazy about when we release it […]. Here the thoughts are correct, the moulding of businesses [is] done the right way.

At time of the research, additional parameters were being put in place at Tshimologong for the accelerator stage. Explicit, written guidelines for expectations at each level of development were being designed by the business unit responsible for monitoring and evaluating the progress of community members (Respondent T1). The goal was for the Tshimologong enterprises who were receiving acceleration support to have their activities and progress measured in terms of formal guidelines and criteria, while at the same time still allowing them the flexibility required to engage in innovation.

In each of the three tech hubs, respondents argued that practices in tech hub management needed to continue to evolve, e.g., by including more advanced processes for pitching ideas and approving community members and their projects, including peer review, panel reviews, and other formats. A respondent called for the evolution of tech hub service delivery to the tech community through movement towards more self-service, e.g., by providing startups with advanced online booking, payment, and accounting services (Respondent W17.1). It was also felt that the hubs needed to increasingly create or foster "clever models" (Respondent W17.1) for pre-incubation (for those developers who have not yet built a prototype or explored the market); for incubation (where developers are building a product and a business model and getting ready to go to market); and for acceleration (where startups have some revenue and need to grow the business and revenue). It was felt that each of these stages or models needed a different kind of mentoring and support.

Another element cited as important to hub service delivery evolution was complaints procedures. Respondents at all three hubs were of the view that the positive evolution of the hubs' physical spaces and services was fostered in instances where complaints were encouraged and responsiveness from hub management was good. In the words of Respondent W17.1, "as residents evolve, they have greater needs, [and] complaint-response breeds evolution, movement […]".

IV. Hub Provision of Networking Opportunities

Another core theme that emerged from the qualitative analysis of the data was the theme of *hub provision of networking opportunities*, with the networks in question being both within the hubs and beyond the hubs in their greater ecosystems, and with the networks being grounded in the sharing of knowledge, innovation, and business opportunities.

Respondent W17.1 spoke of the importance of hub provision of high-quality access to business and knowledge networks. According to another respondent, the events and conversations made possible by the tech hub were not about the passive intake of information; rather, they were seeds for practical approaches to creativity and production: "It's not merely theory" (Respondent W17.3). According to BBK and W17 respondents, tech hubs have to be fail-friendly for tech developers and entrepreneurs, and a space where they can, as one respondent put it, "create businesses that create employers", network with clients and service providers, network with potential service providers, and network with startup investors. Other respondents spoke of the benefits they experienced through business introductions enabled by the "high traffic" at the hub; the heightened opportunity for networking due to the presence of many diverse community members; and the hub providing "access to broader (commercial) networks", a "centre of support in a faulty ecosystem", and"aggregation in the ecosystem" (BBK and W17 respondents).

According to a respondent, for firms and industries wishing to work through tech hubs, the hubs need to be a neutral, non-exclusive playing fields for multiple stakeholders, including startups, corporates, the public sector, and academia—"the whole continuum of the working economy" (Respondent W17.4). On the subject of networking between Tshimologong hub startups and Wits University, which is a core partner in the Tshimologong hub, a respondent spoke of the need to be "one interwoven community, whereas […] there is a disconnect, [and] seeing that push […] now" (Respondent T3). Also, according to Respondent T3, just as important as knowledge-sharing within the hub is the knowledge-sharing with actors beyond the hub's boundaries. Another Tshimologong respondent, from one of the startups, said that that startup was completely self-sufficient, and thus its key interest in being part of the hub was networking within a sharing community:

> […] the people and the networks you make with other people like yourself […] [It] generates interest, gets like-minded people together. That's where real progress starts happening. By us being in close proximity, we can help each out, due to our different expertise. (Respondent T5)

At the Tshimologong hub, it was found that key networking events were its hackathons, workshops, pitch sessions, and the annual Wits Fak'ugesi African Digital Innovation Festival. Also central to networking at Tshimologong are its training-oriented activities for coding and video-making, its tech community-oriented seminars; and its co-existence with a student community engaged in studies in digital media production. One of the Bandwidth Barn Khayelitsha respondents had attended the Wits Fak'ugesi African Digital Innovation Festival at the Tshimologong hub:

> Last year September I attended the Fak'ugesi Festival, Jo'burg for the first time […] the vibe, the culture, the activity […] we were playing games, people were sharing their stories, how they are creating their apps. I made friends. I met a lady doing an Instagram exhibition. We were building games, we were coding and I showed my own creative skills. I was with the Amaze team, programming. That's when I started to realise that I could create apps and websites, so such organisations are really helpful. (Respondent BBK5)

At Workshop 17, knowledge generation and networking are driven to a great extent by its events calendar. The calendar includes networking events to enable startups to engage with each other; and events in which industry leaders, academia, corporates, and enterprises showcase their knowledge and seek to build understanding. Workshop 17 is also active in facilitating introductions for funding, and it keeps a funding register (Respondent W17.2). According to another respondent, networking, both formal and informal, is regarded by Workshop 17 participants as a mode of creation, and a necessity for creation and, accordingly, hub community members invest time and energy in going to the hub's events, thus helping to feed the community's networking, meet-up, and developer ethos (Respondent W17.3).

Respondent BBK1 was providing events management services. For this business, networking and gaining access to knowledge through Bandwidth Barn Khayelitsha's workshops on how to market a business, how to write a business plan, how to manage business finances, and how to approach clients was very valuable: "I don't use the internet to grow my business, I believe in meeting someone 'bila to bila' (sweat to sweat)." According to Respondent BBK2:

> This space plays a role through events and providing the networking. Most of young people are starting businesses and they fail. So this space is important to the long-term success of small business in Khayelitsha. Most of the startups are from Grade 12 and have little further education. This space can add value in terms of training.

A key networking feature for Bandwidth Barn Khayelitsha is its formation of relationships with local partners. Its actual and potential partners were found to include local tour guides and tourist businesses offering "the Khayelitsha experience", creative designers working with crafters, corporate partners Airbnb and Telkom, and a government partner (the Western Cape Department of Economic Development and Tourism). In a similar vein, Respondent W17.3 at Workshop 17 spoke of the need to build durable networking relationships with the hub's alumni. According to a respondent, when enterprises mature and leave Workshop 17:

> […] this becomes a drawback for the hub, which needs to find new residents. […] [It is] a natural progression which has to happen. […] [But we] wish that the alumni would keep in touch and continue the relationship. […] continued networking is important and giving back to the next generation in the tech hub. […] [Without that], something is going missing and new members don't have the advantage of the elders. […] [This is] part of normal fluctuation, but more investment is required [in sustaining relationships with alumni]. (Respondent W17.3)

V. Hub Provision of Opportunities for Collaboration

A third core theme that emerged from the qualitative analysis of the data was the theme of *hub provision of opportunities for collaboration*, with the collaboration being grounded in sharing (of information, knowledge, and experience), and peer-to-peer modalities of learning and skills development.

At Bandwidth Barn Khayelitsha, it was found that enterprises, both non-profit and for-profit, "circulate business among ourselves" (BFG respondent), with some of the hub's enterprises providing, for example, advertising services and facilitation services to other enterprises at the hub. According to Respondent BBK2:

> You learn some other ideas from the other people, not your own way of doing things […] sometimes you meet other business owners here who do auditing and other guys are doing tax returns so they help you, they do the online tax filing […] [and learning] how to use your cellphone for your business, some things I didn't even know, [like how to] speak to a person via Skype.
>
> Success is very much linked to knowledge-sharing […] I can do more, I am getting more business than before […] more clients, more income, more networks. Online includes email, internet payments for staff, internet banking, phone people using Skype. Most young people use technology using their phones. We have pamphlets and posters at the malls and they call and email back, [and we conduct] online interviews using Skype. People email their CVs straight to you, people email requesting interviews […] Easy when you work with the bank. Today I was busy investing money with the bank online.

Another Bandwidth Barn Khayelitsha respondent spoke of the value of enterprises' "trading" skills, in order to generate mutual benefit:

> I'm a painter and a designer […] I wanted to trade the skills to make other businesses successful […] because I saw a gap where small businesses are existing in the market without an image and a corporate identity. In a digital world every business is online but they are not in that world, so I wanted to create digital marketing and branding for small businesses in Khayelitsha and in South Africa, from startup business to existing businesses and make that service available online through direct marketing and driving traffic to my website.
>
> This creative design and digital marketing, this is innovation. There are many graphic designers that I am competing with, but I want to be innovative because I want to teach people how to do creative design and teach entrepreneurs the importance of design for their business, for businesses who do not have a great awareness to tech-enabled branding, mainly startups, especially the design using digital software and interacting through digital spaces. (Respondent BBK5)

A Tshimologong respondent spoke of the importance of peer-to-peer knowledge creation:

> Knowledge creation amongst our peers is predominantly through observation and engaging the market, testing your assumptions. Ninety per cent of the time your assumptions are incorrect and that's at the heart of knowledge creation in the startup context […] can't be too theoretical […] have to put it into practice […]. (Respondent T3)

At Workshop 17, Respondent W17.1 highlighted the power of everyday conversation, and told the story of

> […] two startups talking about different technologies and challenges in collaboration […] [saying things like] "Sounds like this is your challenge […] I've used this alternative tech […] would it be useful to you?" Six months later this tech was core in their delivery, so a casual conversation led to formalisation in their operation.

Another anecdote told was one in which hearing about a failure from peers at the hub led developers along a different route, saving them significant time and money. This respondent spoke of the ideal where the developers and entrepreneurs at the hub are all mentors to each other. Respondent W17.4 spoke of the importance of a collaborative environment in building the resilience that startups need in order "to work through the hard times", noting that:

> [There is] greater resilience in a tech hub than outside a tech hub, because the success of those around you drives you to be successful […]. Being resilient is often not [about] being by yourself and pushing by yourself […]. [You] can be cornered in your own organisation. But when you're surrounded by 93 companies and sharing success and failure, [this] aids resilience. Fail, share, have a coffee, get some perspective. [That] creates resilience.

It was also felt that collaboration was an important contributor to building relationships—relationships, between enterprises, that are built around trust, value creation, and mutual benefit through reaching a given outcome, or through building a particular product, "and sometimes [building] sales opportunities" (Respondent W17.5). It was said that relationships built up over time create credibility in terms of ability to deliver and ability to perform. For startups, such relationships are important not only with their peers but also with hub executive leaders and, often more importantly, hub middle management, with whom the startups interact frequently.

Respondents at both Bandwidth Barn Khayelitsha and Workshop 17 spoke of the need for their respective hubs to be based to a greater extent on creating opportunity to experiment, on being places where "things need [to be] happening on the floor", with greater peer-to-peer exchange, greater levels of advising and understanding among startups, more collaborating through business referrals, and more pulling of other tenants into each other's teams (Respondent BBK6; multiple W17 respondents).

In discussions of the developers' and startups' collaborations with each other and with hub management, matters of hub politics arose. Though the term "politics" was not used by the respondents, it is used here, in its non-party-political sense, to thematically represent matters arising from hubs' governance and stakeholder management practices, and from relations among hub users. Respondent T5 was critical of the practice of inviting external parties to the hub without linking them to the people and enterprises present at the hub. The respondent gave the example of an event that "did not feature any of the local people […] 50 people in the precinct and not one of them is showcased" (Respondent T5).

Addressing the politics of relations between hub users, Respondent T3 stated that "a lot of the attempts to collaborate and create value for our peers left many people feeling that they got the short end of the stick." Respondent T3 spoke of the importance of:

> […] building the culture of creating things together and, if things didn't go well, building the culture of reconciling ourselves to that. [This is] the value of failing forward. But honesty is in short supply. On integrity, we fall short. At this stage of the evolution of the ecosystem, which is still in its infancy, [integrity] needs to be curated into the DNA of the ecosystem [so as to create] a more inclusive innovation space. […] Here it's about us, us, us – the value of the community not the individual. […] For Africa, the community is more important than the individual. Yes, there will be things that go seriously wrong, so how do you come out of that and still collaborate rather than walk away?

Respondent T3 stated that collaboration can be undermined when enterprises perceive one another as competitors:

> […] developers working in Java and PHP should be collaborating, but don't, because they think they're going after the same client – but they're not. They could be creating an integrated or collaborative offering […] [saying to themselves] "I can't do it alone, let's go and present together".

Strongly implicated in the political dynamics of the hubs are questions of values. Respondent T2 pointed to the importance of the values of flexibility of space and community, collaboration, and openness. Respondent T4 spoke of the importance of a sense of community and a sense of trust. This focus on trust links back to Respondent T5's statements above about the need for honesty and integrity. Some respondents argued that a code of conduct to promote common values and understanding should be instituted. Another political and values-based dimension is the relationship between the hub and the immediate geographical community in which it resides. Here respondents from all three tech hubs spoke of the need for a clearer underlying philosophy that creates inclusion rather than exclusion, and a clearer understanding that the contribution to community works both ways: the hub benefits the community, and the community benefits the hub.

It can be argued that what is at play here, in these matters of politics and values, is the need for "soft" skills among hub stakeholders at all levels, i.e., at governance level, at top management and middle management levels, and at the level of the individuals and enterprises making use of the hub. Communication skills, interpersonal skills, emotional intelligence, and other related soft-skill competencies are essential for the effective governance and management of, and participation in, the complex context of tech hub innovation.

VI. Hub and Startup Approaches to Knowledge Governance

A fourth core theme that emerged from the qualitative data analysis was *approaches to knowledge governance* by hubs and by their hosted enterprises. The concept of knowledge governance refers, in this context, to approaches to protecting and/or sharing innovations, including making use of intellectual property (IP) tools.

Respondents T1 and W17.1 said that IP ownership was a not a priority for them, as they wanted to focus their efforts on generating innovations. As one of these respondents said, "[we are] not necessarily interested in owning the IP, because we believe we can always come up with new IP". The prevailing logic among many of the respondents engaged in software development was that, in the software realm, it is important to continually build from scratch, partly because this creates the knowledge foundations that give the particular developer the advantage to continually build the next thing.

From the perspective of a Workshop 17 respondent, the ethos in the digital innovation environment, where a great deal of development occurs on open platforms, was to decrease the "need and desire" to keep IP closed:

> Many companies are desensitised to the core IP […]. They are willing to share with less emotion, because the tech industry is so quick in terms of innovation and how quickly things move. What's relevant today may not be relevant tomorrow. [The] rate of change is key to knowledge-sharing. (Respondent W17.5)

Respondent W17.5 also stated that while the rapid rate of change "may be a barrier to entry for some", it can be overcome through "more familiarity in terms of first to market and, in our instance certainly, relationships". For Respondent W17.3, IP was not seen as something in need of protection, as the firm was more focused on execution based on the IP they had generated. In contrast, some respondents, including Respondent T3 at Tshimologong, insisted on owning their IP and felt that one role of the hub was to provide advice for startups about IP rights and IP law. Respondent T3 stated that "if I write code, the IP is mine", and said that several startups at the hub were hoping that the hub would help them in protecting their IP—due to the fear that an investor might seek access to the IP as part of an investment. A Tshimologong respondent said that the startups in question were not clear about how to manage this part of investor relationship-building:

> […] the startup does not know how to package the knowledge in terms of IP. […] When you are talking to investors, [you] don't know what to keep and what to divulge, what to protect and how to leverage the IP, hence the usefulness of being at the university. That's one core thing that should be given to us at the end of the 12 weeks [of the accelerator training programme]: [knowledge about] how you create trademarks, [how] to open it up to the market so that people play around with it. We think about IP incorrectly as entrepreneurs, [with] fear, [which hinders] entrepreneurial success (Respondent T3).

According to Respondent T5:

> […] posting [an innovation online] gives you some sense of the right to say it was yours first, but that doesn't matter if company X comes and [crushes] you under their legal team. [IP] needs to be explored more. […] we have a lot of companies or individuals coming into the space with new ideas, so we sign an NDA [non-disclosure agreement] with them to protect what they are trusting us with, so [it] will not be disclosed. [That] protects us and their idea.

Respondent T2 explained that the hub does not seek any share of IP rights that may emerge from innovations generated by startups at the hub:

> If there is any sniff of Wits [University] owning IP as a condition for using the space, they [incubatees and startups] will not come here. So they pay a membership fee; we give everyone a vanilla-flavoured package of support; there's no Wits IP in the package and they own 100% IP and equity in their company. If they want to work with a Wits academic to support one of the startups, we would fall under the national IP Act, but that hasn't happened yet.

The Wits IP policy specifies that the university owns IP created by employees, and thus it does not apply to Tshimologong hub participants who are not Wits employees.

VII. Hub and Startup Approaches to Local Appropriateness

Another core theme identified in the data was *approaches to local appropriateness*. Bandwidth Barn Khayelitsha was found to be the hub where these matters were most complex.

The impoverished conditions experienced by most of the households living in Khayelitsha make local appropriateness a great challenge for Bandwidth Barn Khayelitsha innovators seeking to serve local needs. Many Khayelitsha residents do not own a smartphone or have affordable access to data. Also, local clients for Bandwidth Barn developers' services do not have large budgets at their disposal. Due to local factors such as these, Respondent BBK6's development team had found itself "forced", in order to cater for local client needs, to provide basic web development and social media support services—rather than making use of the team's higher-level skills in mobile app development, robotics, and artificial intelligence:

> We want to get into that, but most of these things require a specific amount of funding. If clients cannot meet the cost requirements, then it can't be done. We have been doing some exploration, but it all came down to the fact that we need resources. (Respondent BBK6)

For Bandwidth Barn Khayelitsha, it was found that there was some potential tension between marketing the community of Khayelitsha as a "township tourism" destination and marketing it as a community of tech innovation—with the latter potentially being a difficult sell in the short term due to the generally low levels of data and app use among Khayelitsha residents. According to Respondent BBK4 at Bandwidth Barn Khayelitsha, a tech hub needs to be a space for increasing the levels of digital participation in its broader community:

> A lot of the businesses operating here are tech-enabled, and other businesses operating here are starting to understand the shift to tech enablement, [as are the] local schools coming in […]. The tech hub is a key component in shifting towards a tech-enabled Khayelitsha.

According to Respondent BBK3, who was engaged in app development at Bandwidth Barn Khayelitsha:

> We use Google statistics to measure what users think of our product. We get a [user engagement] score of about 3.1. We should be at least 4; 3.1 is terrible. […] For us, what users think is very important because we are designing for them.

Furthermore, one of the challenges in building this tech hub community is that "most people start a business because they want to earn money, not because they've done a market analysis. However, members of the [tech hub] community need to […] have a creative mindset […] to be able to compete" (Respondent BBK7).

Bandwidth Barn Khayelitsha also faces challenges posed by Khayelitsha's spatial and economic isolation within greater Cape Town (Khayelitsha is 40 kilometres away from downtown Cape Town.) The community's economic and social isolation needs to be decreased—through the efforts of the local community working together with government, and private-sector and non-profit partners—in order for the tech hub to be effectively integrated into the greater Cape Town economy. The hub, and the broader Khayelitsha

community, need to transition from being entities that are "being looked at" to entities that are understood to be partners with economic potential (Respondents BBK4, BBK7).

The Tshimologong hub in the Johannesburg inner city neighbourhood of Braamfontein—next to the city's downtown core where poverty and crime levels are high—experiences some of the same perceptual negatives that Bandwidth Barn Khayelitsha faces, but to nowhere near the same extent. Braamfontein has undergone a highly successful redevelopment since the mid-2000s, with Tshimologong being an important part of the regeneration of the area. Adjacent to the Wits University main campus and with a wide range of economic activities occurring at all hours of the day, Braamfontein has an atmosphere that invites activity on a round-the-clock basis due to its large student population. Workshop 17 has location in its favour, situated in the heart of Cape Town, close to the offices of many of the city's key players in the private sector and government, though it's location would generally exclude participation from low-income communities. At all the hubs studied, irrespective of socio-economic context, the imperative that innovations are locally appropriate is a challenging one to meet. In the words of a Tshimologong respondent, "[…] people fall in love with their technology and may be developing something not wanted by the target market. So [there needs to be emphasis on] understanding your customer/market, not just loving the tech".

Success, according to Respondent T2, is about building sustainable businesses, "not just about ticking the boxes of ideas, the business model […]. Until [you are] operating in the world and creating revenue, you haven't achieved anything". According to Respondent T3:

> One of our primary activities is research, [which] should be [the] practice for all businesses: research your market, would-be buyers, their psychology […]. Any business should be a research-based business, underlying the development of digital products. For us, innovation is about: what are the real problems that people are not thinking about? […] We use design thinking. We are not trained researchers, but we use the available tools within this tech hub to do our work.

According to Respondent T1, ideas for digital production and services need "to be disruptive in nature, or have high impact in one's community, […] social impact, [...] [serving as] an enabler that simplifies people's lives".

VIII. Conclusions: Seeking Scale and Sustainability

Cross-cutting themes running through much of the data from the interviews and the focus group discussion were two core motivations—sometimes explicit, often only implicit—driving the actions of the hubs and startups: the quest for scale, and the quest for sustainability. The terms "scale" and "sustainability" are of course open to varying interpretations. (And, as outlined in Open AIR's recent *Scaling African Innovation* research report (Open AIR, 2020), sustainability is often a central feature of successful scaling.) The conceptions of scaling and sustainability posited by the interviewees and focus group respondents in this research were particularly present in their statements on matters of:

- overcoming adversity and complexity in innovation environments; and
- building multi-stakeholder innovation ecosystems.

A. Overcoming Adversity and Complexity in Innovation Environments

The startup actors studied have emerged from environments characterised by lack of easy access to institutions and resources, lack of easy access to the private sector and markets, lack of formal access to universities or university research sub-systems, and lack of access to publicly funded research entities. These actors were compelled to move into a particular kind of space and setting, a tech hub, at which they must attempt to create and co-create in the face of adverse conditions which do not disappear because they are in a tech hub. They still do not have easy access to significant amounts of finance, investment, skills, and knowledge.

The type of innovation being supported by tech hubs lacks the relative financial stability, and relatively predictable path to achieving scale and sustainability, of innovation endeavours taking place in large private-sector, university-based, or government-supported research and development (R&D) entities. Accordingly, the activities of the three tech hubs and their startups were found to be, at their core, activities conducted in the face of substantial adversity and complexity.

One core area of adversity faced by tech hubs in their efforts to scale their offerings and build sustainability is funding. Reliance on external funding can be a double-edged sword—helping, but at the same time potentially leading to over-dependence on income streams that exist at the whim of the donor. According to Respondent T2 at Tshimologong, resources acquired through partnerships with industry, in which mutual self-interest can be established and both parties feel that they gain from the relationship, have much more potential stability. Ultimately, tech hubs need to foster a multiplicity of resource streams.

Volunteering and "hustling" were noted as important to making a tech hub successful. Hustling was understood as grasping every opportunity, and constantly looking for and taking on temporary projects, particularly ones that create short-term income generation opportunities for large numbers of participants, such as events management for local sports events. Respondent BBK1 summarised this approach as follows: "one space, two hustlers, and 500 people getting an income".

Meanwhile, the startup entities accepted into a hub's incubation programmes, and/or making use of a hub's infrastructure and services, tend to be characterised by low and irregular income, and limited savings. Accordingly, some incubatees give up, while others manage to push through the adversity and stay on the path towards scaling and sustainability. Some incubatees grasp every opportunity to remain in whatever programme they are accepted into, and others drop out, or fail to take full advantage of a hub's services and opportunities. What distinguishes those who push through? According to Respondent T5:

> What defines the real techies [as opposed] to the people just trying to make money, [is that the techies] will push through regardless of the circumstances. Most people in the space will keep pushing through, even if they don't get the support they need, even if they don't get the business models. That kind of mentality is going to grow those people […]. The fact that we believe in the tech that we use [means that this type of business] will be a viable business […]. [We are] spending a lot of resources at the early stage of the technology, getting limited output from the resource input, but we know that this will change […]. [It] has to be sustainable, but even when things are tight, we love what we [are] doing and we keep pushing on.

According to Respondent W17.1 at Workshop 17, a key dimension of adversity is uncertainty. And, according to this respondent, incubated enterprises may at times, in the face of this adversity, need to take on too much —and this may create only small growth opportunities in the short term, with sustainable employment opportunities only coming in the longer term.

In a context such as South Africa, with its huge income disparities and history of deliberate under-development of areas inhabited by black South Africans, another element of the adversity and complexity is the negative assumptions that are often made about small-scale innovators. In the words of Respondent BBK6 "[innovative] ideas are expected to come from a certain organisation/race/company, in terms of size, so when a small, black company comes up with something disruptive, it's not really trusted. There's a question of legitimacy […]".

Another element of adversity for small-scale innovators on the path to scaling and sustainability is the need to take the innovation to market, so as to monetise it. Creating the bridge into the corporate market and speaking the corporate language require more than business models. They require learning how to be in business. In the words of Respondent W17.1, "[…] what we've learnt from the market [is that] being a small company in a mature market is extremely tough". And, according to Respondent W17.5, participation in the market also requires learning how to operate successfully in the face of global economic downturns.

B. Building "Entangled" Multi-Stakeholder Innovation Ecosystems

The themes from the data also focus on tech hubs as multi-stakeholder innovation ecosystems. As Respondent BBK7 at Bandwidth Barn Khayelitsha put it, a hub or startup seeking to build scale and sustainability must "create an ecosystem where you are". Indeed, according to several respondents, when startups begin to mature and pursue scale and sustainability, they want and need to be part of a larger innovation ecosystem. One key feature of such an ecosystem, according to respondents at all three hubs, is the creation of knowledge clusters—for example, a focus on gaming and gamification. Another crucial dimension, all respondents agreed, is having the necessary skills present at the hub and in the enterprise. According to Respondent T3 at Tshimologong, a key feature of scaling is increased access to potential clients, forging relationships that could be profitable in the future, and creating bridges into the marketplace where transactions happen.

Respondent T1 noted the need for the Tshimologong hub to make more progress in optimising the roles of all potential partners in the knowledge generation process: the startups, the academics, and the industry partners. A positive example of integration cited by Respondent T1 was the case in which the design, by one of the hub's startups, of an events app resulted in over 75,000 hits in a month, and influenced the startup's external private-sector partner firm to open a unit "dealing specifically with gamification and mobile apps, because they saw the potential success of capturing a new, young audience".

Respondent T1 spoke of the great potential value of effective integration between relevant parts of the university academic community and the digital tech community at the precinct; shared access to digital technologies; and greater knowledge-sharing between the hub's startups and academics working in various fields. Respondent T3 cited the significant potential innovation that can be fostered by Tshimologong startups having access to Wits University entomologists, to Wits academics in mining or health sciences, and to Wits academics working on IP law. Respondent T3 also spoke of startups' interest in accessing training opportunities at the university, which offers a range of short courses, in order to enhance knowledge and capabilities.

The tone of adversity and complexity in the data, discussed in the previous section, and the benefits of multi-stakeholder engagement discussed in this section, are strongly reminiscent of the concept of "research entanglement" discussed in my previous research on universities as knowledge-economy actors (Abrahams, 2016), which was the initial venture into understanding entanglement. Through that research I was able to identify the importance of "entanglement" between and among the heterogeneous group of non-university-based research-innovation actors partnering with university-based actors.

In the context of this research, this conception of *entanglement* can potentially help to elucidate the dynamics present in relations between hubs, hub startups, and their external stakeholders (universities, private-sector entities, governments, and non-profit organisations) as they engage in innovation-oriented behaviour, which we can conceptualise as innovation entanglement. There is evidence that the hubs and startups work through adversity and complexity, and increase their chances to succeed, through entanglements with large institutions, such as universities, banks, mining companies or other large private-sector actors, branches of government, and development donors and non-profit organisations, in their search for generating value.

Based on the findings of both the earlier research (Abrahams, 2016) and this later research exercise, I argue that it is possible to conclude that, for tech hub entities engaged in innovation as a form of communitarian behaviour—noting communitarian innovation linkages between tech hubs, their startups, universities, private sector entities, and branches of government—the entanglement dynamic among the innovation entities in the ecosystem can play out in one of two main ways.

One possible entanglement modality is one spearheaded by the large, formalised institution(s) in the communitarian innovation ecosystem—institutions which will tend to be oriented towards bureaucratic institutional imperatives. The downside of this kind of entanglement for small-scale innovators is that large bureaucratic institutional formations tend not to have a feel for the DNA of communitarian values as understood by startup innovators. Large, formal institutions—e.g., universities, governments, and sizeable private-sector entities—will tend to assert, or reassert, rigid rule-driven governance and management frameworks. A university, for example, will tend to be guided by highly organised and highly rationalised scientific memes when engaging in an innovation ecosystem, e.g., with standardised lab functions according to which only specific kinds of things can happen in a lab; and with labs conforming to very strong frameworks that are set by the university and must be followed. Traditional science, even in the 21st century, tends to be a highly structured domain.

A second possible entanglement modality, one that is more amenable to the inherent ethos of a tech hub and its startups, is one characterised by what I have come to think of a "soft science" innovation ethos—an ethos characterised by flexibility, rather than by the relative rigidity of the "hard science" innovation pursued by large, formalised entities. The *soft science* innovation practised in South African tech hubs still uses models and frameworks, but not in as rigid a way as in large, formalised, *hard science* innovation contexts. Each of these modalities presents opportunities for tech hubs to become a prominent phenomenon in the 21st century digital economy and in socially oriented innovation.

As tech hubs evolve further, in the decade of the 2020s, in the variety of contexts within and beyond large cities, it will continue to be important to expand further on understanding these entangled behaviours, in order to foster the best possible paths for future scaling and sustainability.

References

Abrahams, L. (2016). *Trends, tropes and positioning in the university research sub-system in emerging knowledge economies: A theory of research entanglement*. PhD thesis, University of the Witwatersrand, Johannesburg. https://core.ac.uk/download/pdf/188775113.pdf

Abrahams, L. (2020). Innovation entanglement at three South African tech hubs. *The African Journal of Information and Communication (AJIC), 26*, 1-29. https://doi.org/10.23962/10539/30358

Beyond our Borders. (2017). The Khayelitsha Project. http://beyondourborders.net/the-khayelitsha-project/

Cape Innovation & Technology Initiative (CiTi). (n.d.). Khayelitsha Bandwidth Barn. https://www.citi.org.za/spaces/bandwidth-barn-khayelitsha/

Comins, N. R., & Kraemer-Mbula, E. (2016). Innovation hubs in Southern Africa. In O. Adesida, G. Karuri-Sebina, & J. Resende-Santos (Eds.), *Innovation Africa: Emerging hubs of excellence* (pp. 37–98). Emerald. https://doi.org/10.1108/978-1-78560-311-220151003

De Beer, J., Millar, P., Mwangi, J., Nzomo, V., & Rutenberg, I. (2017). A framework for assessing technology hubs in Africa. *Journal of Intellectual Property and Entertainment Law*, *6*(2), 237–277. https://www.researchgate.net/publication/318710029_A_Framework_for_Assessing_Technology_Hubs_in_Africa

Desta, T. (2018). ICT innovations, entrepreneurship and hubs in East Africa: The case of Ethiopia. *African Journal of Science, Technology, Innovation and Development, 10*(6), 655–664. https://doi.org/10.1080/20421338.2018.1473064

ElHoussamy, N., Weheba, N., & Rizk, N. (2020). *Power relations, innovation, scaling and knowledge governance at three Egyptian tech hubs: An initial exploration*. Open AIR Working Paper 21. Open African Innovation Research (Open AIR) network. https://openair.africa/power-relations-innovation-scaling-and-knowledge-governance-at-three-egyptian-tech-hubs-an-initial-exploration/

Fak'ugesi (n.d.). [Website]. https://fakugesi.co.za/

Friederici, N. (2019). Innovation hubs in Africa: What do they really do for digital entrepreneurs? In N. D. Taura, E. Bolat, & N. O. Madichie (Eds.), *Digital entrepreneurship in Sub-Saharan Africa: Challenges, opportunities and prospects* (pp. 9–28). Palgrave Macmillan.

https://doi.org/10.1007/978-3-030-04924-9_2

Giuliani, D., With, L., Ekeledo, A., & Isedowo, T. (2019). *Building a conducive setting for innovators to thrive: A qualitative and quantitative study of a hundred hubs across Africa*. AfriLabs and Briter Bridges. https://briterbridges.com/briterafrilabs2019

Gregory, J., & Rogerson, J. (2019). Studentification and commodification of student lifestyle in Braamfontein, Johannesburg. *Urbani izziv, 30*, 178–193.

https://doi.org/10.5379/urbani-izziv-en-2019-30-supplement-012

GSM Association (GSMA). (2017). *The mobile economy: Sub-Saharan Africa 2017*. https://www.gsma.com/subsaharanafrica/wp-content/uploads/2018/11/2017-07-11-7bf3592e6d750144e58d9dcfac6adfab.pdf

International Telecommunication Union (ITU). (2021). Digital development dashboard: Select economy: South Africa. https://www.itu.int/en/ITU-D/Statistics/Dashboards/Pages/Digital-Development.aspx

Jiménez, A., & Zheng, Y. (2017). Tech hubs, innovation and development. *Information Technology for Development*, *24*(1), 95–118. https://doi.org/10.1080/02681102.2017.1335282

National Advisory Council on Innovation (NACI). (2016, June 3). *South African science, technology and innovation indicators report – 2021*. Pretoria. http://www.naci.org.za/index.php/naci-resources/studies/

Nzomo, V., Mwangi, J., Matu-Mureithi, L., Muchiri, C. W., & Rutenberg, I. (2020). *Modes of innovation and enterprise development by Nairobi's mobile tech start-ups*. Open AIR Working Paper 22. Open African Innovation Research (Open AIR) network. https://openair.africa/modes-of-innovation-and-enterprise-development-by-nairobis-mobile-tech-startups/

Open African Innovation Research (Open AIR). (2020). *Scaling innovation: How open collaborative models help scale Africa's knowledge-based enterprises.* https://openair.africa/scaling-innovation-how-open-collaborative-models-help-scale-africas-knowledge-based-enterprises/

Republic of South Africa (RSA). (2007). Final Draft: Information and Communication Technology Research & Development and Innovation Strategy. Pretoria: Department of Science and Technology (DTI). http://www.gov.za/sites/www.gov.za/files/ICT_RDI_Strat_2007.pdf

Statistics South Africa (StatsSA). (2019). *General household survey*. Statistical Release P0318. Pretoria. http://www.statssa.gov.za/?page_id=1854&PPN=P0318&SCH=72766

StatsSA. (2021a). *Mid-year population estimates 2021*. Statistical Release P0302. Pretoria. http://www.statssa.gov.za/?page_id=1854&PPN=P0302&SCH=72983

StatsSA. (2021b). *Quarterly labour force survey (QLFS), Quarter 2: 2021*. Statistical Release P0211. Pretoria. http://www.statssa.gov.za/?page_id=1854&PPN=P0211&SCH=72944

StatsSA. (2021c). *Gross domestic product (GDP), 2nd quarter 2021*. Statistical Release P0441. Pretoria. http://www.statssa.gov.za/?page_id=1854&PPN=P0441&SCH=72932

Trangoš, G. (2015, June 2). Photos: An emerging Joburg neighborhood challenges Cape Town's fickle hipster culture. *Quartz Africa*. https://qz.com/416132/photos-an-emerging-joburg-neighborhood-challenges-cape-towns-fickle-hipster-culture

Tshimologong. (n.d.). [Website]. https://tshimologong.joburg

V&A Waterfront. (2020). Our history. https://www.waterfront.co.za/the-va/the-company/our-history

Workshop 17. (n.d.). [Website]. https://workshop17.co.za

World Bank. (2016). *World development report 2016: Digital dividends*. https://doi.org/10.1596/978-1-4648-0671-1

Zwegers, A., & Sassen, A-M. (2015). Digital innovation hubs at ICT 2015. European Commission, Digital Single Market [Blog post]. https://ec.europa.eu/digital-single-market/en/blog/digital-innovation-hubs-ict-2015

Research Respondents

At Barn Khayelitsha, Cape Town, interviewed in 2017

Respondent BBK1
Respondent BBK2
Respondent BBK3
Respondent BBK4

Respondent BBK5
Respondent BBK6
Respondent BBK7

At Workshop 17, Cape Town, interviewed in 2017
Respondent W17.1
Respondent W17.2
Respondent W17.3
Respondent W17.4
Respondent W17.5

At Tshimologong Digital Innovation Precinct, Johannesburg, interviewed in 2017
Respondent T1
Respondent T2
Respondent T3
Respondent T4
Respondent T5

Barn Khayelitsha focus group, Cape Town, conducted in 2017
BFG respondents

Appendix A: Protocol for Semi-Structured Interviews

Broad designation and institution of key informant (for analysis purposes only):

Date of interview:

Please note that these are guiding questions. The researcher is interested in noting and understanding the histories, nature and characteristics of high-tech hubs and those factors that foster their success, in particular with respect to knowledge governance.

Metrics
(i) Please mention or refer us to some of the key metrics that reflect the status and level of advancement of this high-tech hub, including

- metrics for innovation input and output
- metrics of innovation value produced
- any other relevant metrics

Modes of knowledge creation and knowledge governance
(ii) What are the prevailing modes of knowledge creation at the tech hub and the related governance mechanisms?
(iii) In your view, what is it that academics, innovators and managers do that tends to lead to success in the innovation project, or to lead to failure in the innovation project?
(iv) In your view, what is it that academics, innovators and managers do that tends to lead to success in the long-term innovation venture, or to lead to failure of the high-tech hub?

Understanding the complex context for innovation practices
(v) How do the complex challenges of innovation practice on a short-term (one year) and a long-term (3 to 5 year) basis affect your knowledge creation and knowledge governance behaviours?

(vi) How does government and institutional policy, law and regulation, in particular, IP law and open IP approaches affect your knowledge creation and knowledge governance behaviours?
(vii) How do tech transfer offices, advisors, financing and other support measures enable or present barriers to your innovation projects and to high-tech hub development?

High-tech hub evolution
(viii) Briefly explain this high-tech hub's evolution in terms of any of the following:

- innovation and knowledge production
- collaborative innovation
- appropriation of intellectual property (IP)
- the role and contributions of innovation actors, innovation-oriented institutions and innovation resources
- the nature and importance of innovation-oriented values
- the innovation value produced

Appendix B: Focus Group Guide

Broad designation and institution of key informants (for analysis purposes only):

Date of focus group event:

Note to focus group: Please note that these are guiding questions. The researcher is interested in noting and understanding the histories, nature and characteristics of high-tech hubs and those factors that foster their success, in particular with respect to knowledge governance. This particular set of questions is aimed at understanding your collective view of the collaborative innovation experience.

Metrics
(i) How would you measure the success of the innovation activities that you engage in here at the high-tech hub?

Modes of knowledge creation and knowledge governance
(ii) Please explain how you produce knowledge in this collaborative working environment. [For example, why is it better to engage in collaborative innovation than to work alone?]
(iii) How is the intellectual property you create owned and released or used for commercial or social or public benefit?
(iv) How do you earn income or other value from the intellectual property you create?

Understanding the complex context for innovation practices
(v) Please briefly explain some of the major challenges you face in this form of collaborative innovation.
(vi) How do you address or resolve these challenges?
(vii) What, in your view, are the strengths and weaknesses of how innovation is governed/managed in this high-tech hub? [For example, decision-making, management, leadership, government policy or law or regulation, tech advisors, financing, any other]

High-tech hub evolution
(viii) What, in your view, are the overall strengths and weaknesses of the high-tech hub approach to innovation?

Recognizing Africa's role in the global knowledge economy.

Open African Innovation Research (Open AIR) is a unique collaborative network of researchers investigating how intellectual property (IP) systems can be harnessed in open, participatory ways that have the potential to maximise knowledge access, innovation, and the sharing of benefits from innovation inclusively.
For more information about Open AIR, please visit our website: http://openair.africa
or contact one of our Program Managers:
ottawa@openair.africa
capetown@openair.africa

Open AIR is carried out with financial support from the International Development Research Centre, Canada, the Social Sciences and Humanities Research Council of Canada, and the Queen Elizabeth Scholars Program. More information about Open AIR's current and previous supporters can be found at https://openair.africa/supporters. The views expressed herein do not necessarily represent those of Open AIR's funders.