Unlocking local digital economies through tech hubs:
What we are learning from Digital Mandhwane[1]

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[1] This work builds on previous research on telecentres and on tech hubs by K Magoro and L Abrahams

1   Introduction: Tech hubs and community networks

In the context of a very long-term digital divide, widening with each new advance in digital applications and each phase of further evolution of communications infrastructure networks, rural households and communities are placed in positions of economic and social exclusion from the kinds of digital benefits experienced by many (but not all) urban households. Tech hubs across Africa, of which there are currently more than 600, generally provide spaces for learning digital skills and for applying those skills to generate income for households, through digital enablement of micro- and small businesses. Tech hubs also contribute to digital innovation in countries. However, the number of tech hubs in rural areas is small and the dynamics of tech hubs in rural and resource constrained environments has not been studied in any depth. While there are many negative disruptions associated with the digital age (cybercrime, digital colonisation, harmful online content), this paper is concerned with the positive disruptions associated with the ways in which digital applications and tech hubs enable development, in rural and resource-constrained contexts.

2   Research problem statement

Rural communities are largely excluded from the digital economy due to, among others, lack of access to sustainable and resilient institutions for creating digital artefacts, limited digital skills, and the absence of reliable and affordable broadband connectivity. The peripheral location of rural areas means that communities are disconnected from the digital economy value chain and from centres of learning or innovation. We need to better understand how tech hubs promote the transition to localised digitally enabled economies in resource-constrained contexts such as South African villages.

3   Research question

To what extent can rural tech hubs and community networks accelerate the transition to local digital economies in rural and resource-constrained environments?

4   Background discussion

4.1   Internet statistics for Limpopo province

In Limpopo Province, the geographic context of this paper, about 63,7% of households has access to the internet, with only 1.9% accessing it at home (StatsSA, 2021). Predominantly rural provinces, such as Limpopo Province, function at the periphery of South Africa's digital economy.

Figure 1

Percentage of Households with Access to the Internet at Home, or Anywhere, by Province, 2021

	WC	EC	NC	FS	KZN	NW	GP	MP	LP	RSA
Anywhere	89,1	64,7	66,7	72,6	75,9	67,5	86,7	76,6	63,7	77,5
At home	25,9	5,0	5,9	7,1	6,4	2,4	16,4	1,7	1,9	10,4
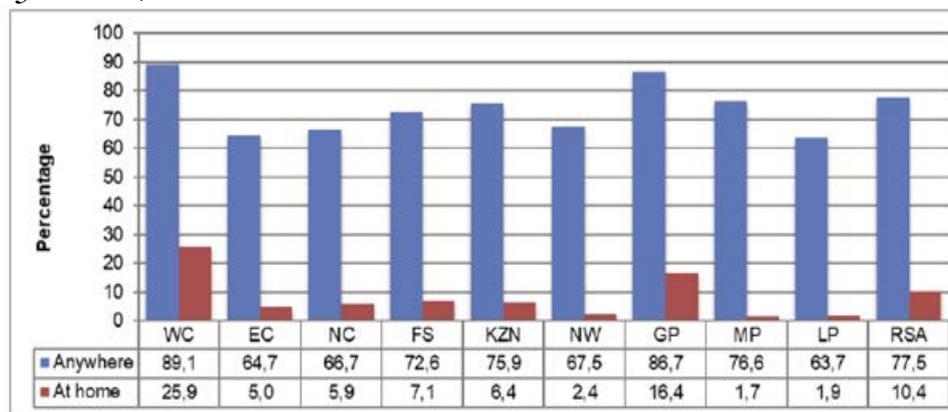
Note: From StatsSA, General Household Survey 2021, Figure 13.2

4.2 Village context: Brief description of Sekgosese cluster and Mamaila Tribal Authority[2]
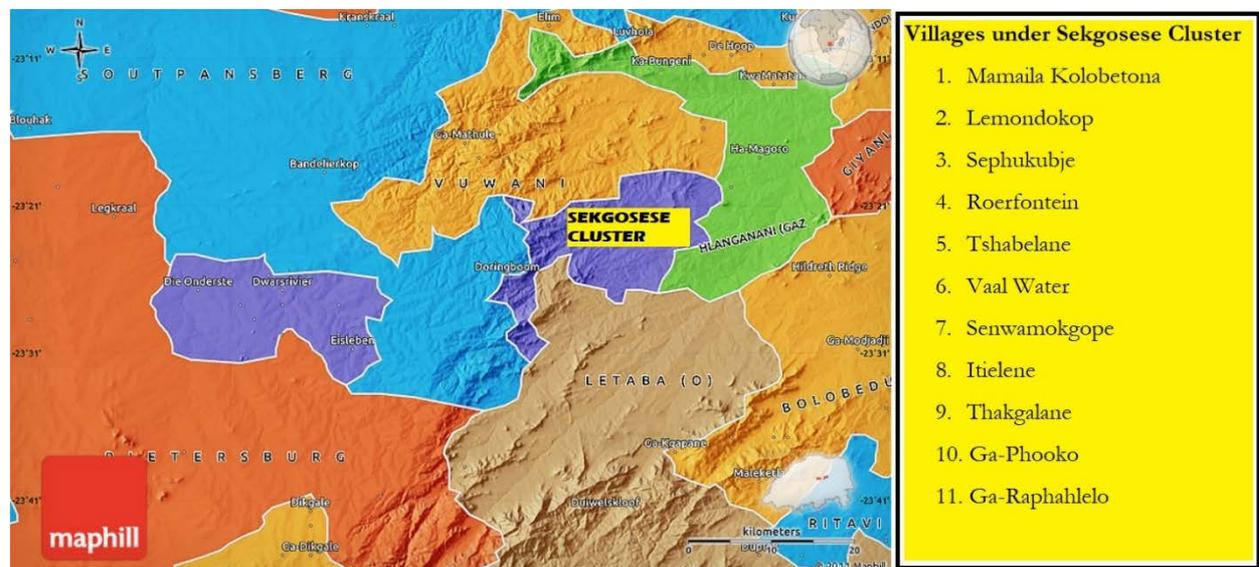
Sekgosese is a cluster of four Tribal Authorities and a township, within the Greater Letaba Municipality, Mopani District, Limpopo Province. According to the StatsSA (2016) community survey, the population of Greater Letaba Municipality was 218,030. The following statistics contextualise the socio-economic challenges faced in Sekgosese, noting low population growth due to continuous migration to cities. Within Sekgosese cluster, almost 60% of households are headed by females, and many households are child-headed. About 47% of the population have completed Grade 9 or higher, with matric being the highest qualification for 30% of the population, while less than 5% of the population has higher education. Less than 30% of the population is employed, with over 50% of people not economically active. The average annual household income was slightly higher than R14600 per annum, approximately R1300 per month, per household (StatsSA, 2011[3]). The main economic activity in the region is farming/agriculture, with fresh produce farming company ZZ2 being the biggest employer. Despite the high levels of unemployment and low levels of income, the majority of households have access to basic services such as water and electricity, although not reliable.

Mamaila Tribal Authority (TA) is the largest TA, incorporating six villages namely, Mamaila Kolobetona, Sephukhubje, Roerfontein, Lemondokop, Vaal Water and Chabelane.

Figure 2

Map of Sekgosese Cluster Villages

Note. From Maphill
http://www.maphill.com/south-africa/northern-province/sekgosese-o/maps/political-map/

Roerfontein is an emerging town, with the historical economic centre for small-scale business, the recently established tech hub, and lodging and conference facilities; as well as two private schools and a 12,496m² shopping mall servicing the over 40,000 residents of Sekgosese. The area serves as a gateway to the Mopani and Vhembhe eco-tourism area, specifically the Kruger National Park. Agriculture and financial services

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[2] In South Africa, a Tribal Authority has limited functions, including approval of land use, in this case they are a partner in advancing the community network ecosystem

[3] The latest year for which data is available at the village level. New data is expected from the 2022 national census and we will update the paper accordingly.

are key drivers of improving income at the household level. However, in the still sluggish post-Covid-19 economy, the limited digital resources in Sekgosese make it difficult to leverage emerging economic opportunities.

4.3 Digital transformation ecosystem, Mamaila Community Network and Digital Madhwane tech hub

Mobile operators include MTN, Cell-C, Telkom and Vodacom, although coverage (2G/3G and 4G) differs from village to village. The overall network coverage and signal are poor and unreliable. Letaba Networks is the main commercial Internet Service Provider (ISP) that provides Wi-Fi connectivity to homes, businesses and schools. The Sekgosese cluster is located on the periphery of the telecommunications infrastructure network. About 57% of the population in Sekgosese does *not* have access to the internet, a significantly lower proportion than the 2021 average for Limpopo Province (67% with access).

Mamaila Tribal Authority, in partnership with a local NGO, Zuri Foundation, attempted to partly address the connectivity constraint by establishing a community Wi-Fi network, known as Mamaila Community Network (MCN). The establishment of MCN was a direct response to a problem highlighted by a resident of Mamaila Kolobetona village who wrote in a blog article titled "Coming from a rural area is like being cursed" because schools lack libraries, computer labs and internet connectivity and, if they go on to further education, students "first have to learn how to switch on and off a computer, learn how libraries work" (Mabogale, 2017). MCN is a licensed Community Network (CN) that evolved from a pilot project, pursuant to doctoral action research[4]. The action research investigates cultural knowledge systems and mind mobilisation for rural communities in the digital era, promoting the concept of digital Mandhwane (unlocking collective capabilities through digitally enabled action[5]). MCN was the foundation for the Digital Mandhwane tech hub built and installed between April and June 2022, opened for public use from July 2022 and officially opened in November 2022.

The first phase of MCN was funded by the Internet Society, powered by Kichose Technology. The MCN aims to provide affordable internet access to community members by creating Wi-Fi hotspots, while the tech hub focuses on building digital skills, to enable active participation of the community in the digital economy. Mamaila Royal Council and the Zuri Foundation have a Memorandum of Understanding, which facilitates the creation of a digital ecosystem within the Mamaila Tribal Authority, including establishing a Community Digital Fund, which depends on the growth and sustainability of the network. The off-the-grid network is designed to operate as a fully-fledged ISP that serves the six villages of Mamaila Tribal Authority and has the potential to serve the surrounding villages in the Sekgosese cluster. However, the limitations of the licensing are a barrier to wider network coverage.

4.4 South African government approach to addressing the digital divide

The South African government has put a few measures in place to address the digital divide, though this is in the context of historically weak policy outcomes, scarce resources and limited capabilities. The National Development Plan (NDP) offers a basic digital transformation vision, which states that by 2030 "ICT will underpin the development of a dynamic and connected information society and a vibrant knowledge economy that is more inclusive and prosperous" (Presidency, 2012).

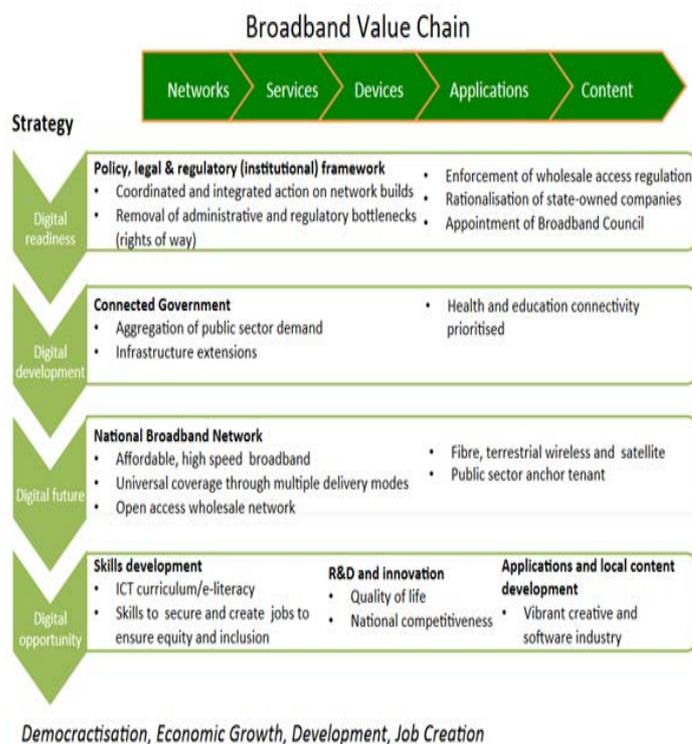---

[4] conducted under the auspices of the Wits University LINK Centre

[5] the term Mandhwane can be described in a variety of ways depending on the context of its use, we have chosen to describe it thus in the context of digital transformation

In response to the NDP, the SA Connect policy considers a four-pronged strategy and a broadband value chain to ensure that both the supply and demand factors are met (DCDT, 2013). Unquestionably, there is evidence that actors agree on the holistic approach and the foundational pillars that are critical in building the digital economy.

Figure 3

Conceptual perspective of SA Connect 10 years ago

Despite the holistic approaches documented in policy directives, allocation of resources by the government, and South Africa being ranked as a digital economy leader on the African continent (World Bank, 2019), most rural South Africans are not active participants in the digital economy. There are also conflicting views on South Africa's digital economy resilience, given the lack of digital infrastructure and energy. For instance, Marivate et al. (2021) argue that "South Africa does not meet the conditions to enable an environment for the development of the digital economy nor for embracing 3IR, let alone 4IR". There is limited evidence on how the holistic approach is translated into practical projects that contribute to unlocking the participation of rural communities in the digital economy.
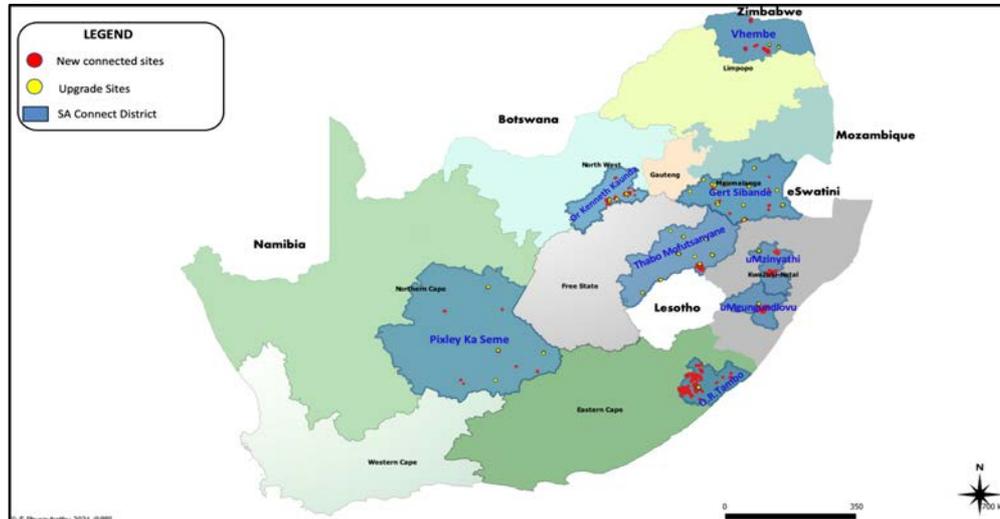
Note. From DCDT, 2013

Currently the SA Connect broadband project aims to connect 44,600 government sites in eight district municipalities, as highlighted in Figure 4, including the rollout of more than 33,000 community Wi-Fi access points (DCDT, 2020). The aim is that households would receive 10GB monthly by 2023/4 and 50GB monthly by 2025/6, with a focus on enhancing service delivery of e-health and e-education (Department of Public Works and Infrastructure, 2022).

Figure 4

Eight SA Connect Districts in Seven Provinces

Note. From DCDT, no date https://www.dcdt.gov.za/sa-connect-document.html

Government has recently allocated R3 billion in financial years 2023/24 and 2024/25 to implement phase 2 of the project for capital equipment and new fibre infrastructure in the eight district municipalities, or to lease existing fibre, in order to expand ICT networks into underserviced areas. Furthermore, mobile operators are expected to connect 18,036 schools, 3,873 health facilities and 8,241 tribal authority sites, as part of their universal service obligations (National Treasury, 2023). According to the draft next generation radio frequency spectrum policy, the South African government "deems access to data as a basic need for all citizens" (DCDT, 2022). Furthermore, the National Digital and Future Skills Strategy builds on the foundations of SA-Connect by requiring a range of stakeholders to put "mechanisms in place to foster digital skills that are necessary for economic growth, social development and cultural enrichment across all sectors of our society and economy" (DCDT, 2020).

5 Literature review: Perspectives on digital inclusion: Tech hubs, digital skilling and community networks

5.1 Sustainable and resilient institutions for creating digital artefacts

In the past three decades, telecentres were built as infrastructure for reducing the access and usage divide in rural areas (Magoro, 2014). However, the relative failure of the telecentre model has led to a shift towards a capabilities-centric approach that emphasises the design and implementation of social innovation solutions such as living labs, to facilitate inclusive and active participation in the digital economy. Various terms, such as digital hubs, innovation labs, incubators, tech hubs, and co-working spaces, refer to these social innovation solutions (Vakirayi & Van Belle, 2020). According to Van der Walt et al. (2009), a living lab is a new approach to community-driven innovation that involves knowledge sharing, collaboration, and experimentation in real-life contexts. Habiyaremye (2020) emphasises the importance of building innovation capabilities and fostering local innovations to address challenges specific to local contexts, particularly in rural areas. Despite differences in their size, methodology, focus, and models, social innovation solutions aim to disseminate knowledge, stimulate ideas, and support projects and businesses (Vakirayi & Van Belle, 2020). According to Abrahams (2020), tech hubs fit within the concept of living labs.

The African continent has seen significant expansion in tech hubs. Briter Bridges reports that there are 618 active tech hubs on the African continent, 80 of which are in South Africa (see Figure 5). Many of these are located in cities, with few or no tech hubs in rural areas. Afrilabs and Briter Bridges (Briter Bridges, 2023) define tech hubs as:

> Community and centre for learning that nurtures innovative ideas and market disruption. The hubs support creative ways of solving problems through offering on ground support and consultancy across the entirety of the startup lifecycle. These hubs serve as centers that provide support to African entrepreneurs, innovators, developers and youths. By providing physical co-working and dedicated office spaces, as well as inclusive training and business, legal and financial support, they help in fostering successful entrepreneurs who will create jobs and develop innovative African-centered solutions.

Tech hubs operate virtually and physically depending on the availability of resources, demand and community needs. Hubs generally provide Wi-Fi, office space, meeting spaces, training, coaching, mentorship, networking, opportunities for building partnerships, and assistance with startup funding, venture capital funding, and other inputs.

Figure 5

Tech Hubs in Africa
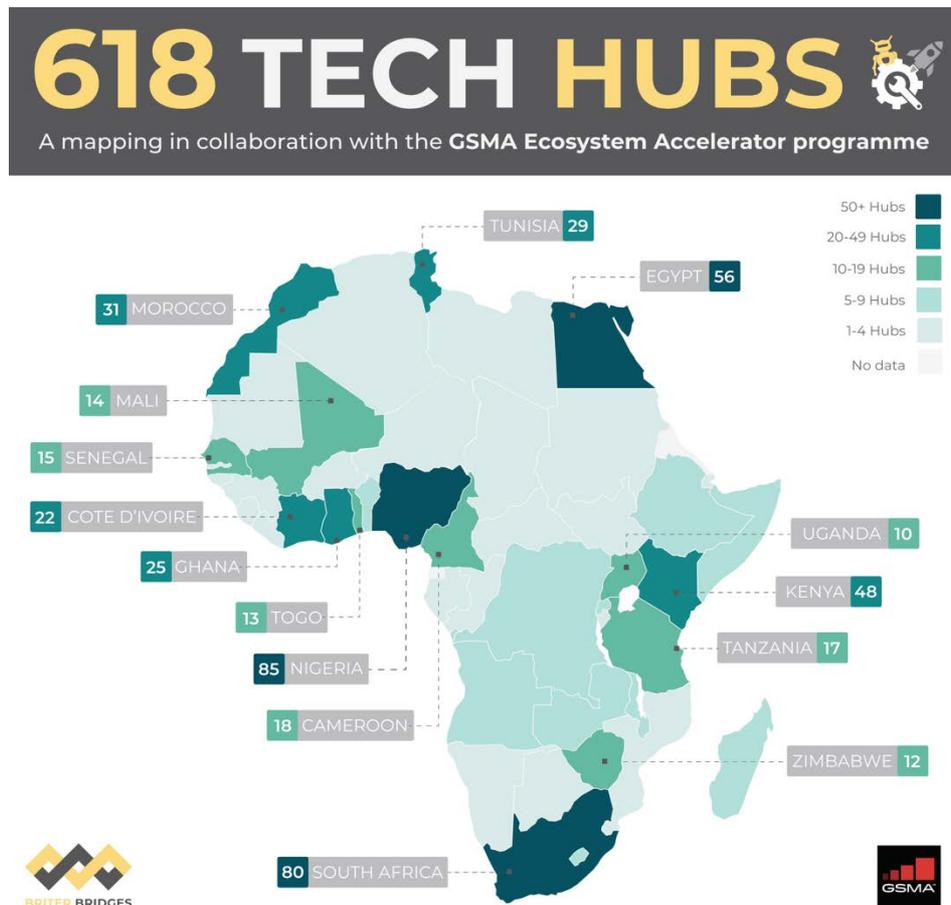
Note. Briter Bridges, 2023

The proliferation of tech hubs in Africa contributes to Africa's active participation in the digital economy. However, rural communities experience limited access to the benefits of the tech ecosystem. This exclusion from the centres of innovation hinders the capacity of rural people, specifically youth, to participate in the digital economy, thus contributing to new forms of the digital divide in Africa. To address the exclusion of rural communities in the tech hub ecosystem, community networks (CN) are emerging as holistic solutions to bridge the access and usage gaps. Community networks generally provide access to connectivity, but some community networks include access to technology and cultivate a culture of innovation in rural areas by incorporating tech hubs in their business models, for example Zenzeleni Community Network, see https://zenzeleni.net/. Mamaila village in Limpopo Province is another example of a community network incorporating a tech hub to encourage inclusive and active participation in the digital economy.

By providing opportunities for local youth to become digital entrepreneurs, rural tech hubs hope to contribute to creating local digital economies and discourage rural-urban migration. The lack of reliable and affordable rural broadband is one of the factors that contributes to rural-urban migration (Iwana et al., 2022). Mubangizi (2021) argues that while there is a consensus that migrant remittances contribute to rural development and poverty reduction, migration also weakens the economic growth of rural communities, specifically the agricultural sector. Furthermore, the migration of the economically active amongst others, "leads to the skills shortage, lack of innovative ideas and entrepreneurship in the migrant rural areas". According to Mubangizi (2021), some of the strategies to discourage rural-urban migration include the establishment of rural innovation hubs and the provision of vocational education focusing on teaching entrepreneurship and innovation knowledge. The United Nations (2022) also argues that "expanding the reach of new technologies into more remote rural areas will decrease urban-rural migration".

Government and private sector led interventions for expanding digital access and closing the digital divide in rural areas do not apply holistic approaches in programme design and implementation. According to the IGF (2022):

> For access to the Internet to make a meaningful contribution to improving people's lives locally, for strengthening national economies, and more broadly to achieving the Sustainable Development Goals (SDGs), it has to be approached holistically. While access to infrastructure is critical, without this access being inclusive, useful, sustainable and affordable, and linked to human capacity development and relevant content that can make it so, it will not achieve its positive potential. Availability of free content and services in local languages offering appropriate services and materials tailor-made on the basis of the needs of local citizens (treated not only as consumers or users, but as informed citizens in their own right) is as important as providing accessible connection.

The International Telecommunication Union (ITU) argues that traditional approaches have failed to solve the most pressing problems in rural areas and suggests "a radically different design and implementation approach", which they have branded as the smart village approach. Smart village is a "holistic and inclusive approach for rural digital transformation towards achieving the SDGs in remote and underserved communities" (ITU, 2020). Therefore, addressing the rural digital divide and economic exclusion requires a holistic and emancipatory digital transformation ecosystem supported by innovative regulatory and policy frameworks and sustainable funding models.

5.2   Holistic, capabilities-centred approach to digital skills

Active and inclusive participation of rural communities in the digital economy requires systems thinking and a holistic approach to developing digital skills and enhancing informational capabilities in this context (Gigler, 2011). The holistic approach considers digital skills development as a component of the broader digital transformation ecosystem, consisting of multiple dimensions including availability of infrastructure, digital applications, and an enabling policy, regulatory and digital leadership environment (Hanna, 2018).

Therefore, to actively participate in the digital economy, people require a combination of skills, both technical and non-technical (Matzat & Sadowski, 2012). The shift from industrial production to knowledge creation driven by globalisation and the pervasiveness of technology, requires a combination of digital and 21st-century skills that include creativity, technical and problem-solving skills (van Laar et al., 2022). The development of digital skills has a strong experiential component, made up of an inter-related process of acquisition, participation and production (Eynon & Geniets, 2016). Learning is epistemically, physically and socially situated and foregrounded on collaboration, participation and connections between people (Carvalho & Yeoman, 2018). This working paper applies the African philosophy of social learning known as Mandhwane, as a way of thinking about digital transformation in resource-constrained environments. Mandhwane is a future oriented practice that the Balobedu designed to transfer skills and knowledge to their children, before the introduction of Western education (Magoro & Bidwell, 2022). Social learning theory focuses on learning that occurs within a social context and how people learn from one another, through observation and role modelling, among other things. Mandhwane is a holistic approach to learning, encompassing sound philosophical foundations, such as communalism (group/collective learning), preparationism (role modelling), functionalism (imitation), perennialism (cultural preservation) and holisticism (multi-skilling) (Adeyemi & Adeyinka, 2003).

A capabilities lens, understood as the knowledge, skills and other capacities required for physical, intellectual, socio-cultural and political participation and self-actualisation (Sen, 2000), is adopted in framing the approach to this framework design and application, noting the power of collaborative creation and participative design, in digital innovation. In addition, three key conceptual building blocks are used to examine the capabilities for human development in the digital environment. This includes the concept of affordances, used to understand the extent to which the digital technologies artefacts facilitate particular kinds and ways of enablement or disablement (Norman, 2013). The notion of assemblages is used to consider the usage of digital technologies, as a mode of ordering heterogeneous entities, that produce new forms of organisation, behaviours, actors and realities (DeLanda, 2016). Furthermore, the construct of agency is used to consider how human agents engage or co-create with digital technologies, in the co-production of human development opportunities (Harbers, 2005).

5.3 Absence of reliable and affordable broadband connectivity and other tech inputs

The digital divide, in this context, refers to both the access divide and the usage divide. The access divide is fuelled by a lack of internet infrastructure, while the usage divide may be due to many factors that make it difficult for the community to use the available broadband connectivity. Such factors may include a lack of digital skills and unaffordability of data bundles (Van Dijk, 2020). The absence of holistic approaches (cross-cutting, interlinked approaches with collaboration of multiple stakeholders) formally designed to close the digital divide means that the reality in many countries is a series of weak, uncoordinated attempts to deploy communications infrastructure, with little or no focus on the many other layers of technology and non-tech inputs required to transition to local digitally enabled spaces. The focus on the supply of connectivity without simultaneous focus on building digital skills inhibits rural people's capability to leverage digital technologies in unlocking local digital economies. Lack of digital skills further limits connectivity benefits to affordances such as communication, social media and online transactions. Thus, reducing rural people to digital consumerism as observed by the IGF, 2022. The Alliance for Affordable Internet (A4AI) (2022) reports that about 12.8% of the South African population have access to meaningful connectivity. "Meaningful connectivity moves beyond measuring the number of people who are online to the quality of connectivity and what people do once they are connected, ie. improved income, access to education, health services" (A4AI, 2022). According to the same report, those living in urban areas are three times more likely to have meaningful connectivity than those living in rural areas.

Community networks (CNs) are emerging bottom-up, community-initiated infrastructure solutions, especially in rural areas where communities develop, manage and maintain telecommunications

infrastructure that fosters economic development (Bhattacharjee & Belur, 2021; Rich & Pather, 2020). Some of the reasons for the establishment of CNs are:

- to enable connectivity in areas that have no connectivity, or are without significant presence of telecom operators and internet service providers
- the need for affordable connectivity based on the needs of the community to share information and knowledge and
- for community empowerment and growth of rural livelihoods

Luc de Tena (2022), highlights that there are three main players in the CN ecosystem operating at the micro, meso and macro level. The micro level refers to the "community and the location where the community network operates (users, operators, etc.)". Meso level actors support the community to implement or operate the community network". The meso actors play a critical role in the delivery of connectivity, either as partners with the communities or as part of their social responsibility, although, in some instances, meso actors might apply extractivist strategies and impose their ideologies on the micro level, taking advantage of the knowledge and skills gaps that exist in the community (Luc de Tena (2022), The macro actors include government entities, the telecommunications industry, the technical community, academia, and civil society organisatios. They influence how the community network integrates into the telecommunications sector.

Amongst CNs, some provide internet connectivity, while others are offline networks. Some community networks have incorporated tech hubs or living labs to facilitate the development of the skills required for active participation in the innovation ecosystem. Unlike traditional Wireless Internet Service Providers (WISPs) who only focus on providing access to broadband connectivity, CNs strive to address local challenges. Regardless of the model applied, a common thread with CNs is their ability to respond to the needs of their local communities by integrating added services such as digital skills development, agritech, e-commerce, e-education, and provision of solar energy, amongst other things. In South Africa, we are aware of seven community networks across five provinces, namely Zenzeleni, Soweto Wireless User Group (SOWUG), Mamaila, Amadiba, Violence Prevention through Urban Upgrading (VPUU), Ocean View and Seoding.

While there is a notable interest in the creation of more CNs on the African continent, studies show that CNs are often not sustainable, mainly due to spectrum regulatory restrictions, lack of access to backhaul, and revenue and technical skills challenges (Gwaka et al. 2022). Some of the challenges include vandalism, solar system theft and sabotage by commercial internet service providers. In their report on community networks, ISOC reported that "even if the community manages to secure seed capital to cover the capital expenditure (CAPEX), creating sustainable business models to cover the recurrent payments for the backhaul connectivity becomes challenging" (ISOC, 2017). Despite the challenges, African governments recognise that CNs are part of the solution to connecting the unconnected. For instance, drawing on the lessons from Murambinda Community Network, the Zimbabwe post and telecoms regulatory authority, POTRAZ, approved the rollout of community networks for all provinces and invited application in May 2022 (Africa Press – Zimbabwe, 2022). In 2021, the Communications Authority of Kenya (CA) released the Licensing and Shared Spectrum Framework for Community Networks. According to the CA, "the scalability could be significantly increased by enhancing the current regulatory environment to lower the barriers to small-scale and social purpose or not-for-profit community network operators" (CA, 2021). In South Africa, the draft next-generation radio frequency spectrum policy for economic development supports the development of alternative infrastructure such as Wi-Fi and Community Networks (DCDT, 2021). The "alternative network infrastructure deployment will also be used to prevent data market dominance by the oligopoly and to address transformation objectives". The policy envisages that the allocation of spectrum for community use and enabling new market entrants such as Mobile Virtual Network Operators (MVNOs), Internet Service Providers (ISPs), Wireless Access/ Internet Service and Providers (WASPs/ WISPs) would increase the proliferation and sustainability of CNs, but this is highly theoretical and there is as yet no evidence for beneficial outcomes.

5.4 Big picture of digital transformation

Hanna (2020) considers the digital economy as arising in an evolutionary process that emphasises the progressive use of digital technologies throughout the sectors of the economy. According to Deloitte (2022) the digital economy "is the economic activity that results from billions of everyday online connections among people, businesses, devices, data, and processes" … enabled by the "interconnectedness of people, organizations, and machines that results from the Internet, mobile technology and the internet of things (IoT)". There is relatively broad consensus in the scholarly, industry and non-governmental literature that digital technologies are enablers of the digital economy and that a holistic digital transformation ecosystem creates favourable conditions for establishing new business models and market opportunities. Digital technologies such as "artificial intelligence (AI), fifth generation (5G) telecommunication, big data, and the internet of things (IoTs) have been continually shaping how businesses are structured, how organisations interact, and how people are motivated and organised" (Brynjolfsson & Kahin, 2002).

The digital economy discourse focuses mainly on the macro and meso level perspectives with little focus on the micro level (Cunningham & O'Reilly, 2018). Focusing on **macro-level systems** often results in missed opportunities at the **micro level**. In this paper, the micro-level digital economy refers to the digitalisation of economic activities at the community level, supported by localised digital infrastructures, digital entrepreneurship, digital skills and applications (apps).

This paper advances theoretical perspectives on a holistic approach to unlocking the local digital economy within the existing resource constraints in rural environments. Hanna's (2018) digital transformation framework argues that governments need to create enabling environments for businesses and citizens to participate actively and meaningfully in the digital economy. He identifies the following necessary components of this very large and complex ecosystem:

Enabling policies and institutions: where the state participates in synergising the whole digital transformation ecosystem. They constitute the environment that will enhance interaction among all elements of the transformation process. They promote the effective supply and use of ICT in all sectors of the economy and society. Enabling policies and institutions are essential to fostering trust in the digital economy. They are shaped by shared vision and leadership. **Human capital:** Skilled human resources are at the heart of the digital revolution, as both users and producers; they include policy, technical, and change management skills, as well as broad information and digital literacy and techno and data entrepreneurship. **ICT and data industry:** A dynamic digital industry ecosystem is necessary to adapt globally available technology solutions to local needs, manage and maintain technological infrastructure, develop local digital content and solutions, and effectively partner with global suppliers of ICT. In particular, local software development and data analytics capabilities represent core competencies that enable wide and effective domestic use of digital technologies. **Digital infrastructure**: This refers to affordable and competitive communication infrastructure, including affordable access to the Internet and ICT tools, broadband, and key platforms such as cloud computing and digital payment systems. **Digital transformation applications**: This component includes digital technology applications and complementary investments in institutional capabilities to transform key ICT-user sectors of the economy, including digital government, digital commerce and finance, and digital transformation of other priority economic sectors.

Similarly, the World Bank (2019) indicates that digital infrastructure, platforms, financial services, entrepreneurship and digital skills are foundational elements that ensure a holistic approach to the digital economy. The presence of the five elements creates an ecosystem that facilitates online transactions and stimulates the development of new business models, products and services. The digital skills element ensures the development of a tech-savvy workforce, with basic and advanced digital skills to support increased technology adoption and innovation, by developing and applying digital technologies to create new opportunities. Similarly, the AU digital transformation strategy's foundational pillars include enabling

environment, policy and regulations, digital infrastructure, digital skills and human capacity and digital innovation and entrepreneurship (AU, 2021).

Abrahams (2017) suggests that while the components of the digital ecosystem are critical for creating an enabling and sustainable environment for digital transformation, it is important to note that many features of digital ecosystems can be considered complex and adaptive systems that are multi-faceted. The multi-faceted nature of the ecosystem provides an opportunity for governments to assume multiple roles as a digital partner in facilitating a transition to the digital economy (Abrahams et al., 2022). According to Abrahams et al. (2022), the state could play the role of digital partner as a regulator (sets rules), innovator (provides funding and non-financial support to foster innovation), distributor (manager or facilitator of a digital marketplace), as an enabler (facilitates open distribution modalities to foster a culture of "produsers").

6   Evidence gathered on tech hubs, digital skills and community networks
This next section provides insight into how the Mamaila Community Network (MCN) experience illustrates a holistic approach to fostering a digital transformation ecosystem that nurtures a culture of innovation for the local digital economy.

6.1   Data collection methods
Data for this short study was collected using community surveys, observation, and three community conversations held in Roerfontein in Sekgosese cluster. The conversations included a community roundtable discussion on rural connectivity, a digital leadership workshop and a women's forum. The community roundtable discussed the status and future of rural connectivity in Sekgosese. Building on the roundtable conversation, the digital leadership workshop reflected on the changing nature of the economy in the villages in Sekgosese and its intersection with the borderless digital economy. The Women's Forum was a participative engagement, with presentations from women residing in the cluster and a guest input from Kenya. In total, 158 people responded to the Solar Community Hub (SCH) needs assessment conducted in 2021, 112 people responded to the MCN user survey conducted in 2022 and 71 people from the villages of Sekgosese participated in the workshops in August 2022. In total, data was collected from 341 informants. The Solar Community Hub is now called the Digital Mandhwane tech hub.

6.2   Highlights from the data: Digital Mandhwane tech hub and MCN case study
The sequence of phases and events presented in this short case study sets out the initial narrative, commencing with data from the community needs assessment (2021), followed the MCN user statistics analysis (March to August 2022), then data from the community user survey (October 2022), and concluding with data from the community roundtable conversation, the women's forum and the digital leadership workshop (August 2022).

The Digital Mandhwane tech hub (previously called the Mamaila Solar Community Hub) is the first tech hub established in the Sekgosese cluster, funded by Computer Aid International. The design of the SCH took into consideration the user requirements gathered through a community needs assessment survey in 2021 which indicated that 145 out of 158 respondents require a place to learn digital skills followed by 124 who wish to access online education.

The community needs assessment (Figure 6) indicates many local needs, ranging from access to gaming, business development services, and online education, to using email and Internet. A significant proportion of the respondents would like to learn how to use apps (66 out of 158) and to develop apps (75 out of 158). The largest proportion of respondents wish to learn how to use computers (145 out of 158). It is noted that the unavailability of skills development institutions influences migration away from the villages because people tend to relocate to other areas, including towns and cities, in order to access learning opportunities.

Figure 6

Community needs assessment 2021

Do you have any suggestions for computer skills training for a local training center?
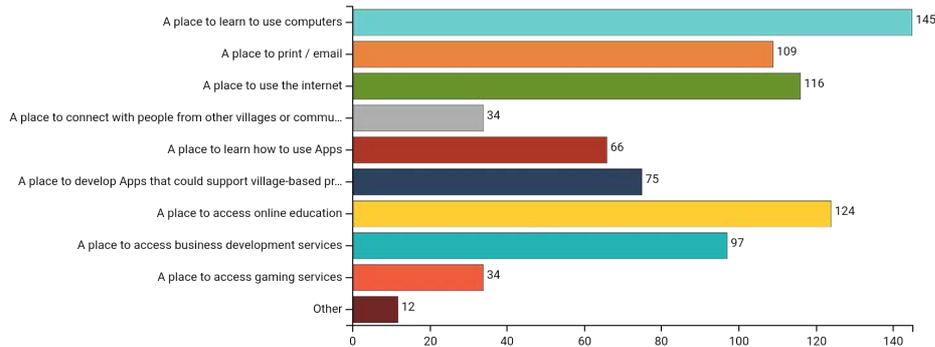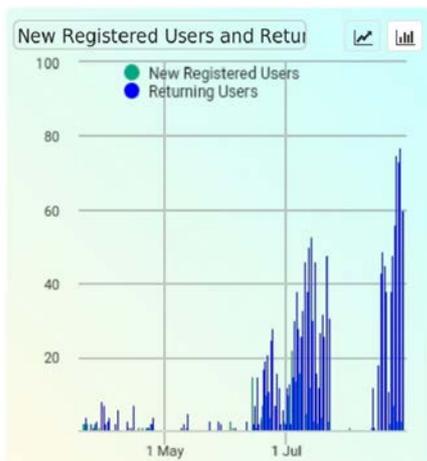

Figure 7

*Graph of User Statistics March to August 2022*

Since its official launch in March 2022, over 3000 devices have connected to MCN. In the first five months of operation, on average 70 returning users connected to MCN daily when the Wi-Fi was provided free of charge, compared to 10 to 20 users per day for paid usage (Figure 6). The diagram further indicates where MCN Wi-Fi was unavailable due to the downtime experienced at the backhaul because of loadshedding and cable theft. The tech hub has now had more than 300 users, including 75 unemployed youth who are active digital skills programme participants, as well as 35 school learners who get assistance with homework and are learning to code. Observation indicates that there is a strong emotional connection to learning and applying digital skills, noting a more powerful reaction to the digital learning space than to Wi-Fi connectivity.

Figure 8

Community User Survey October 2022
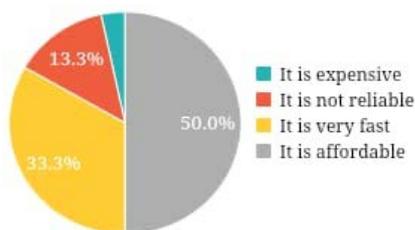
Out of 112 people who completed the user survey, 12 indicated that they have never used MCN because they had Wi-Fi at home or did not have R10 for 1Gig, Wi-Fi hotspots are far from their homes, while others used free Wi-Fi provided by some local shops. User feedback further indicates that MCN is affordable and fast. However, cable theft and load shedding at the backhaul and sabotaging the MCN tower contribute to the unreliability and unavailability of the network.

The network usage increased by 500% when Wi-Fi was provided as a free service, such as during Heritage month 2022. The uptake indicated that the community is aware of the network and that

people want to be online, provided someone is paying for their connectivity. Most people who used the free internet were daily returning users who were satisfied with the speed and reliability of the connection. Once MCN closed the free access, the uptake and usage of the network decreased.

The tech hub facilitates digital skills development through the International Computer Drivers Licence (ICDL) programme and through partnerships with entities such as .ZADNA and the LINK Centre. Although the tech hub is in its infancy, in its current format, it provides mentorship to young people and provides homework assistance to school learners. The tech hub and community network projects are shaping the narrative about the digital future of Sekgosese. Since the two projects became operational, there is a mushrooming of digital transformation interventions in the area, including reselling Wi-Fi, and teaching coding and digital literacy in schools. These initiatives contribute to conversations about digital transformation in Sekgosese and they are inputs into the creation of an ecosystem that cultivates a culture of learning and local innovation, which encourages community members to acquire digital skills and explore the digitalisation of communal and business processes.

Figure 9

Spanish Students Training Local Youth in Computer Networking Skills, Digital Mandhwane Tech Hub, Roerfontein August 2022

Note. Tech hub users extending their existing range of digital skills

6.3 Community Roundtable conversation: Challenges identified
The Roundtable participants discussed the state and future of rural connectivity in Sekgosese, their digital aspirations and opportunities for the digitalisation of the local economic sector.

The Roundtable discussions on network availability revealed community dissatisfaction with the quality of mobile service, due to what participants expressed as extractive conduct and unmet expectations, given high prices relative to income and unreliable Internet connectivity. According to the participants, there is poor mobile signal for all mobile operators. Loadshedding worsens the challenge because the mobile towers depend on power from Eskom, they do not have backup generators and solar systems. Unlike in urban areas, mobile operators in Sekgosese do not have backup towers. Therefore, if the power is down, there is a total shutdown of telecommunication services including Wi-Fi connectivity. Participants expressed how poor connectivity impacts emergency services, police response to crime scenes and the education sector.

The population density of Sekgosese, like many other rural areas, does not meet the investment requirements of the mobile operators, which are based on average revenue per user (ARPU) and profit margins. Therefore, communities must become solution-makers, reducing their dependency on mobile operators.

Participants understand that there are different technologies for connecting to the Internet and would like access to fibre. The discussion highlighted that while it is important for the community to own CNs, it is equally important to understand that telecommunications is an ecosystem that requires all actors to work together, as there is no single entity that can bridge the digital divide alone.

Figure 10

Roundtable Community Conversation, Viorell Conference Centre, Roerfontein, August 2022

A few key statements were made during the Roundtable. From the perspective of poor network coverage and load-shedding, the following statements are important:

> "I am not sure if you noticed, but if you use mobile data in this area, and Eskom decided to be Eskom, you don't have connectivity anymore".

> "We also have the right to benefit from 5G. We would like to participate in the discussion, so we don't become excluded".

> "School children around this area received tablets for their learning programme. Loadshedding and less internet will affect the progress of e-learning. This initiative is important for the e-learning programme. In our area, connectivity is a double trouble issue because of loadshedding, affecting our children and us. We hope to find a quick solution towards this".

From the perspective of physical network security, vandalism and theft are a challenge. The theft of batteries, generators and transformers contributes to the unavailability of the network. In July 2022, Sekgosese did not have access to the MTN network for a month due to the theft of the transformer. The unavailability of the network affected many businesses and communities, requiring them to buy new sim

cards from another operator. The participants criticised the lack of adequate, precautionary security measures to safeguard the infrastructure. According to some participants, mobile operators should create jobs by hiring local people to guard the infrastructure.

> "On battery theft, we cannot blame the community. We must create jobs for security service providers to guard the infrastructure. Operators are not investing in security, but they cry for the stolen batteries. It is their responsibility to secure their property".

> "Maintenance of the resources is important because even if we can have the infrastructure, fibre gets stolen. So if there is no maintenance budget, we will have an issue. There must be a budget for that. And I heard some speakers saying that we have aerials and towers that get stolen. I believe those towers, when they were installed, there was a budget for such risks to cater for repairs. Maybe we need to check who are the people who installed it and what is the O&M plan".

From the perspective of advocacy for rural connectivity, participants indicated that they would like to conduct advocacy campaigns to influence policymakers and regulators on improving rural connectivity and hold the government accountable for their promises to bridge the digital divide. It was agreed that such advocacy campaigns require participation by all stakeholders, especially local government councillors because they have potential influence and they play a role in advancing the local digital economy. It was argued that communities must organise themselves and submit their issues to the relevant authorities, including enquiries about timeframes and budgets allocated for rural connectivity. Such campaigns require consistency, long-term strategies and participation by many local stakeholders.

> "The telecommunications sector is extractive and monopolistic. Therefore, it is important for ordinary citizens to join hands in advocating for access to spectrum to enable the deployment of community networks".

> "How do we rally behind the campaign? I remember a year ago there was a campaign of data must fall by Gereth and TBo Touch. It came with vigorous energy and disappeared".

From the perspective of community-led interventions, community networks contribute to bridging the digital divide and creating opportunities for digital entrepreneurship, affordable services, local content creation and preservation of the indigenous cultural knowledge systems. As such, it is important for initiatives like Mamaila Community Network to grow and develop capabilities to negotiate with operators in the area. In Sekgosese, tribalism, sabotage and project hijacking are some risks that could inhibit the growth of community-led interventions. In cases where communities are trying to connect themselves, they may be faced with anti-competitive behaviour by commercial ISPs and they are not protected against such conduct by regulation. Participants agreed that, despite the identified risks, the growth and long-term sustainability of CNs could enable the Wi-Fi revenue to circulate back into future community connectivity projects.

6.5   Womens' Forum conversation: Local economy value chain, migration and "women in community networks"

The economy of Sekgosese represents an environment that is enabled by the values of self-determination, learning by doing and crowdsourcing/crowdfunding, driven by local people, particularly women.

Figure 11

Key Economic Sectors in Sekgosese Cluster

There is a rapid construction sector enabled by the localised financial sector, notably the stokvel savings clubs. The newly developed Mamaila Mall contributes to the growth of the retail sector in Sekgosese. Agriculture remains one of the main economic activities, with almost every household participating in subsistence farming. In Sekgosese, the impact of migration has created opportunities for women to lead the economy. However, many women are currently excluded from participating in digital transformation activities, due to limited affordability with respect to connectivity and due to low levels of digital skills and capabilities. Women participating in the forum were keen to learn new skills, to use social media for micro-business and to benefit from rural connectivity in as many ways as possible.

6.6   Digital leadership workshop: Digitalising the Sekgosese economy, a role for the tech hub

The existing community infrastructure (MCN and the tech hub) are enablers for a Sekgosese digital transformation strategy, focusing on digitalising the local economy. The participants discussed the opportunity to develop apps for local businesses where customers can initiate the procurement process, rate the service provided, and refer new clients using the apps. Participants said local people would also like to advertise their skills and initiate a bartering system. The tech hub should analyse the skills applied and quantify the local market value of the service. Community members would like to better understand the costing, pricing and value of the services exchanged. Another app could use data analytics to visualise the money and other resources circulating in the village. More advanced functionalities could include value-added services and premium services to business persons at a fee, as a means to sustaining the tech hub. Highly rated businesses could earn points that qualify them for discounted services that the tech hub provides. Other possible apps include e-heritage, homework/education apps and agritech apps.

Some participants who attended the workshop had basic digital and coding skills, advanced design and graphic design skills, research and content development skills, agritech and e-agriculture skills, and ISP technical skills. For example, Joey Wa Rabapane is the founder of Joey Media Group, which produces online content distributed through a website, Facebook, YouTube, WhatsApp and online radio. The company provides advertising services to Sekgosese businesses and has over 35,000 followers.

Figure 12

Community Conversations August 2022

Mahlatse Rantlhakgwa, the founder of Bhedhengwa Creations, a graphic design house whose service offerings include logo design, banners, and billboards says that digital technologies enabled him to access design vectors online. He uses the Internet to research design trends and copyright infringement management.

Many of those who have digital skills learned them by watching YouTube videos. Two participants indicated that they have basic coding skills and knowledge learned through the Vodacom Foundation and WeThinkCode based in Johannesburg https://www.wethinkcode.co.za/.

A further two participants received accredited ISP training as part of the Zenzeleni School of Community Networks.

The conversations indicated that though some people have basic digital skills, most people in Sekgosese do not have relevant skills except for social media usage. Therefore, the digital transformation strategy would need to focus on building foundational digital skills training, delivered through ICDL and other foundational and advanced digital skills programmes, including coding, data analytics, business development, design and communication. Such skills can be applied to creating community-oriented solutions, promote local innovation and create 21st century jobs.

7 Data analysis: Using digital skills and the internet to grow the local economy by creating entrepreneurial opportunities while protecting the infrastructure

7.1 Policy and regulatory environment

The emergence of new CNs in South Africa indicates potential to expand the CN model beyond the limited number of start up CNs. However, lessons learned in this study indicate the existence of tensions between mobile operators, commercial ISPs, CNs and some community members who understand the telecommunications sector purely as a money-making industry. These tensions, as highlighted by the residents of Sekgosese, can inhibit efforts to close the digital divide, regardless of who is leading the interventions. CNs operate in unfavourable conditions, experiencing deliberate efforts to inhibit growth through sabotage and anti-competitive behaviour. The provision of funding and spectrum is currently inadequate to facilitate the expansion and sustainability of CNs. Hence, there is a need for a policy and regulatory environment that understands community owned CNs as complementary interventions that should have regulatory support to co-exist with commercial ISPs. A regulatory framework and decisions are needed that will enable CNs to operate without fear of victimisation and sabotage by commercial interests.

The Private Electronic Communications Network (PECN) licence exemptions and the Electronic Communication Services (ECS) licence exemptions relevant to deploying and operating CN infrastructure contributes to complex negative social relations between the villages who access and the villages who don't. Lessons from Mamaila indicate that communities see themselves as subscribers, not as active partners, hence the protection of CN infrastructure is not viewed as the responsibility of the community.

The lack of reliable energy weakens the sustainability of CNs. While solar energy and other off-grid solutions provide alternative energy, the interconnectedness of the connectivity infrastructure affects the reliability of services even for solar-powered networks like MCN. The unreliability creates inconsistency in providing the service because, unlike in urban areas, rural areas do not have backup towers and CNs like MCN cannot afford backup internet links. Eventually, the unreliability of the services leads to tension as users are not guaranteed the service they paid for.

7.2   A new approach needed to universality for a new digital divide

As evidenced in the literature and in the experience of MCN, CNs struggle to generate sufficient revenue to meet their day-to-day operational expenses. Some community members are not always able or willing to pay for Wi-Fi for affordability reasons, while for others the access points are far from their homes. The need for rural communities to be online and the financial constraints faced by the CNs and users requires regulators and policymakers to design innovative funding models to subsidise access to communities, similarly to the provision of free basic electricity and water. The approach to universality must be "beyond access", as presented in Figure 13 below.

Figure 13

New Regulatory Thinking Needed For Funding that Goes Beyond Access
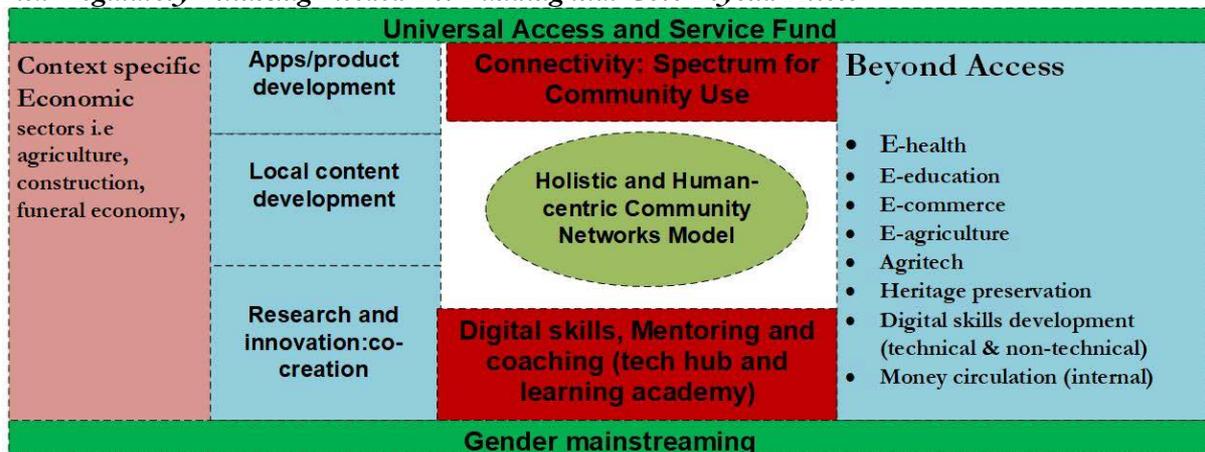
Connectivity serves as the backbone for the digital economy, digital skills and apps development, enabling access to online learning materials, local hosting of digital apps and interaction with tech innovators beyond the targeted areas. A capabilities-centric model, incorporating the multiple dimensions set out in Figure 13, would promote better building of local digital economies over the long-term. Capacity building to transfer technical skills to the local communities to operate as local ISPs, network and solar technicians, while regulation could require commercial ISPs to compete fairly with community networks as a condition of the commercial licence.

7.3   Digital experimentation and digital innovation

The need for local solutions and local digital economies requires us to build our own content, manage our own cyber risk and promote ownership in the digital era. We need to build our own knowledge, our own

capabilities, create our own digital innovations and share them, hence the need to understand the value, strengths and weaknesses of tech hubs. While some tech hubs are in an experimental phase, many tech hubs in Africa have been existence for close to two decades and we can learn from them. Too many rural villages do not appear on the map of the digital economy, they are invisible. Resources are needed for local communities to experiment, and tech hubs can enable experimentation, as a means to innovation.

7.4   Digital skills, mentoring, and coaching: Tech hub and learning academy

The CN ecosystem facilitates the creation of digital value chains and digital entrepreneurship in the local communities. Observations from the community conversations indicate that despite the lack of advanced digital skills, youth are engaging with agritech applications, coding and digital content production, digital marketing, e-commerce, graphic design and network management. A localised CN model linked to centres of knowledge production can unlock greater local participation of rural communities and contribute towards building strong local capabilities in software innovation, locally framed research and knowledge exchange. For example, in the case of Sekgosese, a South African university plays an active role in conducting research that is relevant to the design of a local digital transformation strategy. Young people in Sekgosese could conduct important research assignments, such as the assessment of digital skills capabilities and gaps in the community, as the basis for designing an annual digital skills training calendar. As envisaged in the National Digital and Future Skills Strategy South Africa, integrating the tech hub/learning academy component into the CN model would create opportunities for young people to acquire software development skills, technology use skills, critical thinking and digital entrepreneurship skills. In-demand digital skills in rural areas relate to cloud hosting skills, apps and product development, local content development and other forms of localised small-scale digital innovation are a great need in rural areas.

A holistic, capabilities-centric model for CNs should incorporate mentoring and coaching, side by side with digital skills development. Mentoring and coaching is essential to ensure that the beneficiaries are supported with the tools to apply their knowledge by establishing digital services to support the community's digital ecosystem. At the same time, it positions the community to become active participants in the national digital economy and innovation systems.

Local content is one of the critical inputs into the local digital economy, as it enables the development of products and services that respond to local challenges while identifying new opportunities. The localised model and the expansion of digital services/products can inspire young people to become digital entrepreneurs, creating opportunities for money to circulate back into the local economy, while also contributing to the preservation of the cultural heritage, indigenous knowledge systems. This requires that, after an initial phase of building digital skills, more advanced work can follow, training tech hub users on Internet of Things (IoT), 3D-printers and scanners, artificial intelligence (AI), blockchain and other technologies, to commence the long journey towards building a cluster of smart villages. The focus should be on apps that support the local economic sectors. For instance, in the case of Sekgosese, there are opportunities for agritech, construction, security, funeral economy and financial services.

7.5   Gender mainstreaming

Women and girl children remain offline even when connectivity is provided as a free service. There are many factors that contribute to this reality. Observations from the community conversations is that while Wi-Fi hotspots bridge the access divide, there must be efforts to take Wi-Fi to where women and girl children spend most of their time, requiring street level access points. Currently, the location of the Wi-Fi hotspots is not sufficiently close for everyone. The distance between the home or business zones where women sell their products and Wi-Fi access points means that women and girl children have walk to the hotspots, which reduces selling time and which raises safety concerns.

8 Concluding remarks and recommendations: Key messages

This paper provides empirical evidence that favours a holistic approach to community-based, community-owned CNs, in ways that contribute to the creation of enabling environments with the potential to unlock digitally enabled development, nurture a culture of innovation and digital entrepreneurship. For the purposes of this research, digitally enabled development refers to the revolutionary nature of human-technological interaction, as against the technological determinism typically associated with the theory and discourse of ICT4D and the 4th industrial revolution. An epistemological break from deterministic theories is needed, to draw attention to the capabilities at play. Furthermore, developing countries need a systematic approach to conceptualising digitally enabled development, in a manner that recognises the ways in which human agency and technological artefacts are co-constitutive of developmental capabilities (Braidotti, 2013).

8.1 Digital leadership for the micro level digital economy

The Sekgosese cluster case study provides insights into how a community-led initiative that considered all elements of the digital transformation framework ecosystem could commence the process of unlocking local digital economies in resource-constrained environments. The case study demonstrates that people in rural areas have digital assets that intersect with the global digital economy ecosystem, although mainly in the position of consumers. The case study demonstrates the digital aspirations of virtual citizens who are redefining the village and shaping the emergence of the smart village.

Community led digital transformation strategies are a critical part of the digital economy ecosystem. They have the potential to build local human capabilities, research and digitally enabled practices and processes (financial/agriculture, entertainment/creative economy) to feed into local innovation. Therefore, instead of seeing communities only at the periphery of digital economy, as passive consumers, we need to engage in a mindset shift that place rural communities inside the digital economy.

8.2 A holistic, capabilities-centered local and district CN model

Lessons from the Sekgosese cluster study indicate the need for a holistic, capabilities-centered CN ownership model to facilitate the creation of favourable conditions to unlock the local digital economy. The community-based-owned CNs and the commercial ISPs need transformative and collaborative approaches to address the access and usage divide and for both to remain financially viable. For instance, while some community owned CNs apply a holistic approach in addressing the supply and demand factors, the lack of technical skills and revenue generation weakens the daily technical operations of the infrastructure. The lack of regulatory knowledge, expertise in ISP operations, and business processes weakens the potential of CNs to scale/expand. The knowledge gaps create a dependency on other actors.

In contrast to community-owned networks, commercial ISPs do not have any obligations to address the beyond-access/usage divide because of their focus on profit. Commercial ISPs do not provide digital skills nor ensure effective and meaningful connectivity usage. The inability of community owned CNs to remain technically and financially sustainable and the inability of the commercial ISPs to stimulate the local digital economy and build digital skills for the local communities calls for a rethink of universal access and service strategies.

Given the licence exemption limitations for community networks in expanding connectivity to more villages, we propose a District CN approach that enables the deployment of connectivity infrastructure to cover clusters of villages irrespective of their tribal authority or municipal jurisdictions. The cluster approach could be linked to the SA Connect district focused implementation strategy, district development model and the Presidential Employment Stimulus (PES). The cluster approach could organise young people into formal structures and provide capacity-building interventions, including ISP technical and business operations skills.

8.3 Capacity building and advocacy

Specific aspects of capacity building have been highlighted in this study, in particular the importance of recruiting local people to install, maintain and use the facilities, and then spread the word about the value to the broader community. These technical skills must be constantly updated and new additions to the active technical teams will be needed, as those already active are likely to move on soon to new opportunities. The new universal service funding model must set aside specific funding for supporting community network infrastructure and capacity building for community network maintenance. In addition, there is a need for digital leadership capacity development at the local level.

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