Mud and Cell Phones:
Nonformal Learning Networks in Rural Kenya

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

Despite global efforts to achieve universal education, millions of people still lack access to learning, with a high concentration in sub-Saharan African countries. Like many rural communities around the world, Kenya's rural population experiences challenges in accessing resources and opportunities equal to those living in urban centers. With 74% of its population living in rural areas,[1] research into providing accessible education and access to information and communication technologies (ICTs) is a priority for both the Kenyan government and the communities where these challenges exist.

In response to these challenges, recent critical developments in communication and sustainable energy have enabled remote communities to gain greater access to distant services. In cases where banks and electrical power are not available, off-grid portable solar panels and cell phone banking through the locally developed M-Pesa technology have been remarkably successful. If cell phones can stand in for banks, can other technologies increase access to education for people in remote locations? Could a learning network using ICT paired with essential services such as water and sanitation, support an existing education system which is otherwise not reaching all people?

Scholars such as Ivan Illich, Paulo Freire, Philip Coombs and Wangari Maathai believe universal education is not possible through formal education in the present style of school institutions. Their theories propose strong arguments which support nonformal learning outside of the classroom. Coombs especially argues that nonformal learning is key to rural development where primary schooling is not available due to geographic or socio-economic barriers.

The Kenyan government, as outlined in their Vision 2030 and National ICT Master Plan, believes ICT plays a critical role within many sectors, including education, health and employment. With goals to provide ICT infrastructure in all schools and health centres,[2] and provisions to build innovation hubs throughout each of the 47 counties,[3] architecture plays a significant role in how these spaces of ICT and nonformal learning are designed and allocated throughout rural communities.

This thesis criticizes current models of rural connectivity which fail to acknowledge the strengths and diverse cultures of the communities in which they are inserted. Instead, it recognizes the importance and value of local knowledge, culture, and traditional forms of knowledge exchange and argues for a design process which is in fact rooted in the unique culture and knowledge of each location. This thesis contains a range of work influenced by two visits to Kenya, the first in 2014 for two weeks, and the second in 2017 for one month within the case study site of the thesis.

Designed from the perspective of a foreigner, this thesis emphasizes the importance of an inclusive design process—a process which acknowledges the contributions of many individuals, existing community groups and local experts. The proposal is largely influenced by conversations that took place within the community and takes the form of a network of scalable nodes rooted in cultural tradition, nonformal learning, ICT and essential resources. The placement of these nodes is informed by existing gathering spaces and contains different combinations of architectural program that use ICT as a tool for nonformal learning. Mud and Cell Phones: Nonformal Learning Networks in Rural Kenya proposes a dynamic network, not fixed in any given moment of time, able to expand or contract to suit the changing needs of each community it serves.

1 "Rural population (% of total population)," The World Bank Data, accessed November 4, 2017, https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS.

2 Ministry of Information, Communications and Technology, "National ICT Master Plan 2014-2017," presented during DMB Workshop on e-Participation from 13-16 January 2015 (Nairobi: United Nations Public Administration Network, 2015), 7.

3 Ministry of Information, Communications and Technology, "Constituency Innovation Hubs Agreement," (Nairobi: Ministry of Information, Communications and Technology, 2017), 2.

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For many students, putting yourself through school can be a financial feat. With this in mind, I'd like to thank the people who made it possible for me to focus more on research and less on finances. The scholarships I received allowed for my one-month visit to Kenya and made this thesis so much richer as a result.

Thank you to my friends and family for your constant support in more ways than you know. You have always had my back. Thank you to my partner Isaac who has been incredibly patient and supportive.

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Dedicated to the people of Kenya and to those who see the value in equal learning opportunities.

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INTRODUCTION

Four years ago, I traveled to a remote community in Kenya's Rift Valley. Sleeping in a mud hut, collecting water from a nearby spring, and cooking food over a fire gave me a small glimpse of how people live in this rural community in Nandi County. What inspired this thesis, was the fact that most people are living in wattle and daub huts and using cell phones to transfer money using the locally developed M-Pesa technology. Using a basic text messaging platform, people in rural communities without access to banks or internet can send money to others in their community and afar. I thought, if cell phones can stand in for banks, could other technology in rural communities help to increase access to education—a continuous challenge for many rural communities.

Information and Communication Technology (ICT) is priority of the Kenyan government and is a major component to development within the country. Kenya is striving to be Africa's leader in the technology sector and has created the Ministry of ICT and ICT Authority to facilitate growth and implementation of ICT throughout the country's 47 counties. As defined within the Kenya 2030 Vision and ICT Master Plan, Kenya aims to have ICT within 100% of schools and health centers,[4] and provide internet hotspots in urban areas, bus stations and other public spaces.[5] But what about the 74% of Kenyans living in rural areas?[6]

This thesis focuses on bringing ICT networks to these rural areas in a way which builds upon the existing socio-economic networks within the community. The ICT does not act as the sole driver of any of the designed spaces within the proposal. Instead, the technology is inserted into architectural program which is grounded in existing cultural practices, grassroots innovation, the creation of microeconomies, and existing strengths within the community. This technology and the proposed nonformal learning spaces will provide educational opportunities to those who can not attend school due to geographic location in relation to schools, or socio-economic barriers, and offers a more localized type of education.

Nonformal learning supported by Information and Communication Technology (ICT) can help global efforts to achieve Universal Education—something which is far from being accomplished. A belief that Universal Education can be achieved through formal schooling is a concept that is challenged in this thesis. As supported by the research in subsequent sections of this book, ICT can promote nonformal learning outside of the formal classroom—a space which is currently not accessible to all people.

4 Ministry of Information, Communications and Technology, "National ICT Master Plan 2014-2017," 7.

5 Ibid., 11.

6 "Rural population (% of total population)," The World Bank Data.

So what does "Universal Education" mean? Does it mean attending school? Does it discount lessons learned through oral storytelling or attending community workshops? In Canada, we are finally beginning to recognize the credibility of information which has been passed down through generations of Indigenous people, and this is not dissimilar to how information and learning was in Kenya in the pre-colonial era. The current formal education system in Kenya uses the British school system with English as the primary language. Elders in the community worry youth are becoming disconnected to their cultural traditions and local language. This thesis looks beyond the formal education system and acts to incorporate other types of nonformal learning using both traditional forms of knowledge exchange and Information and Communication Technology as a tool for learning.

The decisions made in this thesis are largely based on the hundreds of conversations I had in the community during my one month visit this past May. I spoke with mothers, grandmothers, the council of elders, local government, teachers, and many others. It has also been influenced by Kenya's 2030 Vision, and other government documents outlining goals the country has in ICT and educational development.

In the book Spatial agency, authors Awan, Schneider and Till describe Spatial Agency as a process in which local people, not just architects and designers, are engaged in the process of design. They describe "Spatial Agents" as designers who effect change "through the *empowerment* of others, allowing them to engage in their spatial environments in ways previously unknown or unavailable to them, opening up new freedoms and potentials as a result of reconfigured social space."[7]
They also state,

> **"The standard histories of architecture focus almost exclusively on the guiding hand of the individual architect, and in this excludes the multiple voices and actions of others."**[8]

It's exactly that which I have tried so hard to avoid throughout my research. Many of my drawings are the result of on-site observations I made, but I acknowledge my bias within this community given that I'm an outsider. I've reviewed the thesis several times with a local community member in Kenya who was my fixer, and a few members of the Kenyan government.

The thesis is a design of a nonformal learning network using ICT and aims to support existing educational infrastructure which is not currently reaching all people due to geographic or socio-economic barriers.

7 Nishat Awan, Tatjana Schneider, and Jeremy Till, *Spatial Agency Other Ways of Doing Architecture* (London: Routledge, 2011), 32.

8 Ibid., 28.

Figure 1.1 [Top Right]
Mud and Wattle Hut.

Many people live in houses similar to traditional Nandi huts which are made of mud and wattle with thatch roofs. More common today, are mud huts with corrugated metal roofing held on by nails or heavy stones.

Figure 1.2 [Bottom Right]
M-Pesa.

A basic Nokia cell phone previews a money transfer which will be sent via SMS text messaging. This simple platform called M-Pesa enables all cell phone users with an account to bank and transfer money between users. The Kenyan-born company is incredibly successful in rural areas where banks are not availbable.

LEARNING OUTSIDE OF THE CLASSROOM

Researchers such as Ivan Illich, Paulo Freire and Philip Coombs challenge ideas around formal education. Illich believes education for all is not possible through formal education in the present style of school institutions.[9] In "Deschooling Society," Illich writes,

> **"that the inverse of school is possible: that we can depend on self-motivated learning instead of employing teachers to bribe or compel the student to find the time and the will to learn; that we can provide the learner with new links to the world instead of continuing to funnel all educational programs through the teacher."**[10]

These "new links" Illich describes correspond to the nonformal learning Philip Coombs discusses in his report, "New Paths to Learning for Rural Children and Youth." He concludes that formal schooling can not successfully achieve universal education, especially in rural communities where a shortage of schools exists,[11] or where access is limited due to poverty or proximity to the schools. Coombs clearly defines the **three types of learning**, stressing the importance of nonformal education in rural communities such as the one this thesis examines.[12]

Informal education

"The truly lifelong process" of acquiring "attitudes, values, skills and knowledge from daily experience and the educative influences and resources in his or her environment—from family and neighbours, from work and play, from the marketplace, the library and the mass media."[13]

Formal education

"The hierarchically structured, chronologically graded 'educational system,' running from primary school" through to university and including "specialized programs and institutions for full-time technical and professional training."[14]

Nonformal education

"Any organized educational activity outside the established formal system—whether operating separately or as an important feature of some broader activity—that is intended to serve identifiable learning clienteles and learning objectives."[15]

9 Ivan Illich, *Deschooling Society* (New York: Marion Boyars, 2002), vii.

10 Ibid., 73.

11 Philip Coombs et al., *New Paths to Learning for Rural Children and Youth* (New York: International Council for Educational Development, 1973), 16.

12 Ibid., 10-13.

13 Ibid.

14 Ibid.

15 Ibid.

Figure 1.3 [Top]
Formal Education.

Written examinations are one of the most common methods of evaluating one's knowledge in formal education. The photo shows an exam being taken in China. Written examinations are also the standard for testing students' knowledge within Kenyan schools.

Information and Communication Technology (ICT) can be a tool for nonformal learning or act as a "new link" to learning as Illich suggests. In conjunction with Kenya's goals for implementing ICT throughout the country, the technology could be developed to support nonformal learning initiatives which Coombs argues are integral to rural communities. Illich predicted the use of technology as a tool for learning in "Deschooling Society" by writing,

"We need research on the possible use of technology to create institutions which serve personal, creative, and autonomous interaction and the emergence of values which cannot be substantially controlled by technocrats."[16]

The beauty of ICT and the internet is the freedom to choose what information to access or upload. With a connection to the internet, people can access information they feel is relevant to them and the needs of their community. ICT acts as a tool for learning directly through its use, but it also creates a way of organizing events within these spaces of nonformal learning. Illich writes,

"The most radical alternative to school would be a network or service which gave each [person] the same opportunity to share [their] current concern with others motivated by the same concern."[17]

16 Illich, *Deschooling Society*, 2.

17 Ibid., 19.

He goes on to describe individuals using technology as a communication tool so people with similar interests can meet up at a specific place and discuss their common interests and learn from and with each other.[18]

One can relate this idea to the theories in Paulo Freire's book, "Pedagogy of the Oppressed." Freire explores the societal relationship between the "oppressor" and the "oppressed" and describes formal education as a "banking" approach to learning. He criticizes the oppressive colonizer for setting up a type of education which has resulted in the dehumanization of teachers and students by oppressive governments and curriculum.[19] Freire proposes a remaking of pedagogy:

"A pedagogy which must be forged *with*, not *for*, the oppressed (whether individuals or peoples) in the incessant struggle to regain their humanity."[20]

It's important to note Freire's language here. "Forged *with*, not *for*." In any design method, whether it be a building or network throughout a community, it is important to design with communities rather than for them, especially in contexts different from your own. This is an approach which gives agency to local people by acknowledging their expertise in the place they live. No people understand the place better than those who have lived there.

By using ICT as a tool for nonformal learning, the "oppressed" can access information and learning opportunities of their choosing, and at any time. No curriculum needs to be prescribed, nor does learning need to occur during limiting school hours. ICT, as Illich predicted, can act as a tool for self-motivated learning and support local group initiatives relevant to the place where this learning and development occurs. This method of learning would theoretically suit the criteria of the new pedagogy Freire describes in book, "Pedagogy of the Oppressed."

ICT in these cases is gateway for accessing information or supporting the spaces where nonformal learning takes place. But the technology also introduces a virtual space of learning and development. Kenyan Sheena Magenya discusses online spaces within post-colonial Africa where "...women can speak out and add their voices to conversations that have too long been dominated by Western anthropologists and scientists."[21] She points out the important freedoms and rights the internet gives suppressed communities which is why bringing internet and ICT to urban *and* rural communities is so important.

The nonformal learning network proposed in this thesis uses ICT infrastructure to bring information and internet services to the rural community. In addition to the ICT, the network carefully considers the physical spaces where gathering occurs. The designed spaces continue to function if the ICT fails because they are grounded in existing local practices and celebrate the unique culture and microeconomies of that place. The architecture is built upon an understanding of daily life and acts as catalysts to economic and social development. This understanding of the community is gained through visits to Kenya, meetings with many different groups of local peoples, and through research which is rooted in successes that grew out of Kenya itself.

Kenyan Wangari Maathai is the first African woman to win the Nobel Peace Prize. In her book "Unbowed," she describes her experiences in the rural community where she grew up. She speaks about the oral storytelling culture and teaching methods in Kenyan communities before the arrival of Christian missionaries, and recounts on what colonization took from her community. She writes,

"The Kikuyu[22] stories served to entertain, educate, and encourage creativity in children. It was an effective informal education." The "stories reflected my environment and the values of my people; they were preparing me for a life in my community."[23]

Maathai goes on to describe the stories that were read to her in school such as "Cinderella:" a story Westerners told their children which was not meaningful or relevant in her life.[24] Maathai says, "the art of storytelling around a fire was an essential dimension of life in the countryside," and was much more meaningful and useful.[25]

Local people need to be given more

18 Ibid.

19 Paulo Freire, *Pedagogy of the Oppressed* (New York: The Continuum International Publishing Group, 2005).

20 Freire, *Pedagogy of the Oppressed*, 48.

21 Sheena G. Magenya, "Women in Africa and Expression on the Internet," GenderIT.org, January 15, 2015, https://www.genderit.org/feminist-talk/women-africa-and-expression-internet.

22 The Kikuyu is the ethnic group of people Wangari Maathai comes from.

23 Wangari Maathai, *Unbowed* (Toronto: Random House, 2007), 50.

24 Ibid.

25 Ibid., 49.

Figure 1.4 [Top]
Wangari Maathai.

She is the first African woman and the first environmentalist to win the Nobel Peace Prize. In her book, Unbowed, she describes daily life in her Kikuyu community and speaks to cultural traditions of education prior to formal schools run by Christian missionaries.

agency in development for this very reason that vernacular practices of learning and design often go unnoticed or are disregarded. Philip Coombs acknowledges this in his report:

> **"These indigenous learning systems are generally overlooked by Western-oriented educational and training specialists, mainly because they do not fit modern conceptions of educational or training programmes."**[26]

Coombs believes these "indigenous learning systems play an important role in the social and economic life" of rural communities.[27] The design proposal is rooted within these nonformal learning methods Maathai and Coombs speak of, but most importantly, the network celebrates the practices and culture that exist in the rural community of Nandi County.

During my past visit to Kenya, I discussed these traditions and learning methods with the Nandi Council of Elders. We spoke of Kenya's goals for creating ICT hubs and worked together to create an architectural program they felt was important in the development of their rural communities and ICT hubs. A full set of these abstracted architectural components are documented within a matrix located in the Appendix. ▬

26 Coombs, *New Paths to Learning*, 42.

27 Ibid..

ATTEMPTS TO CONNECT

Current Broadband

The following section illustrates current internet infrastructure within Kenya and discusses a few precedents which bring internet to rural or isolated communities. These precedents are criticized and compared with other infrastructural projects which fail to engage local people. The approach to designing a network and the associated spaces is critical. With such a variety of cultures and geography, each community should be approached differently, and local people utilized for their inherent knowledge of a place. The spatiality of technology and the role of existing gathering spaces is discussed in regards to the design method used in the thesis.

Information and Communication Technology (ICT) requires a connection to the internet. If ICT, as discussed previously, is to be used as a tool for nonformal learning in rural communities, it must be made accessible infrastructurally, but also in terms of its affordability.

In 2011, the UN Human Rights Council met to discuss the internet and concluded it is a tool which should be universally accessible.[28] In the 2011 report by the Human Rights Council, the internet is given credit for enabling individuals to exercise their right to freedom of opinion and expression in addition to promoting the progress of society as a whole.[29] The UN stresses the importance of the internet and believes it is a government responsibility to make its accessibility a priority. In the report the UN states,

> **"Given that the Internet has become an indispensable tool for realizing a range of human rights, combating inequality, and accelerating development and human progress, ensuring universal access to the Internet should be a priority for all States. Each State should thus develop a concrete and effective policy, in consultation with individuals from all sections of society, including the private sector and relevant Government ministries, to make the Internet widely available, accessible, and affordable to all segments of population."**[30]

The UN stressed the importance of engaging "all sections of society" in the development of internet infrastructure. This is extremely important to ensure the success of any project especially when its implementation and design will be occurring over a wide range of territories. During my one-month visit, I met with a wide range of local people, and considered who the stakeholders would be of each node within the network. Just as the UN states above, the design proposal considers stakeholders from the government, private and public sector.

As illustrated in the following maps, the internet is not accessible in most rural areas thus leaving the majority of Kenya's population disconnected. Internet within rural areas can only accessed using cell phone data. Computers can only be connected using a cellphone's SIM card in a USB adaptor. This is an expensive method of accessing internet but remains the only option in rural communities. As a result, internet is primarily used in urban centres, or along major roadways where fibre optic cables or cell towers exist. This creates a significant imbalance of internet users between urban and rural communities and contributes further to the "digital divide."

The UN describes the term "digital divide" as "the gap between people with effective access to digital and information technologies, in particular the Internet, and those with very limited or no access at all."[31] This gap is extremely evident within Kenya which is why the government is prioritizing ICT development. There is little evidence within their plans for bringing ICT services to rural areas which is what this thesis investigates. The nonformal learning network within the proposal will bring ICT to these rural communities to help bridge the digital divide, but it will also use ICT as a tool for learning outside of the classroom.

28 Frank La Rue, *Report of the Special Rapporteur on the Promotion and Protection of the Right to Freedom of Opinion and Expression*, report no. A/HRC/17/27, Human Rights Council, United Nations (2011), 16.

29 Ibid., 1.

30 Ibid., 22.

31 Ibid., 17.

Figure 1.5 [Right]
Connectivity in Kenya.

A clear majority of Kenya remains disconnected to internet services. Fixed-line internet (via fibre optic cables) runs along major road ways into urban centers. Wireless broadband, shown in purple and pink, generally follows major roadways where cell phone tower infrastructure exists. All other areas remain largely disconnected to ICT and internet services.

LEGEND

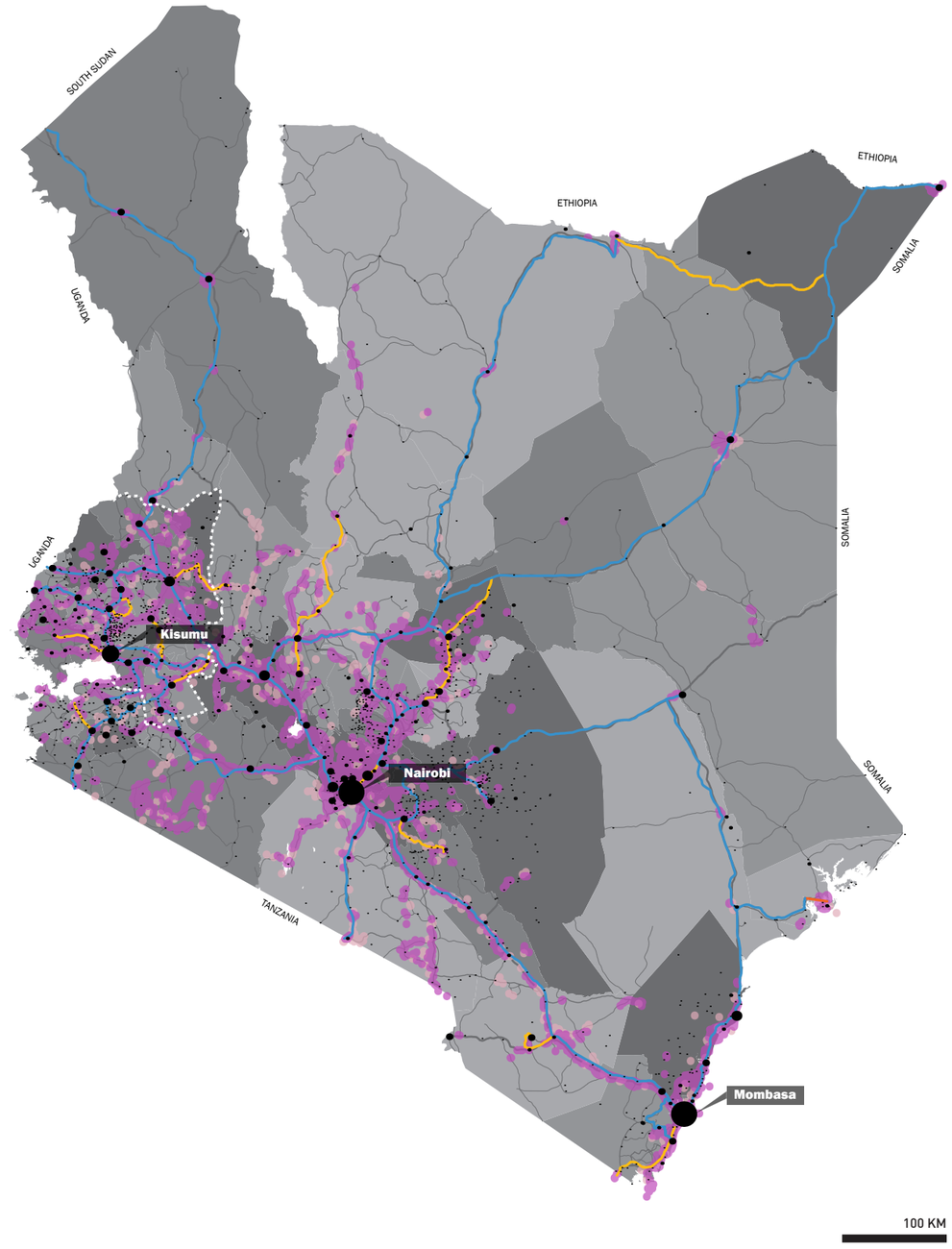
POPULATION
- > 9 000 000
- 400 000 - 9 000 000
- 200 000 - 400 000
- 50 000 - 200 000
- 10 000 - 50 000
- < 10 000

PAVED ROADS
- Primary
- Secondary
- Tertiary

POPULATION DENSITY
- <400 000
- 400 000 - 800 000
- 800 000 - 1 000 000
- 1 000 000 - 2 000 000
- > 2 000 000

FIBRE OPTIC BACKBONE
- Built
- Proposed
- Wireless

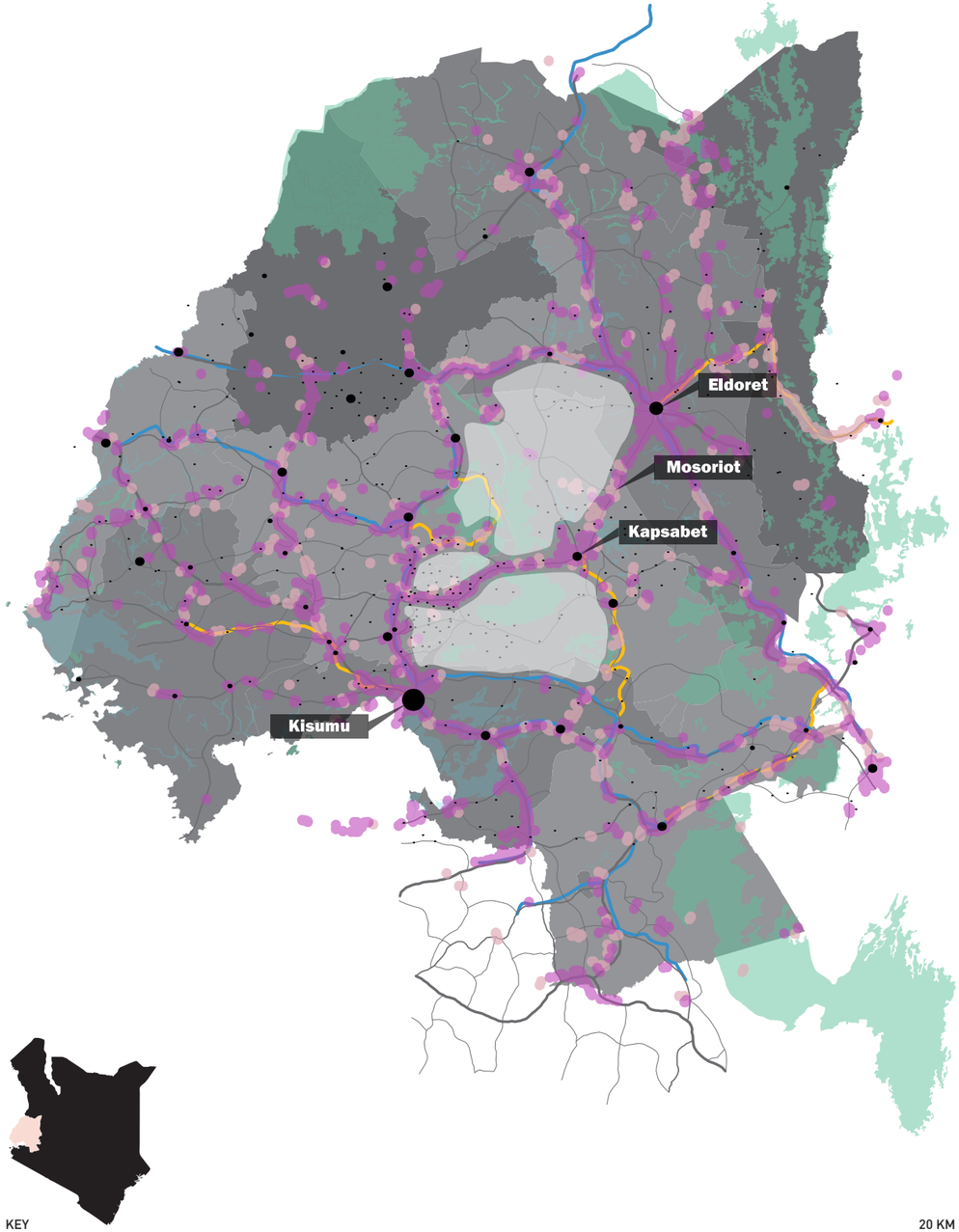
WIRELESS BROADBAND
- Strong Signal
- Weak Signal



Zooming further into the thesis case study site, you can see these rural pockets of disconnection. At best, a slow connection can be made using a cell phone but is often impossible and certainly expensive. To gain better connectivity, I had to walk 45 minutes to a village called Mosoriot. A women with seven children who needs to collect water, cook for the family, take the one cow to graze and simply focus on survival, does not have time to walk to where internet is available. 74% of Kenya's population lives in rural areas like this, so it's a large priority for the government to extend coverage to these rural areas.

Figure 1.6 [Right]
Rural Disconnection.

The map contains the area I primarily travelled within. Internet and communication services were only easily accessed in larger villages or along major roads. Even along these routes of connectivity are disconnected areas due to the valley-type topography. As this scale, disconnected pockets become visible and are highlighted in white. These rural areas are where 74% of Kenya's population live.



Precedents

There have been some attempts to connect communities to the internet, but the majority of these rural communities remain disconnected. The following image shows the Hole in the Wall project by Sugata Mitra. In 1999, Mitra sunk a computer into a wall within a slum in New Delhi. The computer had internet, was visible from the street and available to anyone. Within a few months, Mitra found people had learned how to use the computer, search the web, send emails, skype and how to download information.[32] Through a curiosity to learn, people were able to teach themselves the technology and access information online or within the database. Even when the device was set up in a non-native language, users were able to learn the language or develop their own terminology for components of the computer.[33]

Another common example of bringing internet to rural areas is technology like the Rural Internet Kiosk (RIK). It uses a satellite dish to receive a connection from space, is powered by solar, and contains one or two computers which are available for accessing information and online content. There's even a little window for a vendor who is there to assist and sell snacks. What else could one need?

These innovations should be given credit with enabling users to become familiar with the technology and providing an opportunity for accessing the internet and its capabilities. However, the problem with these precedents is the failure to acknowledge the communities in which they are imported. Certainly, the combination of this technology brings an internet connection off-grid, but what happens when something breaks? Who fixes it? How is the location of this point chosen within the community? Do people have time to use the computer? And does it provide the means for information relevant to each respective community?

Ramesh Srinivasan in his book "Whose Global Village" points out the failures of these tech projects. He makes the valid point that many of these technologies are developed outside of the communities they're placed within which often leads to their downfall. Srinivasan makes a strong argument that a "mere access" to technology is not as empowering or revolutionary as one might think.[34] He says,

"They have been questioned on ethical grounds for clinging to the presumption that mere access to a technology, dropped from the sky, will empower learning and development. Scholars have pointed out that these types of digital divide projects fail to consider the values, practices and protocols of community life."[35]

He argues for a more grassroots approach and credits M-Pesa, a Kenyan invention, with taking a foreign developed piece of technology, the cell phone, and using it to solve a local problem using locally developed technology that works with existing infrastructure.[36] This is why the company

32 Sugata Mitra, "The Hole in the Wall Project and the Power of Self-Organized Learning" Edutopia, https://www.edutopia.org/blog/self-organized-learning-sugata-mitra.

33 Ibid.

34 Ramesh Srinivasan, *Whose Global Village?* (New York: New York University Press, 2017), 57.

35 Ibid.

36 Ibid., 67.

and its services are used everywhere, even in these rural areas. Especially as a designer in a foreign context, one needs to give agency to the local in every aspect from design, to construction, to maintenance, economy and understanding of existing social conditions.

Figure 1.7 [Above]
Hole in the Wall Project by Sugata Mitra.

A group of children use computers connected to the internet in a self-organized learning environment. Sharing the computers and with their natural curiosity to learn, they are able to figure out the technology and its stored and online content.

The following pages contain examples of other infrastructural projects with great failures. These examples clearly illustrate the lack of agency that was given to local people. Clearly evident is a lack of maintenance, little relevance to existing ways of living, and a lack of homegrown or grassroots innovation that comes from the community itself.

A simple way to explain the lack of agency given to locals are projects like these built by NGO's. While their intensions are to provide access to cleaner water are good, they fail to understand how communities collect water or once did successfully. Furthermore, locals do not usually build these projects, nor do they know how to maintain or fix them should they break. According to the Rural Water Supply Network, 30% of handpumps in Kenya are broken and 67% in the Democratic Republic of the Congo.[37] Even when the infrastructure is functioning, not everyone has time to walk the distance to the well. As a result, dirtier water that lies closer to peoples' homes is used.

Figure 1.8 [Above]
Broken Water Well.

A hand pump remains broken: a scene that is too common in Sub-Saharan Africa.

37 Rural Water Supply Network, "Handpump Data 2009," RWSN, http://www.rural-water-supply.net/en/resources/details/203.

Figure 1.9 [Right]
Satellite Dish in Disrepair.

This school in Maasai Mara is very remote and uses a small windmill to general power for the school. The satellite dish was installed for internet and communication but has been in disrepair for a few years. No one on site knows how to fix the technology.

The local county government installed the following pump station and water kiosk. Although the infrastructure was installed by local people in some sense, it failed to address locals living in the adjacent rural area. Rural residents say they do not have the time to walk to Mosoriot to retrieve water—not to mention the strength needed to carry water back home. The kiosk has limited hours of operation putting further limitations on accessibility.

Figure 1.10 [Above]
Water Pump Station in Mosoriot.

Solar panels power a pump to bring clean water from 300 meters below the surface. The well was drilled by the county government and pumps water to a kiosk nearby where people can fill up.

Figure 1.11 [Above]
Water Kiosk in Mosoriot.

The water kiosk receives water from the pump station set up by the county government and dispenses water for 5 ksh/20 L ($0.06).

Most people in this rural community collect water using hand dug wells or rivers and springs. There was a time when these waters were safe to drink but they're now polluted by agriculture and poor waste disposal. Despite the clean water kiosk in Mosoriot, people still collect water from these sources mostly because of a time restraint.

Figure 1.12 [Above]
Hand-dug Well.

Wells are a common method of collecting water in this area of Nandi County because of the geology and underground springs. Wells can be hand-dug up to 21 meters.

Figure 1.13 [Above]
Groundwater Spring.

This pool of water is the entrance to a groundwater spring. People come to sources like these when they have no well of their own.

Often shockingly close to peoples' water sources are the following pollutants. Family burial sites are on the property next to the well, pit latrine, burn pit and cows. Even with these severe contaminates, people continue using the water for drinking and cooking because there isn't yet an alternative that suits their needs.

Figure 1.14 [Top Left]
Burn Pit.

Most properties have a burn pit to manage waste as there are no garbage or recycling programs in the community. This contributes to soil pollution which is highly problematic when most of the pottable water is sourced from the ground.

Figure 1.15 [Top Right]
Pit Latrine.

There are no septic systems in this community so pit latrines are used. Holes are dug in the ground, and a small shed is erected above allowing for the waste to seep into the soil. This contributes to groundwater pollution.

Implementing a safer alternative or "better" infrastructure doesn't always solve the problem especially when the infrastructure fails to acknowledge the daily life and needs of the community. Locals need to be given more agency when it comes to sustainable development. They need to be invited to the table when their local government or third parties come to propose design. Ideally, the solution should be grassroots and homegrown. Instead of creating new methods of water collection, the design proposal modifies current methods of collecting water in a way which makes water safe for drinking, using infrastructure that is made locally.

Figure 1.16 [Above]
Cows Drinking Upstream.

Cows are herded here to drink but just downstream is where people collect water for cooking and drinking. The cow waste contributes to the water pollution, but so does the run-off of the many farms in this agricultural community.

Water projects are an easy way to illustrate how possible it is for a project to fail in a community that is not fully understood or if local people are not engaged in the process. Looking at Kenya on a country-wide scale makes design solutions even more complex because of the variety of geography and cultures. Given this, every location looking to build clean water source, or in this case a nonformal learning network with many different types of infrastructure would need to carefully examine each community individually. Each location requires technology, infrastructure, and an architectural program which works with the respective location's culture, geography, and existing social networks. No one design could fit in all regions of the country. Through two visits to Kenya and through getting to know the community on a personal level, I have tried my best to understand how the community currently works and have rooted the proposal within this knowledge.

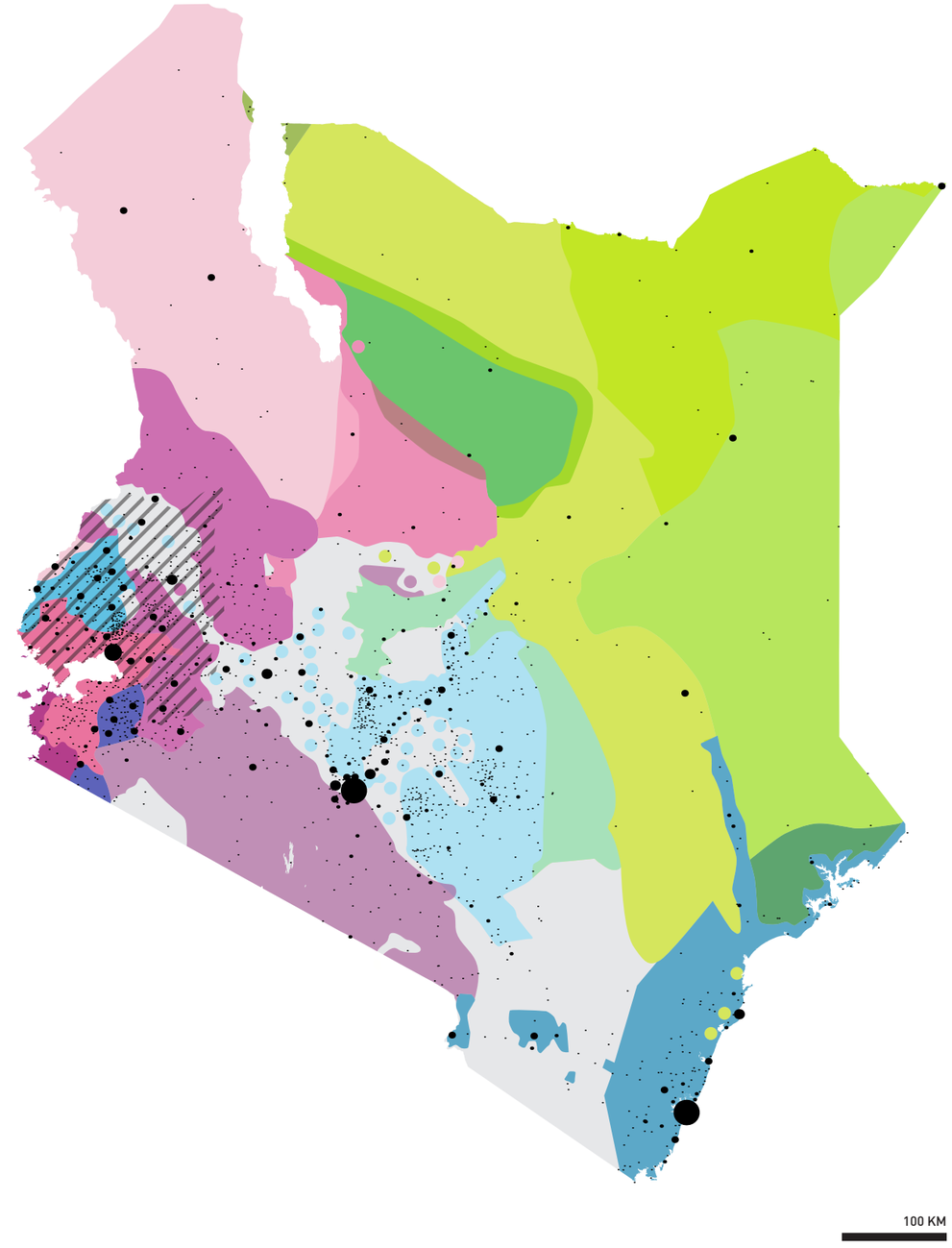
As previously mentioned, Ramesh Srinivasan argues successful technology is developed from the grassroots and is understood and developed by local people. Successful architecture must be the same. In his book "The Production of Space," Henry Lefebvre argues that "[social] space is a [social] product."[38] He argues that the production of space is a shared enterprise where professionals are involved in the process, but the spaces are largely developed by others outside the profession of architecture.

This design approach is used to create both the network shape, and the three design proposals. The existing gathering spaces and daily life of community members was built upon

38 Henri Lefebvre, *The Production of Space* (Oxford: Blackwell, 1991), 26.

Figure 1.17 [Right]
Ethnic Groups in Kenya.

There are 43 ethnic groups in Kenya, many of which have their own sub-group and language. Because of this cultural diverseness, Kenya has many different methods of learning outside the classroom and many ways of living. All of these will affect the design of a nonformal learning network and any design for that matter. Some Kenyans are nomadic, for example, so the design would need to accommodate that lifestyle.



rather than introducing entirely new spaces of nonformal learning and technology. Local people helped create the architectural program and components found in the matrix. These spaces have been carefully placed throughout the network and adapted to fit together on three test sites within the community.

The technology never solely dictates the design of these spaces, but ICT has certain spatial requirements that will influence the design. On a smaller level, how the technology integrates into local construction techniques is explored. The approach taken within the design proposal is that technology is an enhancer of existing typologies within the community.

A reed matt workshop, for example, can introduce WiFi, a computer and projection screen to enhance the space, and over time may transition into a more technologically-based workshop such as a maker-lab. A space which is primarily ICT based would not succeed in this survival-based rural community because people currently lack free-time to learn new technology. The transitioning of these spaces must be in flux with the needs and development of each community. If the approach to designing a space considers the existing practices or daily life, then the technology can integrate itself into these practices and eventually become part of the community.

Henry Lefebvre discusses the transition of space of time arguing that social space is dynamic and not fixed to a single moment of completion.[39] Each of the proposals consider project phasing and how the architecture might expand or contract. If the nonformal learning and ICT spaces are a success, expansion will need to be considered in the design process. This proposed network and its various nodes will be in a constant flux, changing as its users see fit. Nodes are designed to either contract and redistribute or expand and grow with its resources and stakeholders. ▬

39 Lefebvre, *The Production of Space*.

Figure 1.18 [Right]
Satellite of Kenya.

As seen in the satellite image of Kenya, the country has an incredibly diverse landscape. There are two deserts, savanna, the high altitudes of the Rift Valley, mountains, ocean, freshwater, and forests. These changing conditions affect any infrastructure. Water for example, will need to be collected much differently than the methods presented within the proposed nonformal learning network where natural springs are abundant. The area highlighted in white is where I primarily travelled.

COMMUNITY CONTEXT

Existing Gathering Spaces

Before returning to Kenya for a longer second visit, I recalled the existing gathering spaces within the community. Knowing where people traveled to frequently, or where they went to charge their cell phones were important factors in deciding where to place nodes of the network. The following drawings were preliminary examinations of where and how people gathered in the community which is something I explored in much greater detail upon returning. Most of the gathering spaces revolving around cell phones, connectivity or electricity is based in Mosoriot. The design proposal investigates similar spaces but within a rural context.

LEGEND

1. ROADSIDE SHOP
2. SHOP WITH ELECTRICITY
3. CELL PHONE CHARGING
4. DIRT CURBSIDE
5. EDGE OF PAVED ROAD

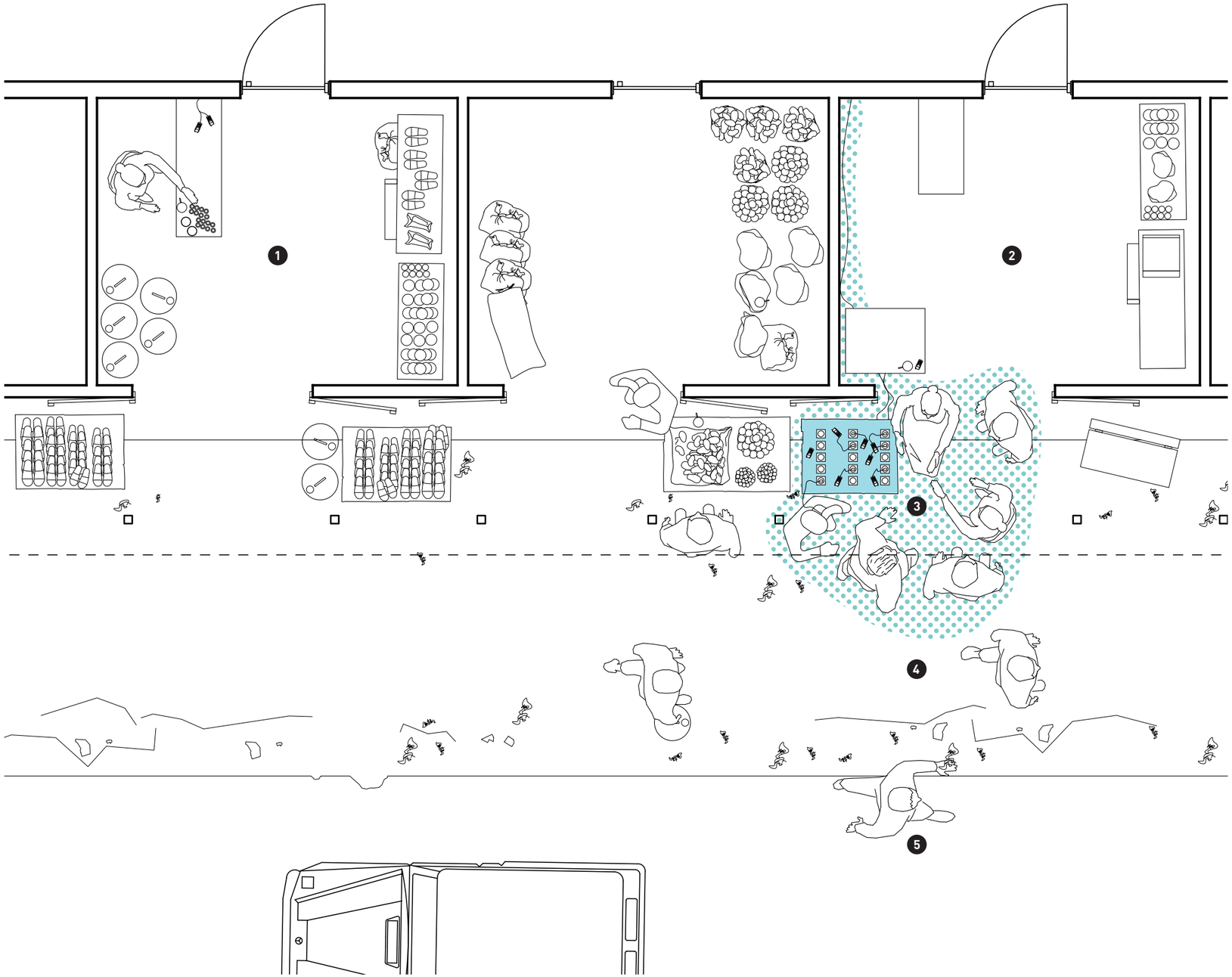


Figure 1.19 [Right]
Existing Charging Station.

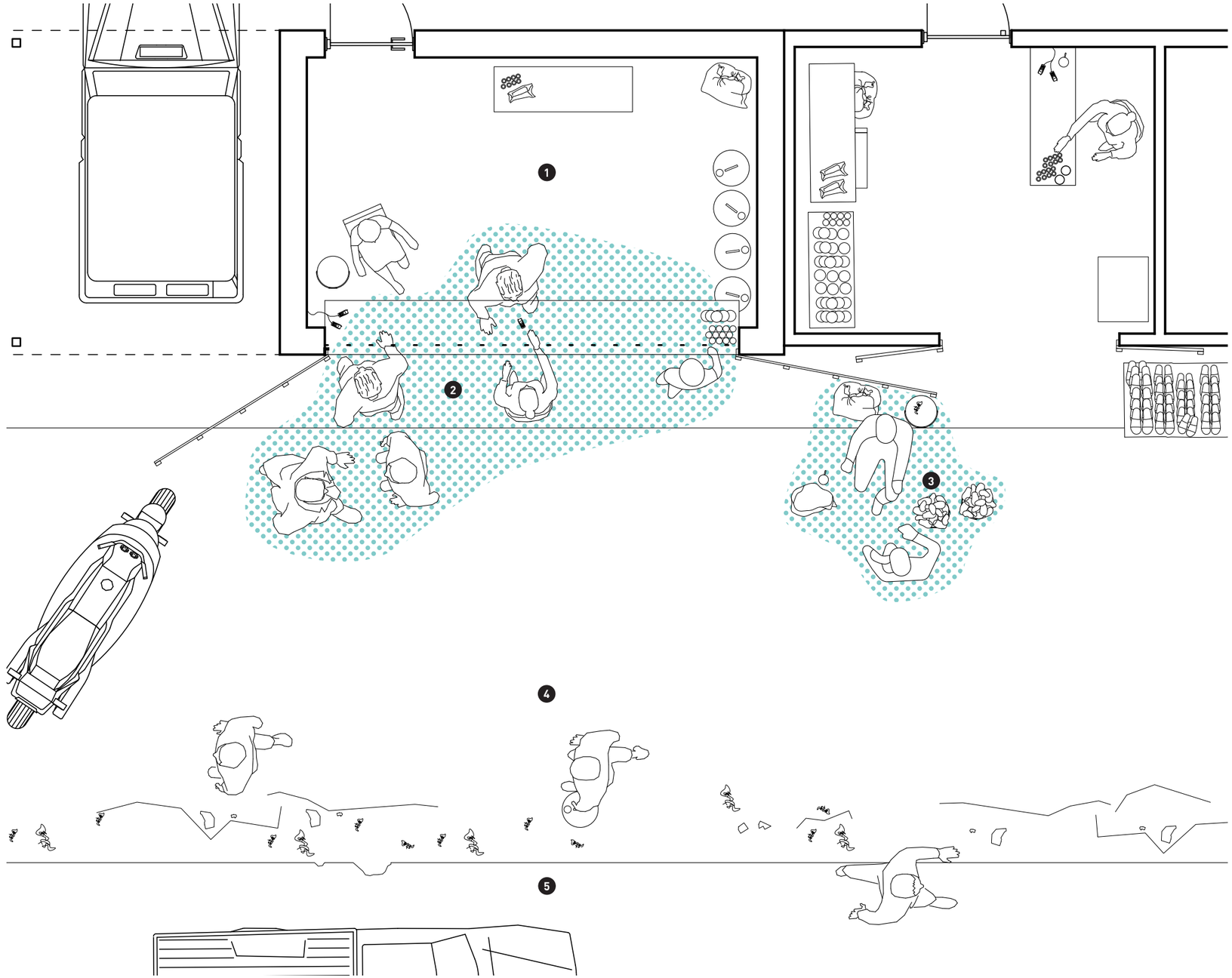
Where electricity is available, many phones will always be found charging. With many phones comes many people. This is a gathering space that can be built upon when designing spaces of ICT. Areas where phone charging is available become inevitable spaces of gathering. Even those living in rural areas walk to Mosoriot to charge their phones.

LEGEND

1. M-PESA SHOP
2. FREQUENT GATHERINGS AT M-PESA SHOP
3. SMALL VEGETABLE STAND
4. DIRT CURBSIDE
5. EDGE OF PAVED ROAD

Figure 1.20 [Right]
Existing M-Pesa Shop.

M-Pesa shops exist in larger villages or urban areas. They attract heavy traffic since most cell phone owners use the service to transfer money. Knowing the popular M-Pesa shops attract a high volume of people, other small businesses such as street vendors or veggie stands pop-up.

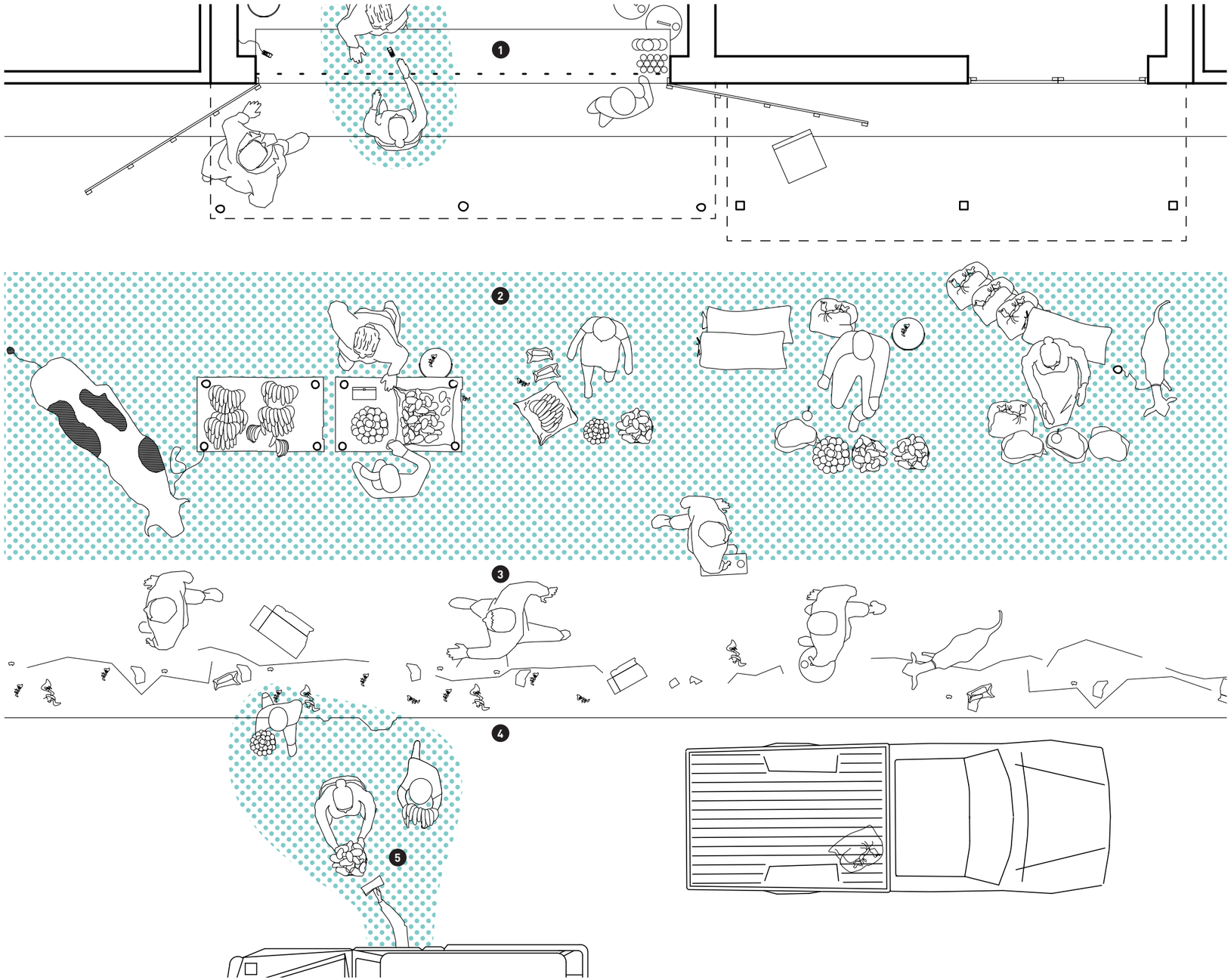


LEGEND

1. M-PESA SHOP
2. WOODEN ROADSIDE MARKET STALLS
3. DIRT CURBSIDE
4. EDGE OF PAVED ROAD
5. MARKET VENDORS SELLING TO DRIVERS

Figure 1.21 [Right]
Existing Roadside Market.

Roadside markets are popular in high traffic areas. They are places of exchange and social gathering. Being an agricultural community, many people earn a small income from selling veggies to neighbours or here, at the market. M-Pesa shops also pop up where markets are because they benefit from the high traffic.



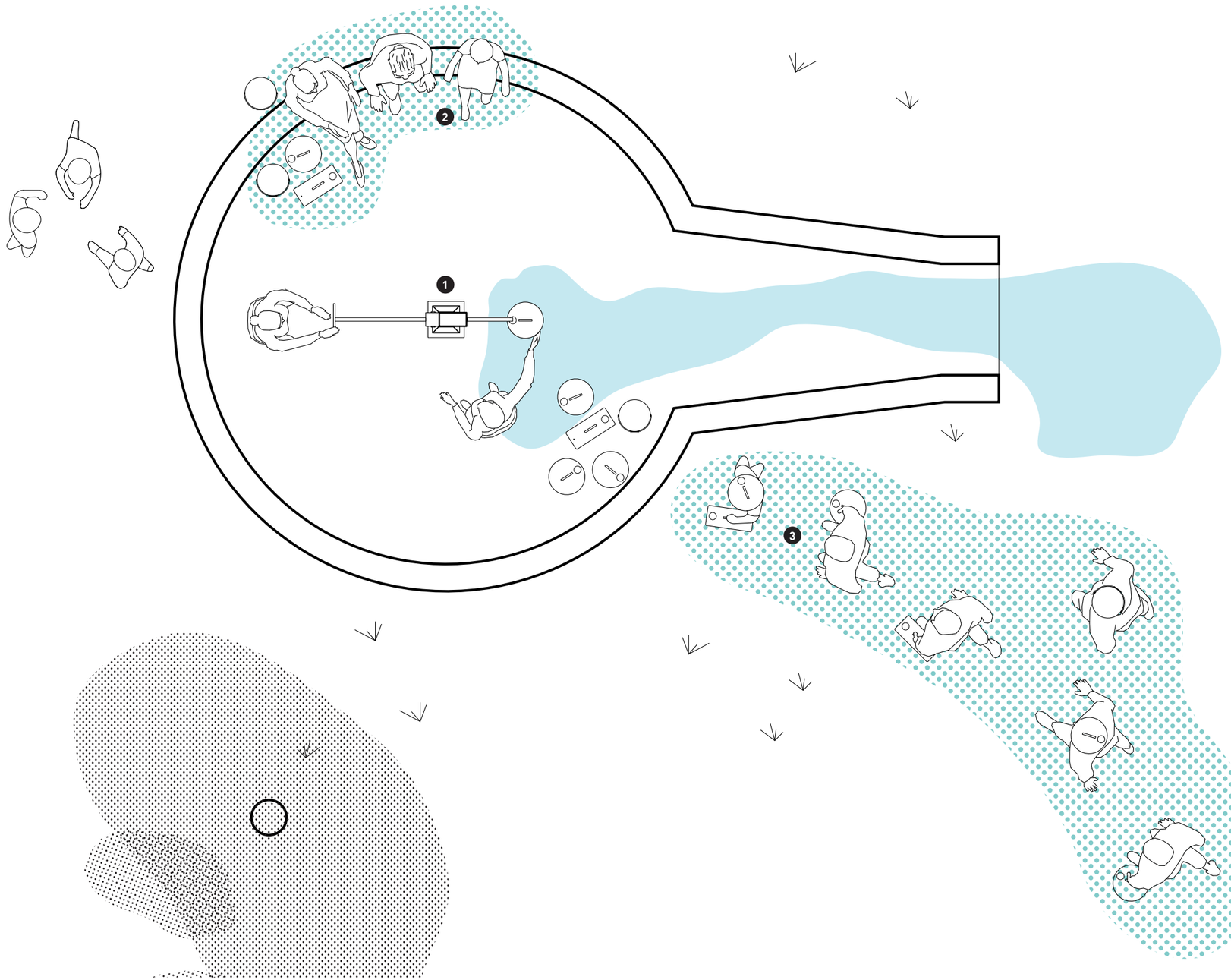
LEGEND

1. WATER WELL
2. WOMEN GATHERING
3. COMING TO COLLECT WATER

Figure 1.22 [Right]
Water as a Gathering Space.

Some streams or water access points have become gathering spaces. Every Saturday, boarding students bring their laundry to a stream and wash clothes together. The air is filled with laughter and water is carried back to school.

Many properties in this rural area have their own well which is sufficient during the rainy season, but during the dry season, additional sources are scouted.



The following images and diagrams illustrate how differently people move through this rural community in Kenya compared to here in Cambridge. I wanted to better understand how people move through the community, so I could properly situate the network and its nodes. This community does not have paved roads, nor does it have street lamps. Navigating the community and attempting to map out where exactly I walked everyday was challenging. I navigated the footpaths and dirt roads based on geography like hills and streams. If I got lost, I would approach someone saying "Sokkin?" which is the name of the sublocation I was staying in. While disorienting at times, this experience of getting from place to place was beautiful and much more in touch with the natural surroundings from what I was used to at home.

Luce Irigaray is the director of research in philosophy at the Centre National de la Recherche Scientifique in Paris. In her book, "Through Vegetal being," she writes about her escape to nature and describes her life in the city as formulaic: "instead of moving according to my desire, I had to obey codes."[40]

"All is rigid: the ground, the walls, the gestures, the words. All remains fixed, keeps the same form from one day to the next. And we hear the same sounds, smell the same odors or lack of odors, whereas in nature everything changes all the time-a leaf, a flower, a blade of grass, a smell, or a sound changes in one night."[41]

40 Luce Irigaray and Michael Marder, *Through Vegetal Being: Two Philosophical Perspectives* (New York: Columbia University Press, 2016), 57.

41 Ibid.

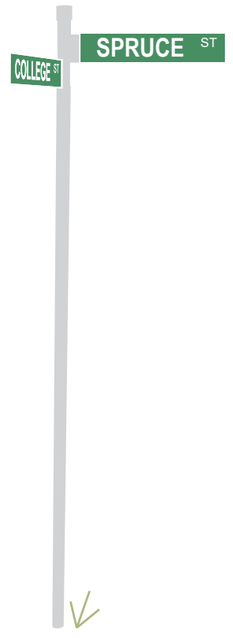


Figure 1.23 [Right]
My Walk to School.

These diagrams represent what it's like to walk to school in Cambridge, Ontario. The path is very linear and public and private space is clearly marked by sidewalks, lawns, and roads. Signs are used as way-finding and the route to school and other amenities is usually not too far. This illustration is used to highlight how different it is walking to school in rural Kenya.

Compared to the rigidness of walking from one proptery to the next in Cambridge, Kenya is much more fluid and organic. Wangari Maathai describes in great detail these experiences of navigating her Kenyan community. Her descriptions in the book "Unbowed" are very similar to the Kenyan community this thesis is situated within. She writes,

It was so dark I had to listen carefully to the water flowing down the hillsides and through the gullies bordered by arrowroots and dense vegetation so I could work out where I was and where I was going. The streams would hiss and whoosh as they joined the Gura River, which swept along the valley floor until it slid over a waterfall and crashed onto the rocks below.

When I climbed a particularly steep hill I knew I was nearly home. As I got to the top, if it was not during the June to August foggy season, I could see the sky exploding with stars and the Milky Way spread across the heavens. Once I arrived, quite often I didn't even want to go inside."[42]

Some of the most well-traveled routes in this community are footpaths, not roads. Gathering spaces are often not at the busy roadside, but at the end of a beautiful walk along a valley's ridge line. These are the paths that have influenced the network's shape in the design proposal.

42 Maathai, *Unbowed*, 47.

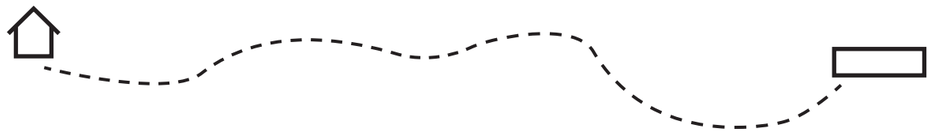


Figure 1.24 [Right]
A Walk to School in Kenya.

These diagrams illustrate a scenario of walking to school in Kenya for some. Some walk seven kilometers every day to get to school in this community. The route is much more organic, following dirt roads and foot paths. There is still a feeling of shared land like it was before the country was colonized. Formations in the landscape such as rocks, hills and trees are way-find devices. Understanding how people move through the community is key to designing a well utilized ICT network.

Existing and Proposed Networks

After returning to Canada, I began to map out the community using Google Satellite and Google Earth. I was able to find where I had gone based on the geographical landmarks and arrangement of small buildings. The following map illustrates the routes community members use either on a daily or weekly basis. It reveals existing areas of gathering, the duration of time spent at these gathering places, and hints at the type of infrastructure along each path whether its extremely muddy, has heavy cow traffic, or is a busy walking route home from school. Each circular icon denotes the type of gathering space frequently visited by people and how long they usually spend there. With a greater understanding of where people are already going within the community, we can better understand where to locate the nonformal learning nodes of the network. Overlaid on this map is the proposed nonformal learning network which uses mesh network typology. The existing social and economic networks of daily life influence the placement of the proposed network and its various nodes.

Giving Locals Agency in the Design Process:

As much as possible, the proposal has been informed by an understanding of the community, its people, geography and existing conditions. In any design or infrastructural proposal, more information should be collected from local people making use of their inherent expertise of that place. Rather than engineering a tech system which only addresses the spatial requirements of the technology, existing networks of daily life in a community should be addressed in the project. Especially in a country that is as varied and diverse as Kenya, accessing enough of this information is not a simple task.

In regions where collecting information is difficult because of remoteness or poor security, research groups have started collecting data via cell phones. From collecting statistics on food shortages in dangerous regions of Somalia, to understanding poverty based on the frequency and type of cell phone calls, government and research groups have started safely collecting information that was once extremely difficult to obtain. In his essay "Seeing the World in Data," Nathan Yau discusses the roles people can take in their community by "collecting data about what is around them, contributing to a common database that experts can in turn analyze to find solutions to local problems."[43] This on-the-ground information could then be used by local experts to create a solution relevant to the users of that community. Yau points out,

> **"We can use advancing technology, like mobile phones and the internet to collect information about our surroundings and ourselves. An individual can collect thousands of data points during a single day without even batting an eye or picking up a pencil and a notepad."**[44]

43 Nathan Yau, "Seeing the World in Data," in *Visual Complexity: Mapping Patterns of Information*, Manuel Lima (New York: Princeton Architectural Press, 2011), 246.

44 Ibid.

Because the majority of people have a cell phone, and now commonly two phones, data collection in rural areas is much easier. There is an opportunity to engage with local people through their cell phones which can be a tool for better understanding how they interact with their surroundings.[45] With the expansion of ICT in these remote or rural areas, more information could be gathered by locals and used in future development.

Members of the community felt this method could be helpful for sending information using basic SMS texting similar to the M-Pesa platform. This data collection could occur prior to any ICT infrastructure being built in the rural community. Once the network was constructed, obtaining data with multiple WiFi locations would make data sharing even easier. A community member suggested taking pictures around their community and along the routes they frequently take to document and share road conditions, water sources and broken infrastructure or technology. Making maps of routes in the community could be instantaneous with GPS tracking, and pictures uploaded could have automatic GPS locations attached. Of course, there is the discussion of internet security which would need to be addressed if information were shared and collected this way.

Kevin Lynch discusses various methods of collecting information about a place in his book "City Sense and City Design." He understands the value of information that comes from local people and has tried different methods of mapping and documenting information from his perspective as well as the local peoples'. Lynch believes "we learn to see as we communicate with other people,"[46]. He goes on to say,

> **"the most interesting unit of study for environmental perception may therefore be small, intimate social groups who are learning to see together, exchanging their feelings, values, categories, memories, hopes, and observations, as they go about their everyday affairs."** [47]

This was the most helpful method for collecting valuable information about the community while I was there for a month. Every casual conversation I had with an individual or group of people influenced my design decisions. Often during larger group discussions, people began to come up with ideas themselves and the process became collaborative.

Lynch elaborates on this and describes various methods of helping others to learn to see for themselves. He believes designers can use their studies and methods to help others surface their "own way of viewing the world, and to help [them] to clarify and extend [their] own concepts."[48] These very conversations and team effort approaches are what helped develop the component catalogue found in the appendix.

Ramesh Srinivasan discusses a similar method but one which uses modern technology as a tool for developing ideas locally. Srinivasan believes a technique for giving local people agency in projects lies in "collective action." He

45 Ibid., 248.

46 Tridib Banerjee and Michael Southworth, eds, *City Sense and City Design: Writings and Projects of Kevin Lynch* (Cambridge, MA: MIT Press, 1990), 233.

47 Ibid.

48 Ibid.

describes the process "by which the authorship and sharing of videos expanded outside a small focus group to recruit authors and viewers across the village and thus inspire larger scale conversations."[49] He recounts on the ideas that community members came up with *themselves* out of a process of taking videos. The technology enabled community members "to create and share their experiences regardless of their level of literacy and education."[50] At local meetings, discussions developed from these videos and certain assets of the community were built upon. When local people identified problems in the videos, such as a polluted stream near a school, community members would troubleshoot the problem themselves rather than from external parties, or foreign NGOs.[51] Cell phones could easily act in place of video cameras given that they're often already installed.

The following map was built upon my own understanding of how people move throughout this community in their daily routines. But in an ideal design process, this information would come directly from the local people themselves. The map has become a tool for revealing information that has directly influenced the placement and design of the nonformal learning network.

With mesh networks comes certain layout requirements, but what this map helps to deduce is the existing *social* networks. The nonformal learning network is paired with the existing social and economical networks within the community while acting as a strong ICT mesh network. Each ICT node will be located and paired with existing gathering spaces.

No project, community or place exists in a single moment of time. Everything is constantly changing and it's certain the nodes within this network will expand, contract, and even impact people's existing routines. With the introduction of these nodes and their resources, people living in rural Kokwet will no longer need to travel to Mosoriot to access M-Pesa banking, the vegetable market, or to gain access to the internet. Especially regarding employment, education, and available resources, urban communities are better equipped than their rural neighbours. This rural network will help decrease the need for rural residents to move to larger urban areas. The community routes shown in the following map represent the routes that were visible during my site visit in May 2017, but these will undoubtedly change over time, especially with the introduction of the nonformal learning network.

Kenyin Lynch speaks about the importance of acknowledging that patterns are constantly changing. He says,

> **"Patterns analyzed at one moment fail to tell us where perceptions come from, or how they may change. They even fail to convey the flavor of the momentary experience, which is changing into something else. Even more, they prevent us from making a just evaluation, since the quality of life is not dependent on a single event, nor even on the finale, but on its form as a realized process."**[52]

49 Srinivasan, *Whose Global Village?*, 109.

50 Ibid.

51 Ibid., 109-111.

52 Banerjee and Southworth, *City Sense and City Design*, 233.

Taking this into consideration, the three design proposals consider project phasing both in terms of construction, but also in terms of monetary funding. Stakeholders are identified within each node and realistic economic plans for scaling up are proposed. The materials used in the construction are locally based and in the event that a building should scale down, or relocate, materials can easily be disassembled and used elsewhere.

On a planning scale, the mesh network is also scalable over time. Nodes which make up the strong backbone[53] of the mesh network would be the first nodes constructed and the most stable. Smaller nodes that are government regulated such as health centres or schools, would tie into the backbone of the network and be fairly constant over time. The most variable node type would be that of the private node. Individuals or small business owners looking to create a node of their own using the minimum required technology to connect, can tie into the network at any time. This would result in a constant changing shape of the network as small nodes appear, disconnect, or change locations. As the network and technology becomes more well known and used within the community, more of these small nodes will appear, changing the mesh network's shape but not likely the shape of its stable backbone.

Three design proposals and their respective stakeholders and phasing are discussed in the next chapter following the network drawings. Each node is of a different scale and location within the overall network.

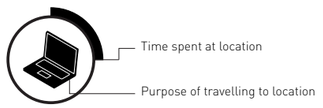
53 The backbone of a mesh network is the primary route of connection and contains the most stable nodes. Other nodes which make up the network tie into this backbone.

LEGEND

INDIVIDUALS' ROUTES

- Route taken 1-2 times weekly
- Route taken daily
- Woman, employed, 25 yrs
- Female teacher, 28 yrs
- Woman, employed, 30 yrs
- Woman, mother of 7, 43 yrs
- Woman, 47 grandchildren, 90 yrs
- Man, runner, 22 yrs
- Man, unemployed
- Man, employed, 26 yrs
- Male teacher, 34 yrs
- Boarding student 26 yrs
- Students
- Other community members

LOCATION ACTIVITIES



- Time spent at location
- Purpose of travelling to location

* Colour indicates the activity is person-specific

- Quick stop (1-15 min)
- Short duration (15-60 min)
- Medium duration (1-3 hrs)
- Long duration (>3 hrs)

- Cyber
- Cattle dip
- Water
- School
- Money
- Barber/charging
- Boda boda
- Church
- Meal
- Market
- Women's group
- M-Pesa
- Health clinic/chemist
- Matatu

DIRECTIONAL ACTIVITES

- Herding cows
- Grazing
- School kids on route
- Frequently muddy
- Very bumpy
- Slope of valley
- River

AREAS OF GATHERING

- Gatherings 1-2 times weekly
- Gatherings daily

NON-FORMAL LEARNING NETWORK NODE TYPES

- Linear node WiFi backbone
- Small node - weekly gatherings
- Small node - daily gatherings
- Rural node - daily gatherings
- Village node - daily gatherings

* See Appendix for more detail on proposed/future spaces and amenities.

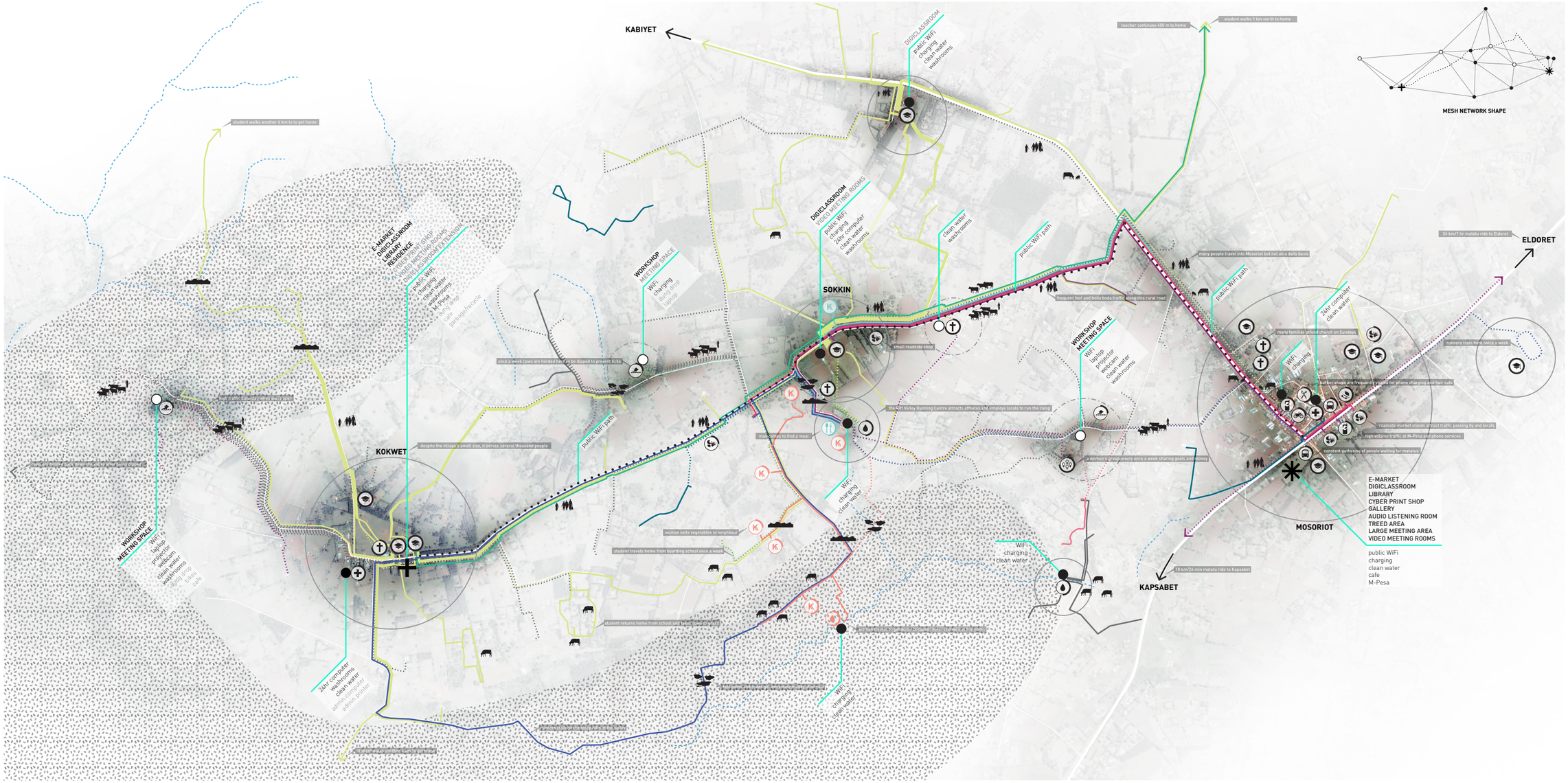


Figure 1.25 [Above]
Proposed Nonformal Learning Network and Existing Community Routes.

The map illustrates existing routes taken by community members on a daily and weekly basis. These routes reveal some of the existing places of social interaction and gathering. The proposed nodes of nonformal learning and ICT build upon these existing spaces and will change how people move through the community over time.

Laying Out the Network

Figure 1.26 [Below]
Existing Community Routes.

Routes community members frequently take as part of their daily life were documented to better understand movement through the community. Gathering spaces and groupings of amenities become apparent and intersections of routes are revealed. Many routes follow foot paths that weave through the rural community, while others follow dirt roads and the paved road into Mosoriot. Three areas of the map have been blown up for easier viewing.

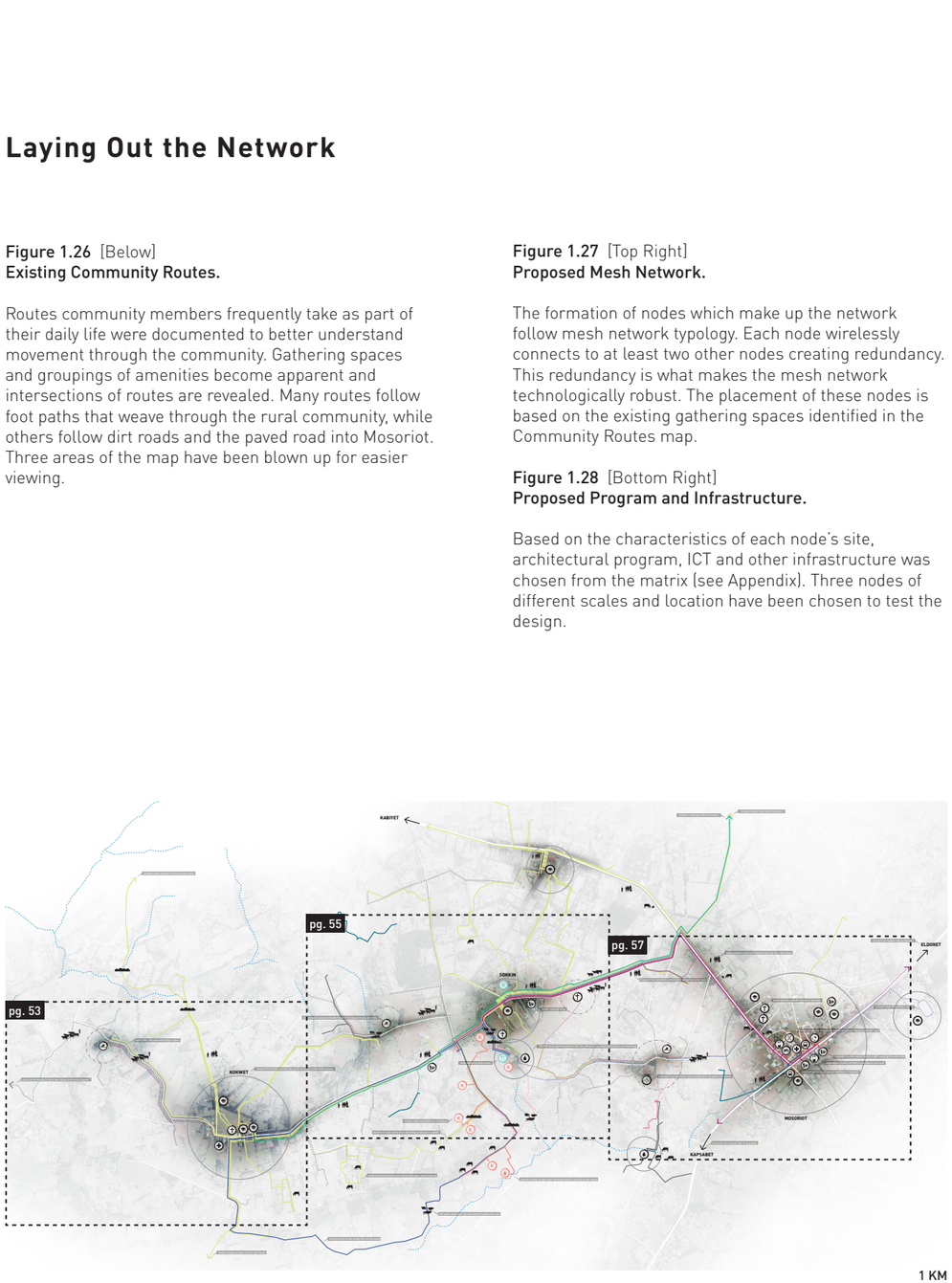
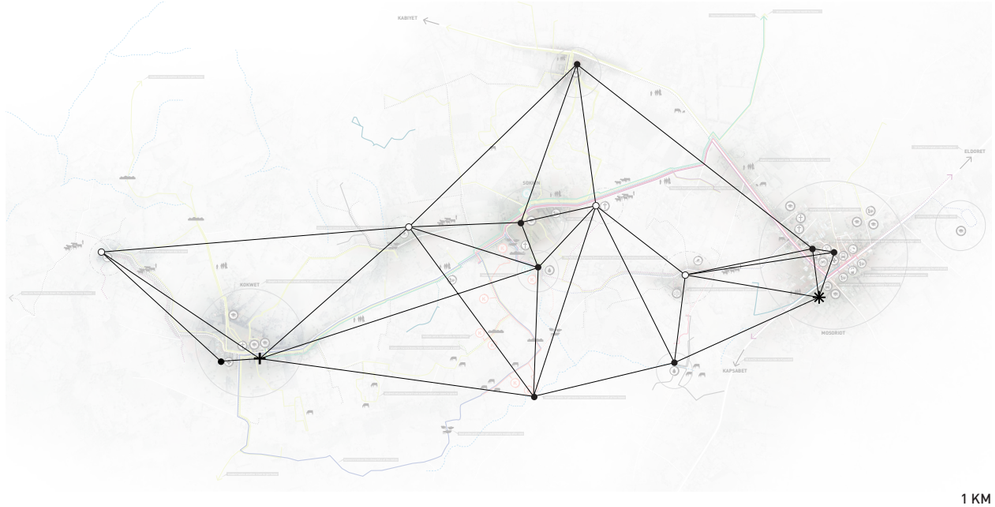


Figure 1.27 [Top Right]
Proposed Mesh Network.

The formation of nodes which make up the network follow mesh network typology. Each node wirelessly connects to at least two other nodes creating redundancy. This redundancy is what makes the mesh network technologically robust. The placement of these nodes is based on the existing gathering spaces identified in the Community Routes map.

Figure 1.28 [Bottom Right]
Proposed Program and Infrastructure.

Based on the characteristics of each node's site, architectural program, ICT and other infrastructure was chosen from the matrix (see Appendix). Three nodes of different scales and location have been chosen to test the design.



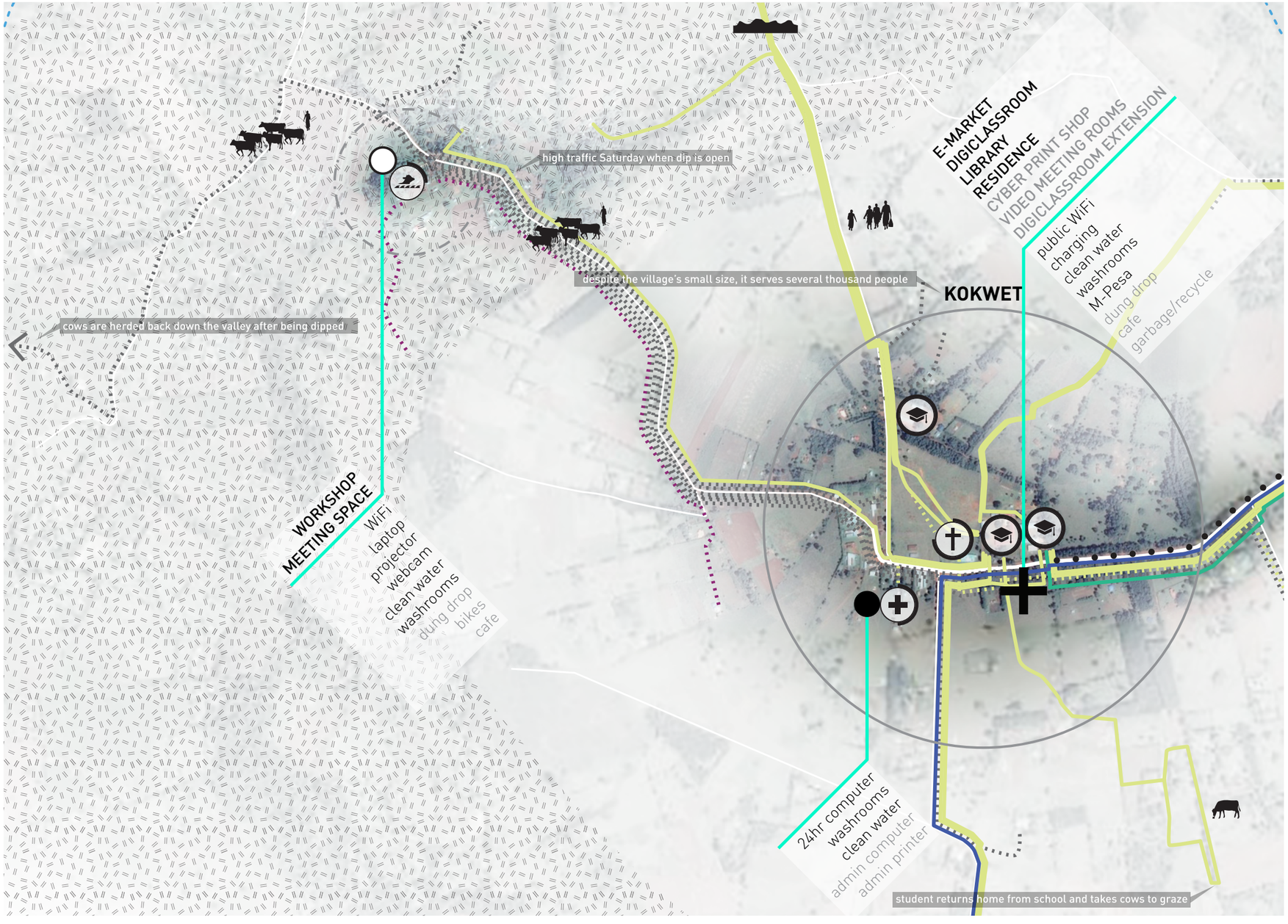


Figure 1.29 [Right]
Kokwet Area Blow-up of Nonformal Learning Network Map and Existing Community Routes.

This area of the community is called Kokwet. The node placed at the cattle dip is one of the design proposals presented in the thesis. A second design proposal is tested in the center of Kokwet where there are two existing schools.

*See page 47 for legend.

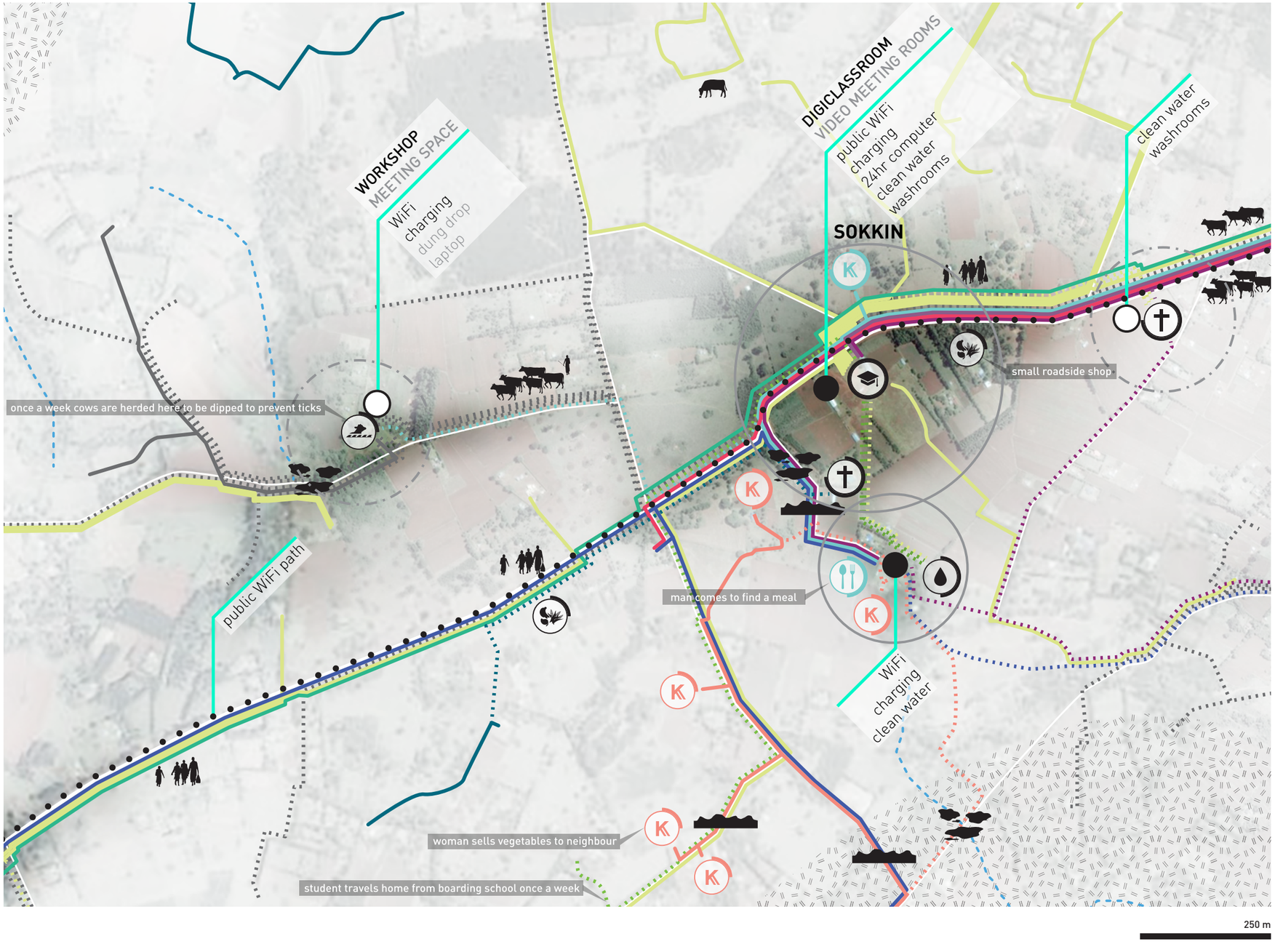


Figure 1.30 [Right]
Sokkin Area Blow-up of Nonformal Learning Network Map and Existing Community Routes.

This area of the community is called Sokkin. A major dirt road from Kokwet runs through the area heading towards Mosoriot and therefore sees heavy foot and cattle traffic.

*See page 47 for legend.

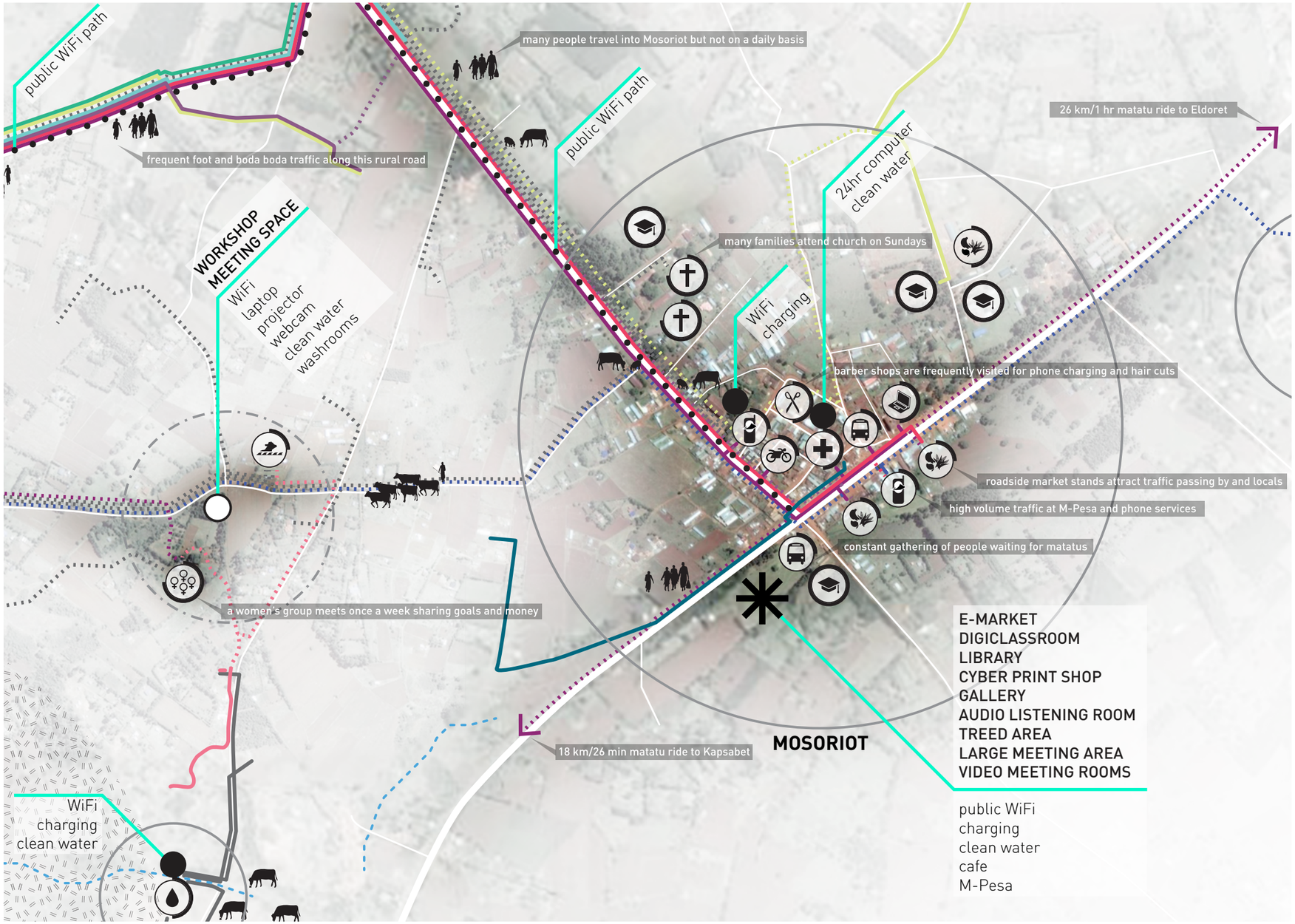


Figure 1.31 [Right]
Mosoriot Area Blow-up of Nonformal Learning Network Map and Existing Community Routes.

Mosoriot is the largest village neighbouring the rural community and lies on the connected periphery of the disconnected rural zone. Internet here is only accessible via cell phone tower. The village or gateway node is the largest within the network and provides the most stable connection to the network.

*See page 47 for legend.

NETWORK TESTING: PROPOSED NODES

The primary goal of the proposed rural network is to provide points of internet connection throughout the community. These connected points, or nodes become spaces of nonformal learning. Although the main idea is to increase access to education, other aspects of this rural community play a large role within these nodes. Education can not be narrowly developed without considerations of other community factors at play. These nonformal learning nodes and their chosen architectural program must consider economy, daily life, and job creation which all play off each other in successful rural development. In "New Paths to Learning," Philip Coombs believes,

> **"the paramount goals of rural development, along with increased production and income, include the equitable distribution of income, increased employment, land reform, better health, nutrition and housing for all rural dwellers, expanded educational opportunities for all, the strengthening of local means of community self-government and co-operation, the eradication of poverty and the promotion of social justice."**[54]

Coombs makes the argument that universal education can not be achieved without the development and consideration of all these sectors of society.

54 Coombs, *New Paths to Learning*, 22.

55 Kiva, "About Us," https://www.kiva.org/about.

The proposed nodes of this network include spaces that are relevant to nonformal learning, but also address these other aspects of community. The architecture allows for spaces and activities which help to generate micro-economies and is designed for long-term sustainable development. Equal resources to nearby urban areas are strived for in the design proposal, but in a way which suits rural daily life and builds upon existing rural practices.

ICT development in these rural communities is inevitable, but community members stressed their belief that ICT would not be successful before poverty and corrupt government were eradicated. With extremely high unemployment, poverty and poor food security, ICT development alone would not take off in this community. The three node proposals consider all of the mentioned problems identified by locals and build upon the existing strengths of this rural community. Solutions are grassroots, and the architecture and ICT are designed and implemented in a way which creates jobs, micro-economies, and even saves time in peoples' days.

Although many women seemed interested in what ICT could offer, they argued they would never have enough time in a day to access it because of the time it takes to support their family. Basic survival, cooking, taking the cows to graze, and the walk to Mosoriot they currently undergo to access resources such as M-Pesa fills their entire daily schedule. These designed nodes take this into consideration and include the amenities that are currently only available in Mosoriot which will spare community members the long trip and save them a few hours in their day. This time could be used to access information at the ICT nodes, gain important family health information, or allow them to work online.

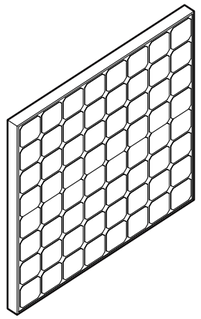
Each design proposal uses local materials and construction techniques to maximize job opportunities in the trades, and to ensure the project is as local and sustainable as possible. The nodes are designed to be easily scalable, and **project phasing** is considered both in terms of construction and finance. The **stakeholders** of each node are identified and play a role in the financing and phasing of each respective building and its maintenance. These stakeholders range from individuals within the community, existing community groups, local government, private Kenyan companies like M-Pesa, and local tea plantations. One stakeholder that is not mentioned in the three node proposals but is very likely to take part in projects like these, are lenders of microloans.

Microloans have proven to be incredibly successful and very low risk for the people lending the money. Microloans are a bottom-up approach that allow local and grassroots projects to get their feet off the ground. Rather than risking large losses for improperly managed aid money, microloans are usually very small amounts of money spread across many different start-up initiatives. If a few small projects fail, and money is not returned, the loss is much less significant. The company Kiva, which operates in Kenya, has a 97% return rate for its lenders.[55] Kiva does not take a percentage of the loan money so 100% goes towards the start-up.[56] Microloans could contribute to the development of any of the nodes within this network.

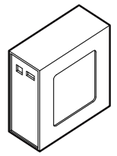
Illustrated on the following page is the minimum required technology to create a connection to the internet. All of these components are required for the node to be present within the mesh network. The ICT is meant to enhance the architectural spaces conducive to nonformal learning, cultural and social exchanges, and amplifies the technological interactions within this rural community. However, if a power outage occurs or the ICT is need of repair, the architecture continues to function successfully as conducive learning and meeting spaces. The three design proposals are part of the mesh network within the rural community and illustrate technology and infrastructure from the component catalogue. These items are discussed in detail within the appendix.

56 Ibid.

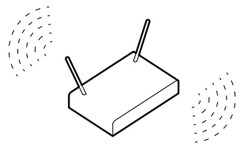
Minimum Required Technology



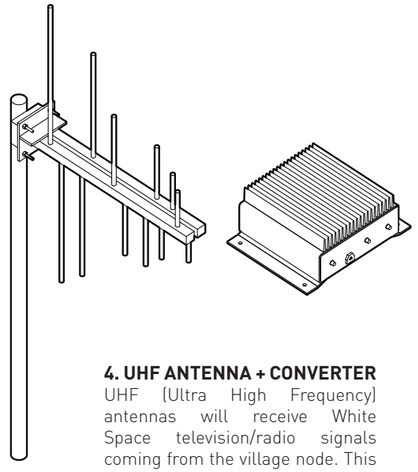
1. POWER SOURCE
Many rural areas do not have access to the electrical grid. Solar panels will provide power to ICTs when the location allows for adequate solar gain.



2. BATTERY BACKUP
Power outages where electrical grids exist are unreliable at times. Supplying a second source of power to the primary source will ensure a constant connection to the Internet.



3. WIFI ROUTER
Provides WiFi signal at nodes.



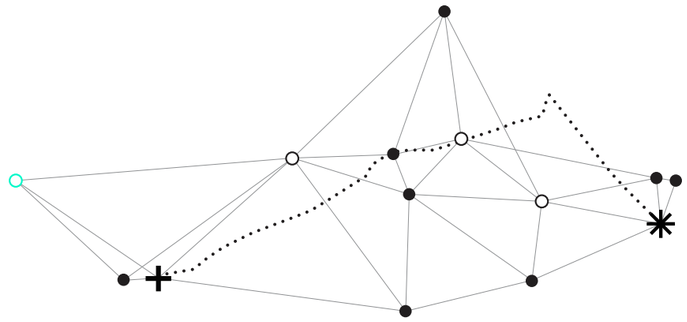
4. UHF ANTENNA + CONVERTER
UHF (Ultra High Frequency) antennas will receive White Space television/radio signals coming from the village node. This technology is ideal for this region because the low frequency waves can travel over the hilly terrain and through treed areas.

5. SCREEN
At the very least, a cell phone can be used to access information and internet via WiFi.

Figure 1.32 [Above]
Minimum Required Technology for Connection.

The above catalogue contains the minimum amount of technology that is needed for accessing WiFi internet in this rural area.

Cattle Dip Node



Once a week, people bring their cattle here to be dipped in pesticides which prevent deadly ticks. The dip is run by the Kokwet Women's group and is one of their primary incomes. The women's group currently meets in group members' homes to discuss community issues, business ideas, table-top banking and other relevant topics in the community.

LEGEND

- LINEAR NODE - WIFI BACKBONE
- SMALL NODE - WEEKLY GATHERINGS
- SMALL NODE - DAILY GATHERINGS
- RURAL NODE - DAILY GATHERINGS
- VILLAGE NODE - DAILY GATHERINGS

Figure 1.33 [Right]
Location in Network.

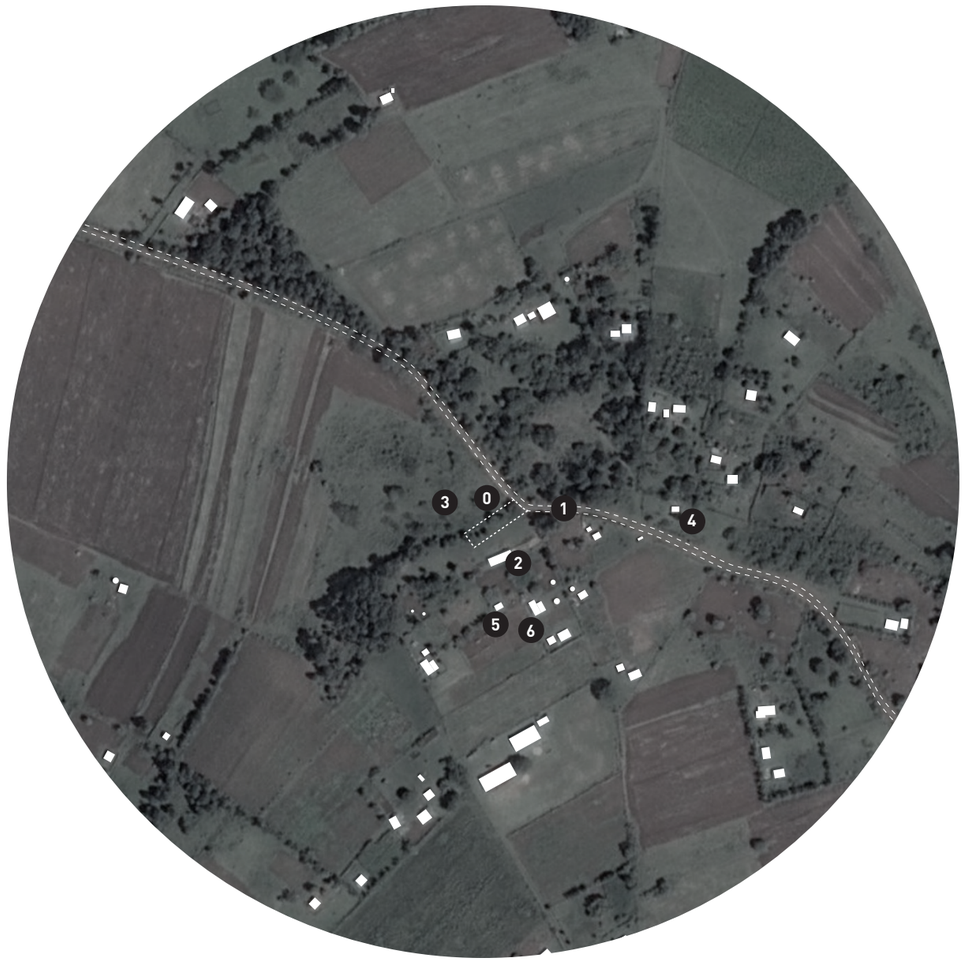


Figure 1.34 [Above]
Cattle Dip Node Site Plan.

Numbers correspond to photos on next page.

0. Proposed Node 1. Road to Dip 2. Cattle Dip 3. View of Valley
4. Mud House 5. Mud + Thatch House
6. House where Women's Group Meets

Figure 1.35 [Top Left]
Every week, cows are herded to a cattle dip run by a women's group. (1 on map)

Figure 1.36 [Bottom Left]
Cows jump into pesticide solution to prevent deadly ticks.

Figure 1.37 [Top Right]
Cattle Dip. (2 on map)

Figure 1.38 [Bottom Right]
View of river valley from proposed node. (3 on map)

Figure 1.39 [Top Left]
Tall eucalyptus trees penetrate the proposed building.

Figure 1.40 [Bottom Left]
Mud and thatch roof house. (5 on map)

Figure 1.41 [Top Right]
Mud house along road. (4 on map)

Figure 1.42 [Bottom Right]
Mud and concrete house where meetings are held. (6 on map)

This node provides spaces which can be flexible to accommodate their meetings but also hold larger gatherings. Outfitted with WiFi, a computer and projector, the group can better advertise their events and products made here on site and hold video meetings with people outside of the community. The projector can be used on the outdoor screen, or inside for smaller group meetings.

On the roadside, is a water station which uses water collected from the roof. Displayed to convey how the system works, water filtering pots are used at the fill station. These pots are made right here on site and are available in the gallery. A service window is used by those who have come to pay for their cattle to be dipped or pay for charging/tech services. A covered outdoor space with stairs leading down towards the beautiful river valley function as a large meeting space. Existing eucalyptus trees penetrate the space. The workshop opens to the view and expands onto the covered deck. A gated outdoor space is used for storing pottery and wood next to the kiln. Washrooms and a wash station are provided on site and a large dung drop used for biofuel.

A larger dung drop is located here so farmers can bring their cattle's waste and receive some payment. Some communities have started to do this, and in turn a microeconomy is created while using a greener process to create electricity or fuel. The kiln and dung drop could be outfitted to fuel the firing of the pottery or be collected by a tea farm and used as fuel in the drying process. Space for bikes is also provided should the women's group expand their services over time.

Given the remote location of this node, bikes help get nearby community members to larger nodes found in Kokwet or Mosoriot.

The **key stakeholders** of this site are the members of the women's group, Nandi County government, local participants and the tea plantations within Nandi County. The women's group currently owns the property and runs the cattle dip which earns them money. With the government subsidy for the technology, the women's group could build phase one of the project. **Phase one** is the shop and roadside area with charging, WiFi and a clean water fill station. Phone charging, WiFi access, and items sold from the shop will be the secondary income for the group and will help build phase two of the project. **Phase two** includes a larger workshop and outdoor learning space. The cattle dip, gallery shop, and workshop will all help to create a constant flow of money through the site. This will help with job creation, site maintenance, and feed the low-interest loans the women's group offers people in the community.

The **external stakeholders** of this node are the participants and customers. People can partake in the learning and training opportunities offered onsite. They are the customers of the services and goods this node provides.

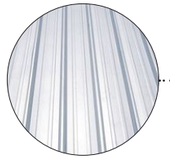
A dung drop can be added during any phase of the project as it is inexpensive infrastructure. People bringing their cows to be dipped can also bring cow dung for the drop and receive payment from the women's group. Once the dung drop is filled, it is collected and transported to a larger dung collector which is then transported to the tea plantations and used for fuel. Tea requires large amounts of fuel in the drying process and cattle waste can be used as biofuel for this. As a result, a **stakeholder** in this site is the tea industry which pays for the biofuel the women's group have been collecting.

Figure 1.43 [Right]
Building Materials.

Local building materials, crafts and innovations are used in the building for construction and water filtration.

Figure 1.44 [Bottom]
Catalogue Components.

*See Component Catalogue in Appendix for detailed descriptions.



METAL ROOF
For small roofs, metal is preferred when collecting water as opposed to thatch roofing which absorbs a portion of rain water.

RAMMED EARTH
Most buildings in the community are made of mud and wattle or earth bricks. Rammed earth walls gives a traditional look to Nandi construction while being structurally sturdy and secure.

PAPYRUS REED MATS
Growing locally in the marsh just down the hill from this node is papyrus. Drying and stringing reed mats is a local practice. The mats are used as a false ceiling to help control temperatures which are not moderated with metal roofing.

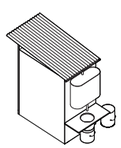
CLAY POTTERY
Pottery with sugar cane husk and wood chips can filter 97.9% of bacteria from water. The pots are made on site, and used to clean water for the fill station. This local practice helps generate an income and works well with existing water collection practices.

CALABASH
Dried decorated gourds are still made in the community and given as gifts. Traditionally they were are used to carry water and milk and are used as lamps in this node.

STAKEHOLDERS:

WOMEN'S GROUP
NANDI COUNTY GOVERNMENT
LOCAL PARTICIPANTS/CUSTOMERS
TEA PLANTATIONS

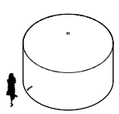
CATALOGUE COMPONENTS:



FRESHLIFE TOILET

BIOFUEL TANK + DUNG DROP

BIKES

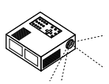


CLEAN WATER FILL STATION

WIFI

ELECTRICAL OUTLETS

LAPTOP



PROJECTOR

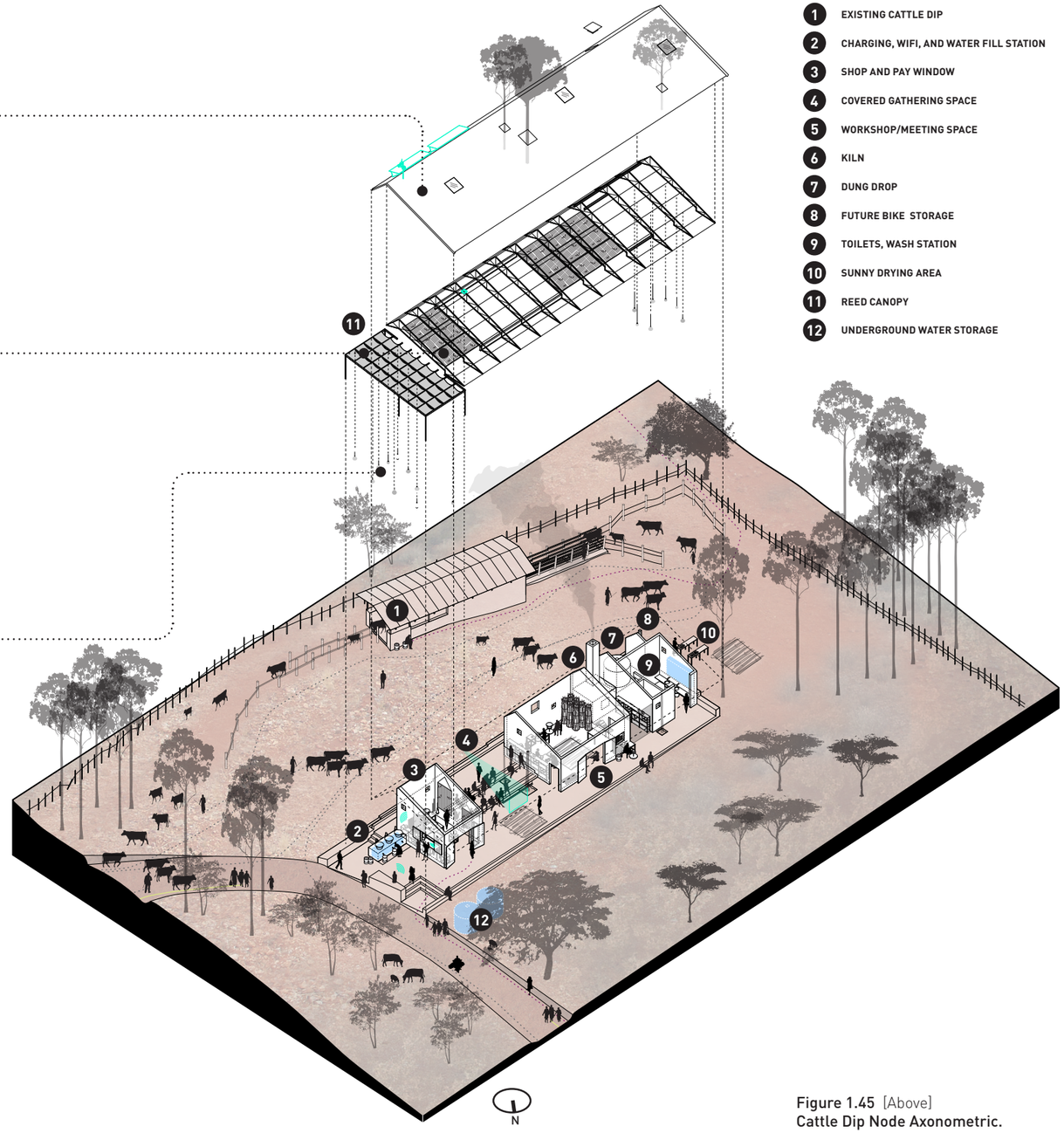
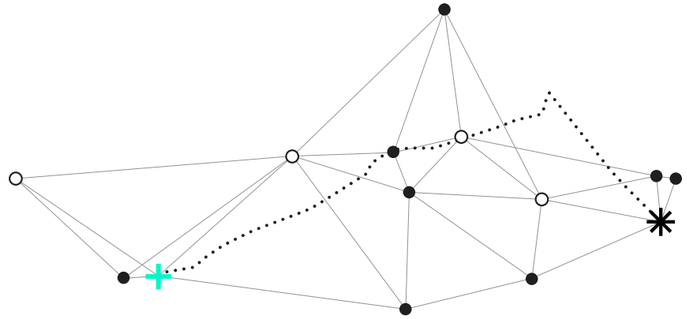


Figure 1.45 [Above]
Cattle Dip Node Axonometric.

Kokwet Node



This is the largest node within the rural network and provides multiple different services requiring internet. It uses the grounds of Kokwet Primary and Secondary School. The Kenyan government aims to have ICT in 100% of schools to create better digital literacy within youth. As a result, the government is one of the larger **stakeholders** in this node given that it's an extension of the two schools.

Although this node serves students and teachers, it largely serves the public and those not able to attend school. The proposed building makes use of the main road-front where filled pit latrines sit un-used. People passing by can easily access all amenities, many of which open their doors to the street.

LEGEND

- LINEAR NODE - WIFI BACKBONE
- SMALL NODE - WEEKLY GATHERINGS
- SMALL NODE - DAILY GATHERINGS
- RURAL NODE - DAILY GATHERINGS
- VILLAGE NODE - DAILY GATHERINGS

Figure 1.46 [Above]
Location in Network.

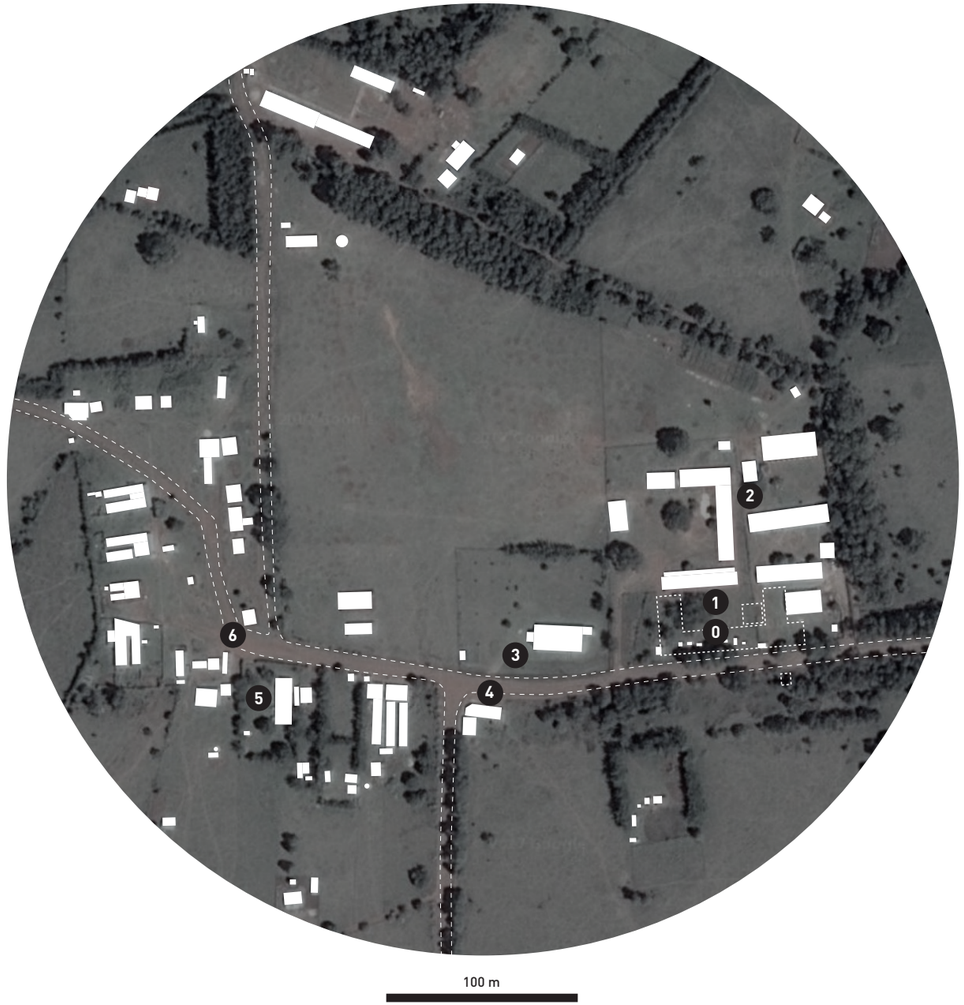


Figure 1.47 [Right]
Kokwet Node Site Plan.

Numbers correspond to photos on next page.

0. Proposed Node 1. Proposed Courtyard 2. School Kitchen
3. Church 4. Shops 5. Health Clinic 6. Chief's Office

Figure 1.48 [Top Left]
Proposed building will replace filled pit latrines and make use of road front. (0 on map)

Figure 1.49 [Bottom Left]
Interior of Classrooms. (1 on map)

Figure 1.50 [Top Right]
Existing Classrooms. (1 on map)

Figure 1.51 [Bottom Right]
School Kitchen. (2 on map)

Figure 1.52 [Top Left]
Neighbouring Church. (3 on map)

Figure 1.53 [Bottom Left]
Health Clinic. (5 on map)

Figure 1.54 [Top Right]
Kokwet Shops. (4 on map)

Figure 1.55 [Bottom Right]
Chief's Office. (6 on map)

The design mimics the courtyard conditions found on the site and maintains a clear axis from the main road to the opposite end of the school. At the center of it all is a covered gathering space with a fire for discussions and group meetings. The space celebrates traditional forms of knowledge exchange and invites those passing by into the site. Celebrating local building techniques, the thatch roof and its steep angles allow water to shed properly. With a heavy rainy season, the water shed from the roof is collected in a trench drain and carried to a water fill station. Skylights increase airflow and bring light into the high ceilings.

The DigiClassroom opens its doors to the street and is used by both students and the public. During school hours, the classroom and laptops can be used by students, and afterhours by the public. A 24hr computer and WiFi space with charging is always available for anyone's use. The proposed E-Library uses the existing schools' books which do not currently have a library space. Computers are connected online and contain an offline digital library, health and government information. The space can be easily adapted to accommodate for small group gatherings and screenings. On the second level are the residences. This is an important piece of program for teachers who are currently enduring long commutes, or for those who maintain the Kokwet Node. Rural schools have historically had a harder time acquiring teachers because of the lack of decent living space and resources such as communication and clean water. This residence helps to accommodate those who may not live locally or give employees a place to live and thus increasing the likelihood of their commitment to the site.

Across the road is the E-Market funded by M-Pesa. This new market allows people to sell food in one place rather than walking from neighbour to neighbour or having to walk several hours to Mosoriot's market. This time saved from eliminating the commute could allow for time to access information at this ICT hub. People could work online for a few hours, gather data to help with their crops, or access the e-health resources. Each market stall is outfitted with power allowing vendors to keep their cellphones charged to permit the use of M-Pesa money transfers. This is ideal for rural communities where banks are hours away and on-hand cash is limited. Not only will M-Pesa transfers occur frequently at the E-Market, but people will be able to fill their M-Pesa accounts at the vendor. Prior to this proposal of an ICT network, vendors could not set up shop in this rural area because there was no internet connection. Now they can, and as a result, M-Pesa is very likely to be a **stakeholder** in both the vendor shop and E-Market.

Tea plantations will be a smaller **stakeholder** in this node next to the county government and M-Pesa. A large dung drop at the node's roadside makes dropping off dung easy for those herding cattle along the busy road. Tea plantations collect the biofuel and use it in the tea's drying process. The school and node are paid by the plantations for the fuel, and the funds can go towards future development or maintenance. Some tea plantations are foreign companies and Kenya is starting to increase the amount of money these companies contribute to development initiatives within the country. Kenya could make investments in ICT a requirement of the foreign company's corporate social responsibility plans. These requirements would feed large amounts of money to ICT programs within Kenya including the development of the Kokwet Node represented in this nonformal learning network.

EXISTING PRIMARY SCHOOL

1. EARLY LEARNING
2. CLASSROOMS
3. CLASSROOMS
4. KITCHEN
5. CLASSROOMS AND ADMIN
6. CLASSROOMS

EXISTING SECONDARY SCHOOL

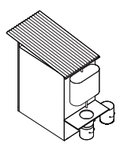
7. FUTURE DINING HALL
8. STORAGE
9. KITCHEN
10. CLASSROOMS
11. CLASSROOMS
12. ADMIN, PROPOSED HUB ADMIN, PROPOSED EQUIPMENT ROOM

13. ST. JUDE CATHOLIC CHURCH

STAKEHOLDERS:

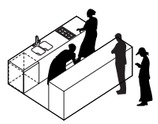
NANDI COUNTY GOVERNMENT
M-PESA
KOKWET PRIMARY AND SECONDARY SCHOOL
TEA PLANTATIONS

CATALOGUE COMPONENTS:

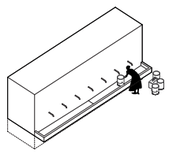


FRESHLIFE TOILET

BIOFUEL TANK + DUNG DROP



CHAI CAFE



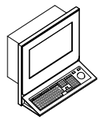
CLEAN WATER FILL STATION

WIFI

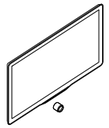
ELECTRICAL OUTLETS

LAPTOP

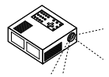
DESKTOP COMPUTER



24HR ACCESS COMPUTER



TELEVISION (KIPTANG'ANYIIT) + WEBCAM



PROJECTOR

TABLETS

Figure 1.56 [Left]
Catalogue Components.

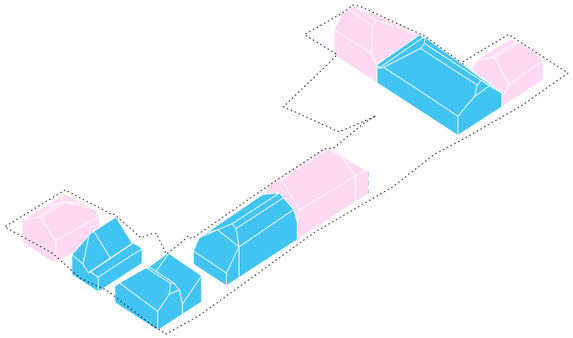
*See Component Catalogue in Appendix for detailed descriptions.

Figure 1.57 [Above]
Kokwet Site Axonometric.

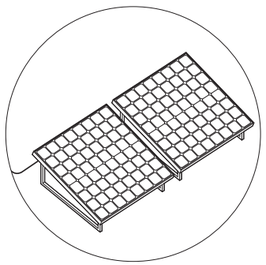
The proposed building along the road maintains the existing courtyard conditions of the site and forms a clear visual path through the site.

PROPOSED KOKWET NODE

14 PHASE 2 VIDEO MEETING ROOMS
15 VIDEO MEETING ROOMS, TOILETS, WASH STATION
16 STORAGE/FUTURE GARBAGE, DUNG DROP, RECYCLE
17 WATER STATION
18 DIGICLASSROOM
19 24HR COMPUTER AND WIFI ZONE
20 PHASE 2 DIGICLASSROOM EXPANSION, VIDEO MEETING ROOMS
21 FIRE GATHERING SPACE
22 LIBRARY, E-LIBRARY
23 PHASE 2 LIBRARY EXPANSION
24 PHASE 2 CYBER PRINT SHOP
25 M-PESA AGENT
26 M-PESA MARKET STALLS
27 PHASE 2 MARKET EXPANSION
28 RESIDENCE
29 PHASE 2 RESIDENCE
a SOLAR PANELS
b MARKET STALL CHARGING

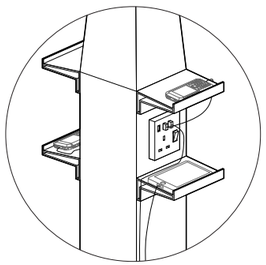


PHASE 1 BUILDINGS
PHASE 2 BUILDINGS



a

SOLAR PANELS
The site has access to grid power but with frequent blackouts, the node needs backup power. In addition to the solar power, there are backup power units to keep basic services running such as the TV White Space network and WiFi provided on site.



b

MARKET STALL CHARGING
This allows market vendors to charge their phones while using M-Pesa services with customers. The market is sponsored by M-Pesa which helps to pay for the power and initial construction. M-Pesa benefits from earning a percentage of each transaction completed.

Figure 1.58 [Top]
Phasing Diagram.

The Kokwet Node can expand and shrink as needed underneath the large canopy roof.

Figure 1.59 [Left]
Detailed Elements.

Solar panels are used to power the proposed building and charging is available at each of the market stalls.

Figure 1.60 [Above]
Kokwet Node Axonometric.

Figure 1.61 [Top]
Vignette of View Corridor.

THATCH ROOF
Thatch roof requires steep slopes to shed water properly. The material is still used in the community in addition to metal roofing. The Council of Elders felt traditional building materials were important to incorporate in this community ICT hub.

RAMMED EARTH
Most buildings in the community are made of mud and wattle or earth bricks. Rammed earth walls gives a traditional look to Nandi construction while being structurally sturdy and secure.

EUCALYPTUS WOOD
The structure supporting the roof in phase 2 areas is constructed of wood. This allows for its re-use elsewhere in the hub or community as the node grows. Eucalyptus is a fast growing tree farmed locally, and is a strong, durable building material.

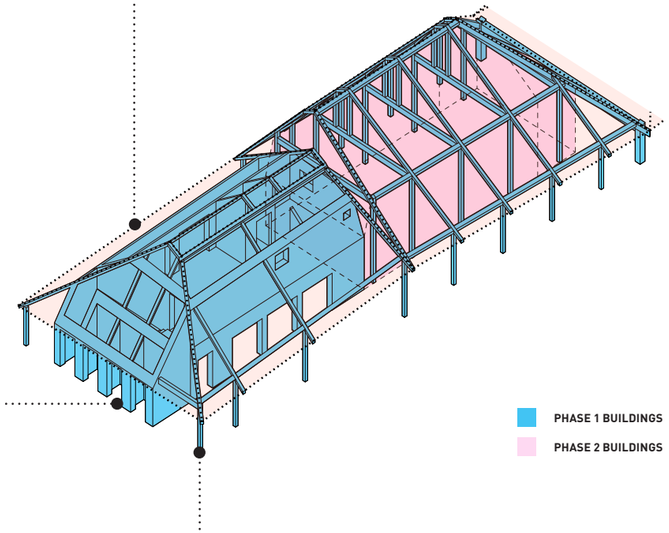
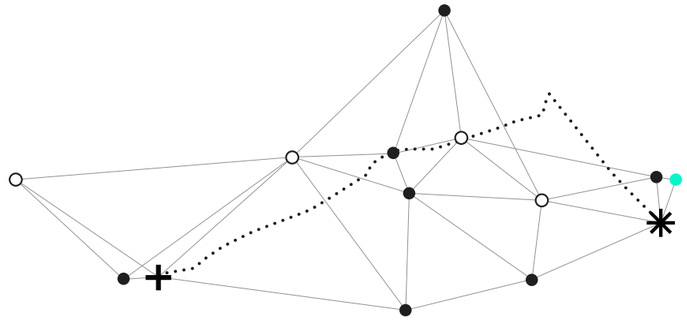


Figure 1.62 [Above]
Building Materials and Structural Phasing.

The building's structure in areas where expansion can occur is built from wood. This allows for easy expansion and reuse of materials elsewhere in the network.

Mosoriot Health Node



On a much smaller scale, looking at how these technologies fit into local construction methods is critical. The Kenyan National ICT Master Plan aims to create a substantial community health network where 100% of health centers are equipped with ICT. Their goal is to provide each health centre with one computer, a printer, and a WiFi hotspot. The following design proposal uses an existing health centre as the test site where the proposed a pre-fabricated panel is inserted into the existing concrete block wall. Following this proposal, is the same technology but inserted within a newly constructed rammed earth wall. The design builds upon existing strengths of vernacular architecture in the region.

Traditional Nandi huts are constructed out of wattle and daub with a wood and thatch roof. Where roof members meet the wall of the hut, an air space exists allowing for ventilation. Maintaining this airspace in the construction of tech walls is crucial and allows for the WiFi signal from the router to extend both inside and out.

LEGEND

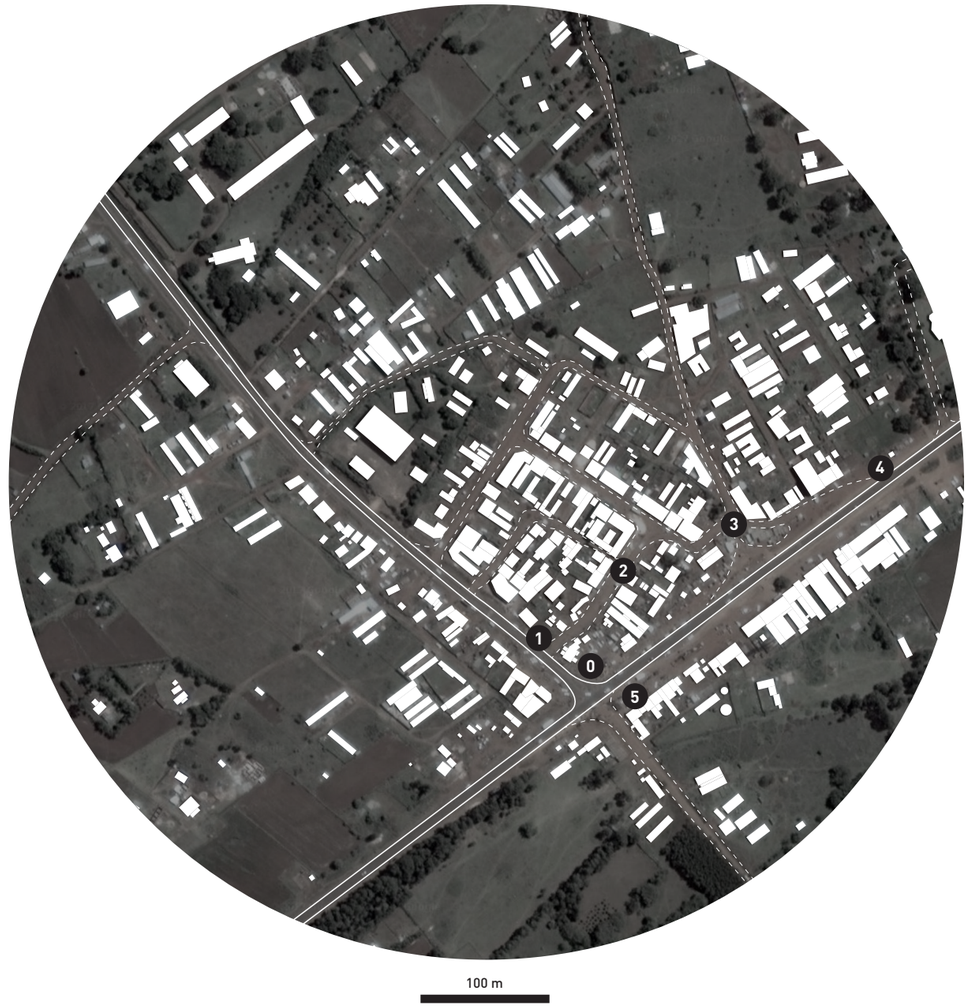
- LINEAR NODE - WIFI BACKBONE
- SMALL NODE - WEEKLY GATHERINGS
- SMALL NODE - DAILY GATHERINGS
- RURAL NODE - DAILY GATHERINGS
- VILLAGE NODE - DAILY GATHERINGS

Figure 1.63 [Above]
Location in Network.

Figure 1.64 [Above]
Air Space in Traditional Nandi Hut.

Figure 1.65 [Right]
Mosoriot Health Node Site Plan.

Numbers correspond to photos on next page.



0. Proposed Node 1. M-Pesa Fill Station 2. Post Office
3. Milk ATM 4. Clean Water 5. Roadside Market

Figure 1.66 [Top Left]
Boda Bodas wait to give rides to passengers. (0 on map)

Figure 1.67 [Bottom Left]
Butcher and hotel (restaurant) adjacent to chemist. (0 on map)

Figure 1.68 [Top Right]
Chemist: proposed site of tech wall. (0 on map)

Figure 1.69 [Bottom Right]
M-Pesa Fill Station. (1 on map)

Figure 1.70 [Top Left]
Post office receiving internet via satellite. (2 on map)

Figure 1.71 [Bottom Left]
Clean Water Fill Station. (4 on map)

Figure 1.72 [Top Right]
Milk ATM where you can deposit milk for cash/buy milk. (3 on map)

Figure 1.73 [Bottom Right]
Roadside Market. (5 on map)

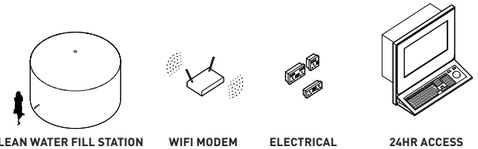
At this node, a pre-fabricated tech wall is transported to the site and fit into the exterior wall of an existing Chemist, or health centre. The tech wall contains the minimum required technology to create an internet connection as well as a 24hr computer and outlets for charging capabilities. The node sees heavy foot and vehicle traffic as sits at the corner or two major roads, and adjacent to a petrol station.

The government is a **major stakeholder** in this site given that it's a health centre, however, this tech wall can be inserted into any existing building. Any business or building owner looking to create a node or connection to the internet can order or recreate this panel and insert it within an existing wall. The wall can generate revenue for the owner if they decide to charge a small fee for cell phone charging or computer use. Local barber shops and cybers already charge a small fee for cell phone charging and now WiFi could generate another income. Microloan lenders could also be **stakeholders** within these smaller nodes and help fund the tech walls. The businesses which construct and transport these panels could also be stakeholders in the projects and allow a monthly payment plan to those who have ordered a panel. Solar panels have been successfully financed in a similar way.

STAKEHOLDERS:

NANDI COUNTY GOVERNMENT
HEALTH CLINIC OR BUSINESS OWNER
MICROLOAN LENDER

CATALOGUE COMPONENTS:



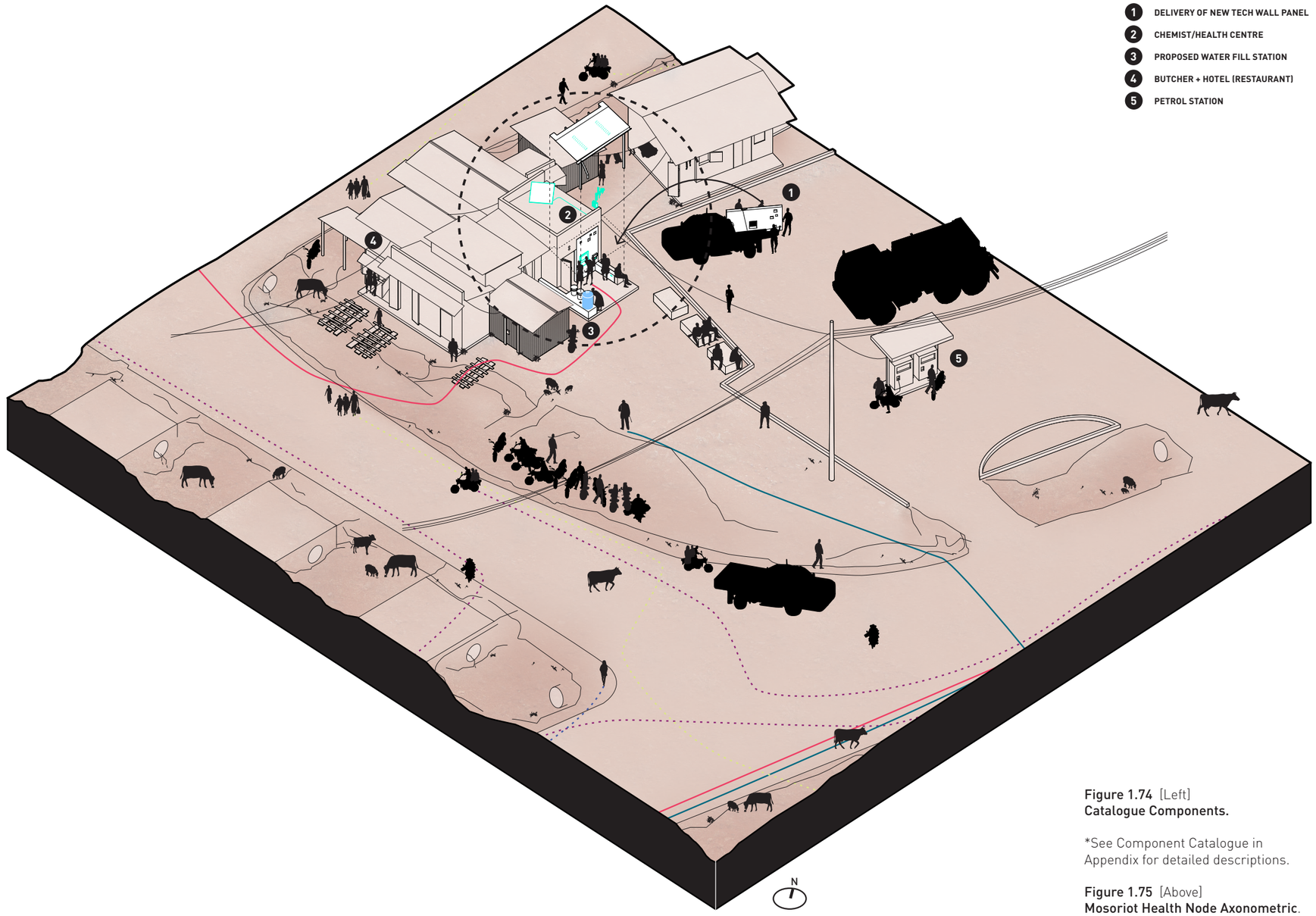


Figure 1.74 [Left]
Catalogue Components.

*See Component Catalogue in Appendix for detailed descriptions.

Figure 1.75 [Above]
Mosoriot Health Node Axonometric.

The tech wall panel is inserted into an existing chemist shop at the intersection of two major roads.

Tech Wall Panel

The pre-fabricated tech wall is used which is a framed with local eucalyptus wood. Electrical wiring runs along an air space behind the framing and access panels cut into the wall cladding make repairs simple without having to take the panel apart. The panel is designed to withstand forces from roof loads or a second level. The cladding is corrugated metal which is readily available in most villages, including Mosoriot in this case, and can be easily cut to include windows and openings.

1. EXISTING OR NEW ROOF
2. SOLAR PANELS
3. LIGHTING FOR SECURITY AT NIGHT
4. EXISTING OR NEW STRUCTURE CAPABLE OF RAINWATER COLLECTION
5. INTERIOR METAL PANELS WITH ACCESS DOORS TO TECHNOLOGY
6. TV WHITE SPACE ANTENNA AND RADIO
7. STRUCTURAL FRAMING FOR EXISTING LOADS
8. WIFI ROUTER AND BACKUP POWER
9. SOLAR POWER INVERTER
10. OPTIONAL SERVICE WINDOW
11. 24HR COMPUTER
12. HIGH ELECTRICAL OUTLET AND PHONE SHELF
13. SITE-POURED CONCRETE BASE/KICK PLATE
14. FASTEN TO EXISTING WALLS
15. OPENING FOR WIFI PATH
16. OPENINGS FOR VENTILATION
17. EXISTING WALL

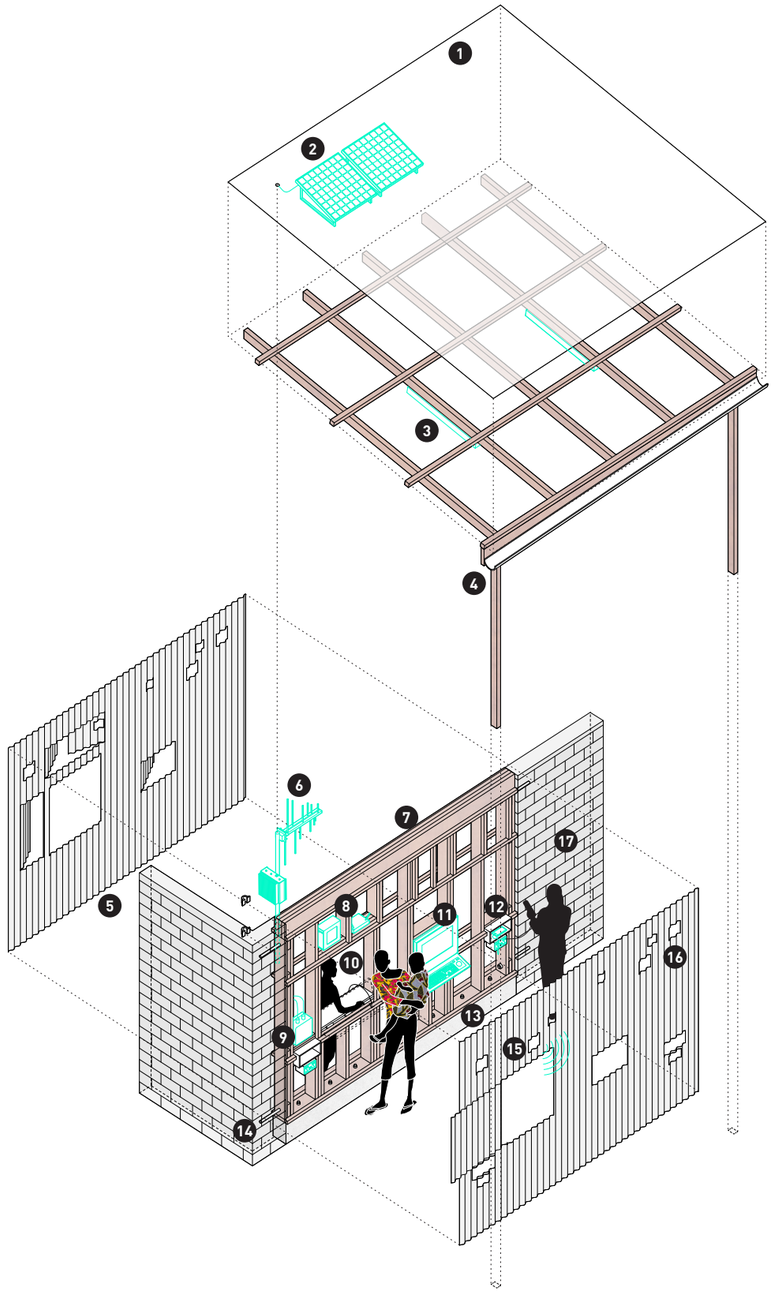


Figure 1.76 [Right]
Tech Wall Panel.

This panel can be inserted into any wall and is outfitted with connected technology. The panel can be easily adapted to include a window (shown here) or additional elements. It can be constructed off-site and shipped via a standard-sized truck with on-site poured concrete for extra stability.

Technology in Proposed Rammed Earth

Within the new rammed earth construction, cables run along a cable tray at the top of the wall and into the wall via bamboo conduit. Broken wires or sockets can be easily removed and pulled out from the top of the wall. An optional concrete bench is constructed from soil-filled water bottles and chicken wire. This technique decreases the amount of concrete needed and therefore decreases the shipment load and embodied energy of the node. It also makes use of the littered bottles throughout these communities which have no waste or recycling programs.

1. ROOF
2. VENTILATION AND WIFI PATH
3. LIGHTING FOR SECURITY AT NIGHT
4. FRAMING WITH HOLES FOR WIRING
5. ROOF STRUCTURE CAPABLE OF RAINWATER COLLECTION
6. WIFI ROUTER ON STAND OVER CABLE TRAY
7. CABLE TRAY AND WIRING
8. BAMBOO CONDUIT IN WALL
9. 24HR COMPUTER
10. HIGH ELECTRICAL OUTLET AND PHONE ALCOVE
11. ELECTRICAL OUTLETS AND WIRING EASY TO REPLACE
12. ELECTRICAL WIRES IN BAMBOO SHADING DEVICE
13. IN-BENCH ELECTRICAL OUTLETS
14. SITE-POURED CONCRETE BENCH WITH SOIL-FILLED WATER BOTTLES IN CHICKEN WIRE

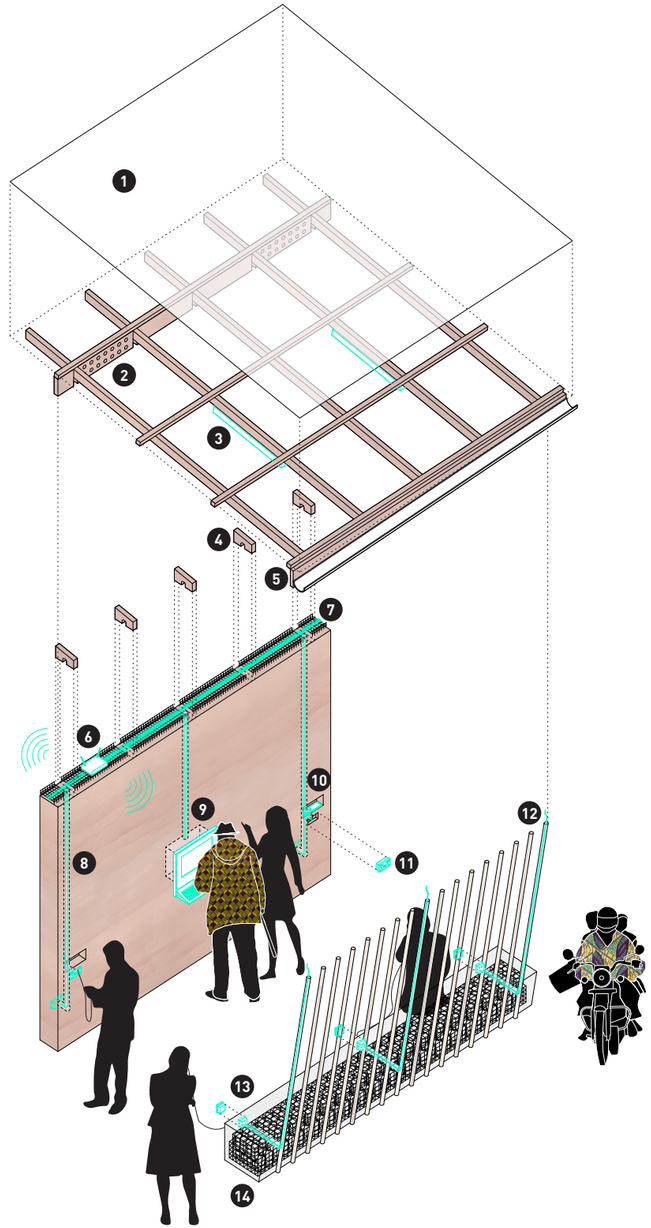


Figure 1.77 [Right]
Technology in New Rammed Earth Construction.

Earth is the most common building material in this rural area. In the proposed nodes, rammed earth walls are outfitted with bamboo conduit for easy wiring and replacement of elements. A cable tray runs the length of the wall where an airspace is usually located within locally built architecture. This airspace also allows WiFi to travel through the wall construction and makes for easy cable placement.

CONCLUSION

Information and Communication Technology has become a necessity in the technological world we live in today. Kenya is making it one of their top priorities to increase digital literacy within schools and institutions throughout the country. ICT has enabled people to access online microloans to start their own businesses and support community groups' efforts. It has enabled almost everyone in Kenya to transfer money via cell phone instead of traveling several hours to distant banks. The internet has become a tool for standing up for human rights, for accessing information, uploading data and sharing content relevant to each person's life and community. The capabilities of what technology can do for communities is endless, but how the technology develops from community to community will affect its success and how that place progresses.

The success of these technologies depends on their ability to integrate and build upon the existing strengths of each rural community. As Ramesh Srinivasan points out, the successful technologies are those which have been developed from the grassroots.[57] Although technology and internet are helpful tools across disciplines and within the educational community, their downfall in rural communities like this is the lack of time people currently have to use them. In a survival-based community, new technology must also save its users time in the often-busy schedule of providing for a family.

Rural communities all over the world have experienced challenges in accessing equal resources to their urban counterparts. Jobs are less plentiful, infrastructure is more costly to build over large areas, and people are harder to service in terms of learning, community building and essential services. Especially challenging in rural Kenya, is providing equal learning opportunities to communities where driving to school is not an option. Schools are not only far away geographically, but they are often inaccessible because of poverty. This is where ICT can assist.

57 Srinivasan, *Whose Global Village?*, 67.

The technology can help bring more learning resources to rural communities and become a tool for learning within nonformal learning programs existing outside of school.

Elders are excited for what ICT can bring to their rural community. Throughout Nandi County, they have recorded stories and created a library available for listening. They hope to build a space where youth and future generations can engage in their cultural past. The architecture presented within the three design proposals and in the appendix build upon this type of locally-sourced information. Each aspect of the design from the overall network layout, to the individual components found in the matrix aims to strengthen traditional forms of knowledge exchange through the engagement of ICT. Each of the design proposals support spaces conducive to nonformal learning, but also engage in other aspects of society which are important in the community's development.

The process of design has been the most important in the development of this network and its architectural program. There are endless ways to design a building, but deciding what the architectural program is, or what materials and construction techniques to use is information that must come from local people. Giving local people agency in the design process is what makes projects like this successful. With a country as diverse as Kenya with different cultural groups, geography, learning styles and gathering spaces, no one design can be multiplied across the country. If an ICT network is to be successful in providing learning opportunities to people in rural areas, the local peoples' expertise in each respective community must be engaged.

How technology integrates into rural communities is a question which engages multiple disciplines and expertise. Acknowledging that local people are experts in their own community will strengthen any project, architectural or not. Providing equal learning opportunities to those living in rural areas is a challenge infrastructurally, economically, and socially, and each community will pose different challenges. How these evolving technologies

manifest into spaces of learning and daily life will be different from place to place.

M-Pesa's success began as a small, local effort and grew into the widespread, popular application it is now, but is it possible for all projects to begin as grassroots efforts? With technology progressing this rapidly, can smaller and local initiatives compete with larger companies or can they work together? Will the voices of communities be heard and valued in large-scale projects in the future? We live in a world that expects a greater respect for different cultures and ways of life, and these differences are what make a project unique and successful within its respective environment. The methods of development in any profession be it design, engineering, aid work, or technology, must engage with local people to make it truly successful. The design proposal illustrated in this body of work is a singular example of how ICT can create more accessible learning in rural areas, but the approach to design and the influence of local knowledge aims to inspire not only architects, but other professions interested in rural development.

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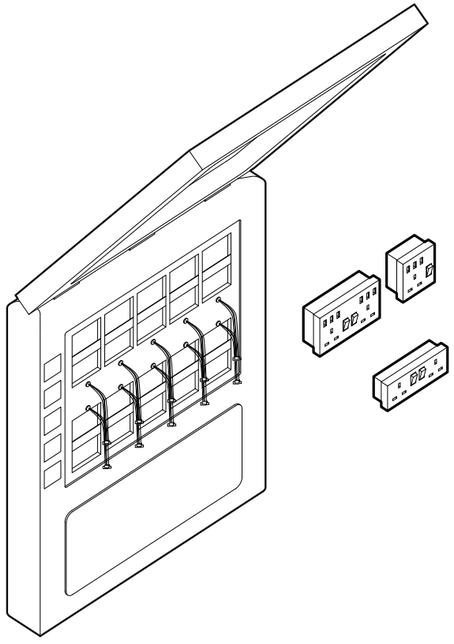
APPENDIX: COMPONENT CATALOGUE

Each node must contain the minimum required technology to gain a connection to the internet. The technology documented here can be added to enhance the nonformal learning spaces at each node. Also included in the catalogue is a set of infrastructure. Items such as clean water and sanitation foster longer visits at nodes and promote sustainable development in general.

Following the infrastructural components is the building matrix. It contains the architectural program that is locally relevant to this community and its traditional forms of learning. The spaces are not site specific but can be easily modified within the network or node.

The catalogue was developed from many conversations I had within the community. Some spaces grew from preliminary research, but most developed from observations or group discussions about ICT development. The gallery and listening room are two examples that grew from discussions with the council of elders. They are extremely important in this oral storytelling community and help to celebrate historical technology in addition to the proposed ICT. The site visit to Kenya was integral to the making of this catalogue.

Technology Add-ons

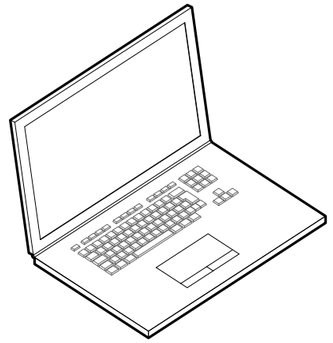


CHARGING

Some people walk to the nearby village one hour away to charge their phone. Adding outlets will attract those seeking power and create a new type of gathering similar to what is seen at barber shops in the village. A charging station will allow people to stay longer at the node locations if using personal devices.

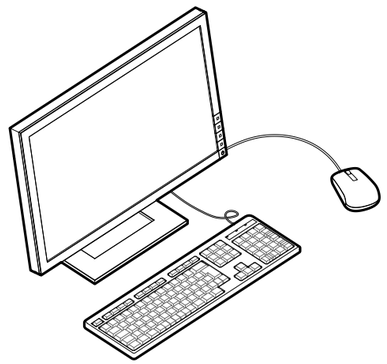
TABLETS

Tablets are currently being distributed by the government into some public schools. To charge many tablets is a much lighter electrical load than many computers. Being portable, students can take tablets home, or be loaned out for use.

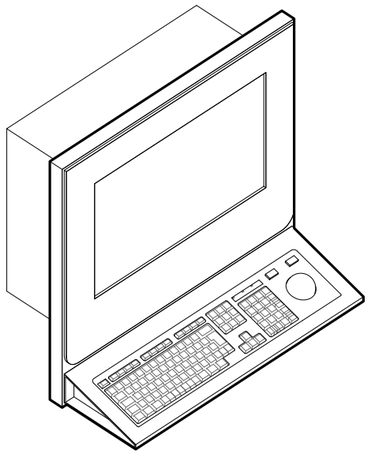


LAPTOP

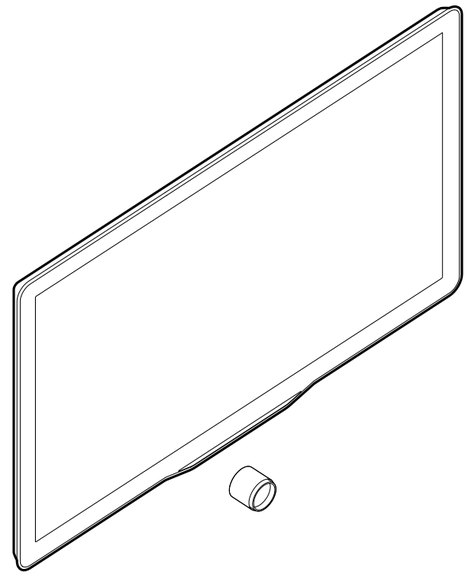
This portable computer works well in the DigiClassroom so teachers and students can use them in both computer classes, but also in other classes and subjects. Students can take them home, or community members can loan them out for learning, work or entertainment.



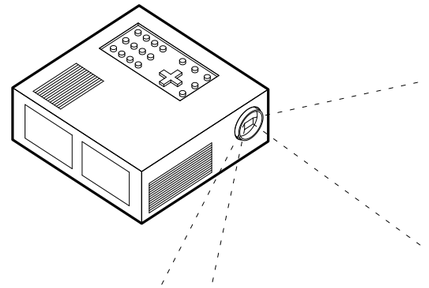
DESKTOP COMPUTER
Desktop computers at this node are used for administration and make up the E-Library. The library has two computers to start, and contain a digital library in addition to e-health and e-government.



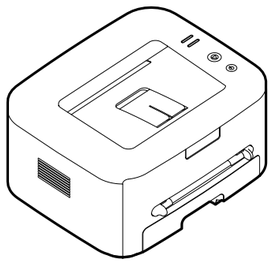
24HR ACCESS COMPUTER
The wall computer is outfitted with internet and information databases such as e-health and e-government. This computer is great for providing 24/7 communication and database services at health centres, libraries or other locations where personal devices might be scarce. Information can be easily downloaded onto personal devices and a microphone allows those who can not type/ write to access information and services.



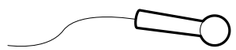
TELEVISION (KIPTANG'ANYIIT) AND WEBCAM
Televisions at this node are used primarily in the digital meeting rooms. The webcam attachment enables video conferencing which is extremely helpful for rural communities. Students can decrease the number of lengthy commutes to the university two hours away, and staff and community members can communicate more easily with distant family and friends.



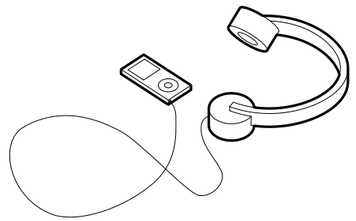
PROJECTOR
Projectors are provided in the DigiClassroom and Library space. They are used for teaching larger group lessons, gatherings and are portable to allow for outdoor screening.



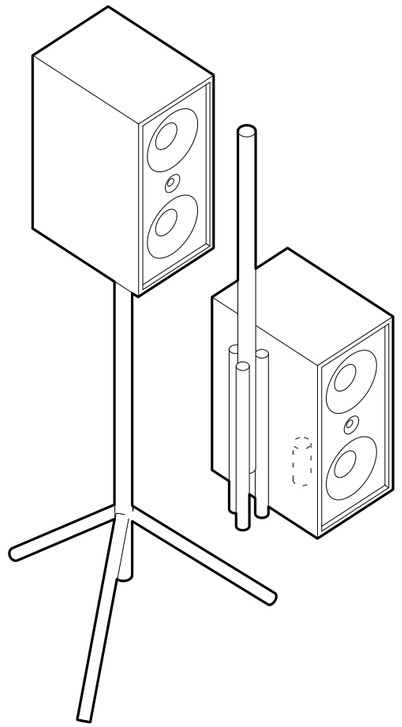
PRINTER
Printers allow those who do not own a cell phone or other personal device, the ability to take home information. These are especially handy at health clinics, the gallery, and cyber print shop.



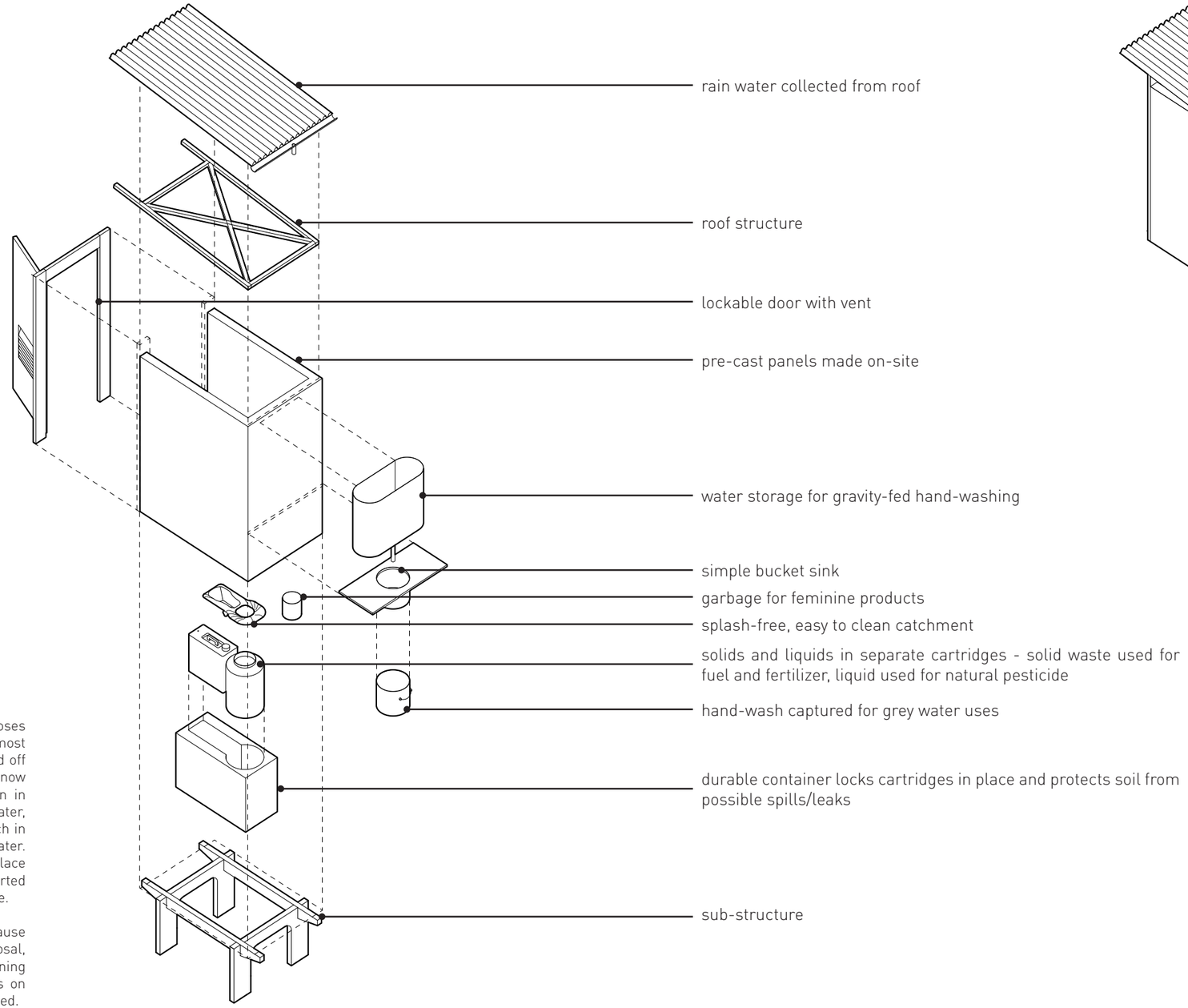
MICROPHONE
This is important in recording and preserving stories of those who do not read and write. Elders in the community can record their stories and share them in the Listening Room. It is also helpful when used with the loud speakers for larger community events and gatherings.

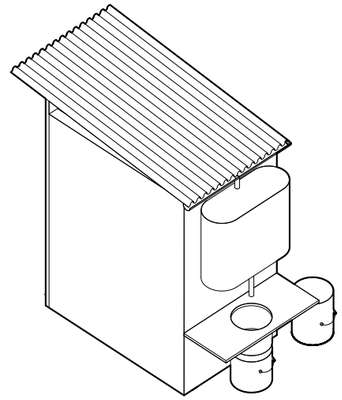


LISTENING DEVICES
Used in the Listening Room, these allow people to hear stories told by their elders, and other members of the community. Kalenjin music made locally is another popular method of telling stories.



LOUD SPEAKERS
Large events are popular in this community and take many forms. Loud speakers would aid in these events and could be rented from or used at the Listening Room creating a micro-economy.

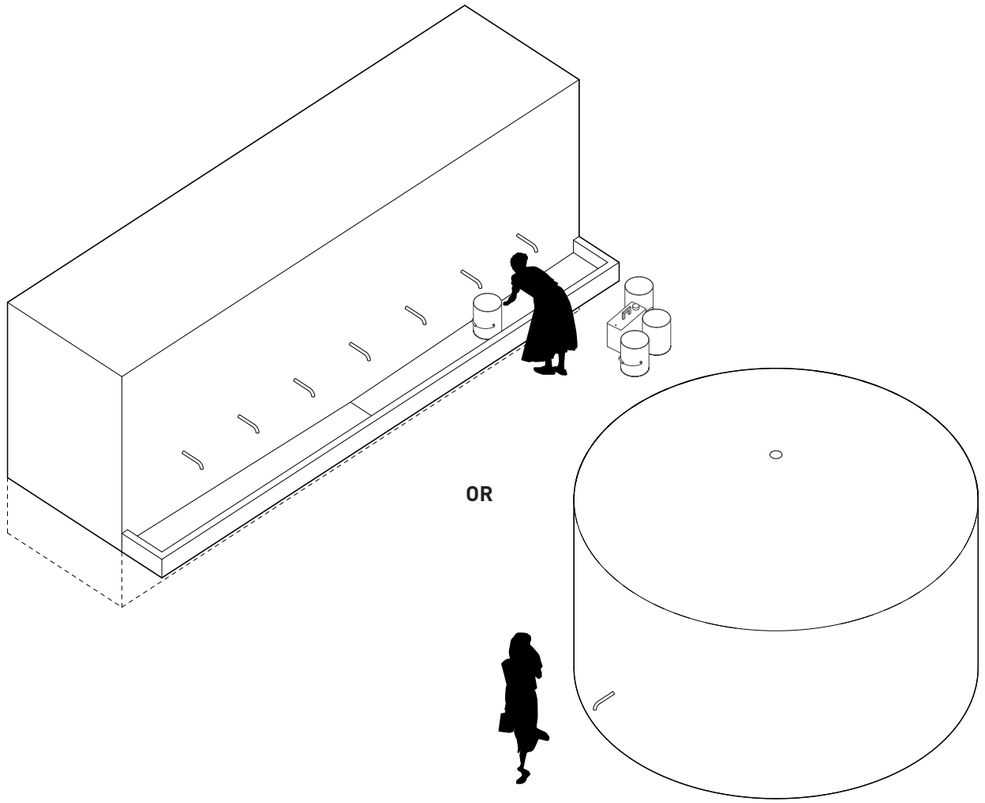




SINGLE LATRINE TOILET

Pit latrines are widespread in this community. This poses serious health risks as shallow ground water is the most common water collection method. This toilet is based off a model created by a company called FreshLife and now acts as one of the key models for future sanitation in Kenya. Waste does not pollute the soil or ground water, and the system produces jobs in the community which in turn, keeps toilets clean and stocked with soap and water. Workers remove the solid and liquid canisters and replace them with empty ones. The urine and feces is then carted away and used for fertilizer, fuel, and farming pesticide.

Proper sanitation is essential within the network because without adequate privacy, and feminine product disposal, girls attendance to school or other spaces of learning dramatically decreases. It is common for most girls on their period to stay home from school until it has passed.

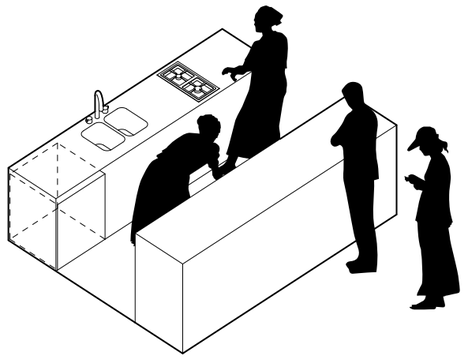


CLEAN WATER STORAGE

60 m3 (53 000L)

The UN says 50L/day per person is required for drinking, adequate cooking and personal hygiene. These tanks hold 53 000L which is the daily need of 1072 people in the 2.5km radius of the case study site. A well should pump water when electricity is available. That's based off the rural population density of 54.6 people/KM2.

Water in the community is primarily collected by hand through hand-dug wells or natural springs. Is it most cost effective to store water in the ground and then pump the water to the surface for storage.



CHAI CAFE

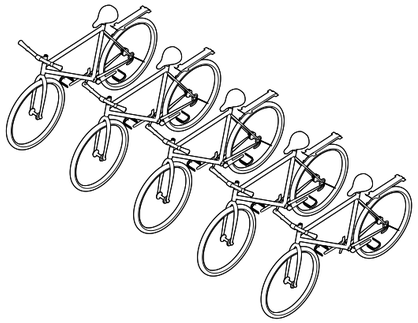
fridge = 30-75 L/hr
household burner 200-450 L/hr

Kenya's love their milky chai tea. This cafe's fridge and small stove can be powered by the biofuel collected by the community and school farm and help create income for the node where it exists.

BIOFUEL TANK + DUNG DROP

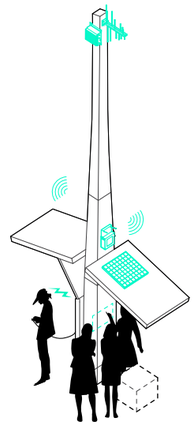
1 kg cow dung = 40 L biofuel
1 kg human feces = 50 L biofuel
1 kg chicken droppings = 70 biofuel

In this agricultural community, many families have at least one cow for producing milk. The county is also one of the largest tea producers in the world and requires huge amounts of fuel to dry the tea. Biofuel using agricultural waste is an opportunity for community members to make money while benefiting the tea farms by providing them with fuel. One cow defecates 15 times per day creating 42 kg of waste. That will produce 1680 L of biofuel! This is enough fuel to power a small cafe for over 6 hours.



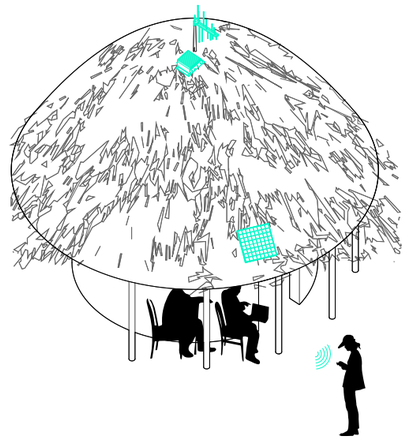
BIKES

Bikes are hugely popular in rural areas but are too expensive for many people. Bike rentals at the nodes could create a small income while serving those who need to access distant services or travel into Mosoriot and back. Made only a few hours away in Kisumu are "Buffalo Bikes" which can endure the rough bumpy roads of these rural areas. The bikes would also help to provide a safer way to travel for children and women.



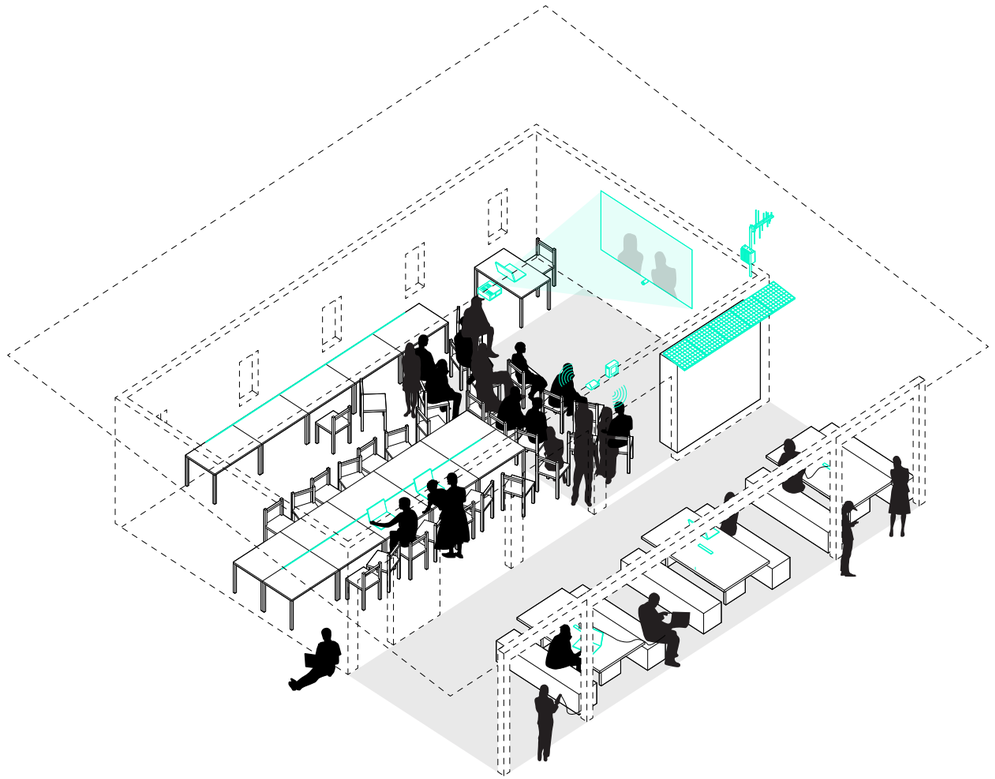
TECH POLE

The pole is complete with all components to provide a WiFi signal for personal devices within range of the unit. This unit is found along the WiFi path of the network. Where power lines and poles exist along the route, technology can be attached instead of providing the above structure. Locally-made shading devices cover a charging area and mounted screen at accessible height.



PRIVATE NODE

The Kenyan government aims to have 35% of homes equipped with ICT by 2030. Private properties outfitted with the TV White Space Technology could become part of the mesh network and could charge or lend WiFi to other community members.

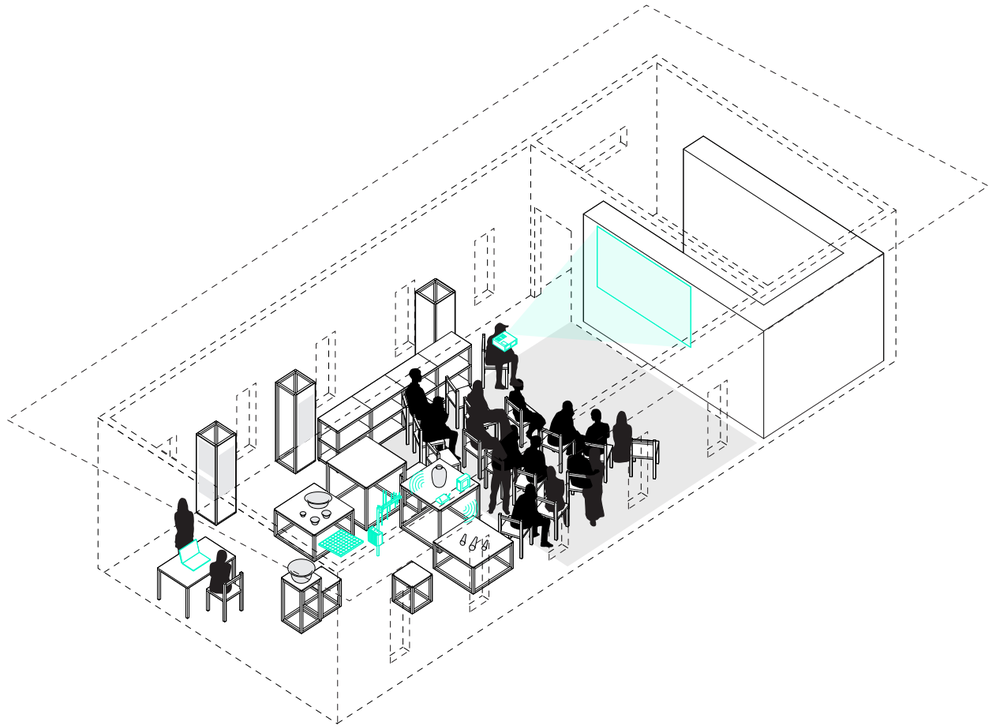


DIGICLASSROOM

The DigiClassroom uses laptops so students can use them in other classes, outside, or even take them home. Two chairs should fit at each desk for computer sharing. This also allows for children to teach parents after school. For group lessons, a teacher can hook up their laptop to a projector. This projector could also be portable for large movie showings outside. Sokkin private school has a 15-inch TV which they currently use for school-wide showings. That's one 15-inch screen for 220 students.

The DigiClassroom can also be used for after school gatherings or video conferencing. Desks with electricity can be unplugged and moved to arrange the room in a several formations.

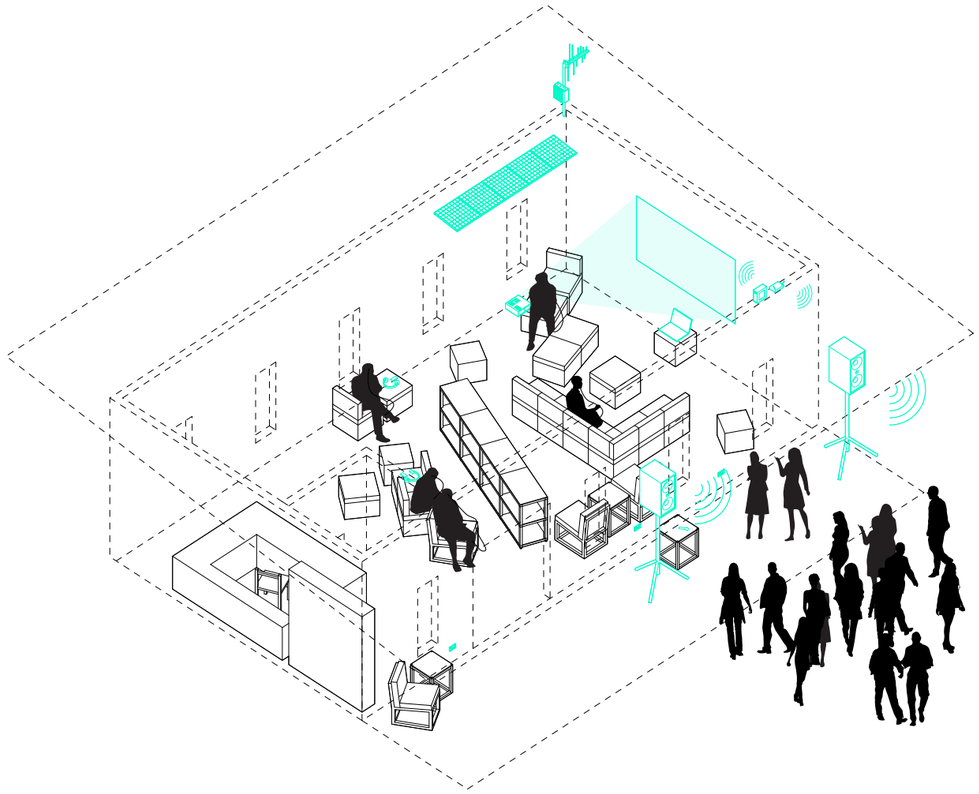
On weekends and certain week nights, computers can be used by community members for personal use or business. The school can charge for usage during certain hours to raise funds for expansion of resources. In the covered outdoor space, people can charge personal devices and connect to WiFi 24/7. The roof extends to provide a shaded outdoor area. Columns are outfitted with power at table height for protection from mud and for convenience while sitting.



GALLERY

The Gallery is a flexible space to display local artifacts, cultural items, or borrowed exhibits from other counties. It could house larger pieces such as sanitation and water filtration technology. The space houses new innovations created in the community, but also celebrates older cultural innovations. As new technology enters Nandi County, the literature department in the county's capital believes each component of ICT infrastructure deserves a name in the local language. This allows the language to remain strong rather than having to rely on the English names for communication. The gallery and support staff make this a priority.

The flexible display furniture allows for group learning or community meetings during non-gallery hours. A projection area on one wall is used for group screenings or exhibitions.



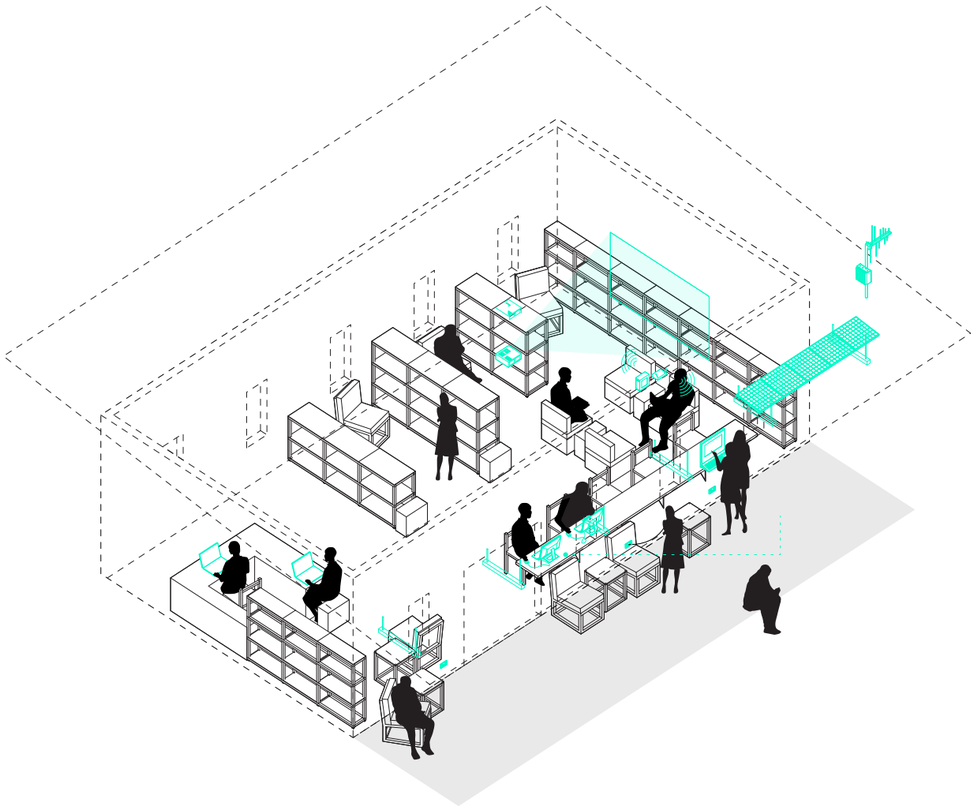
LISTENING ROOM

The council of elders has recorded stories told by elders in the community. The oral stories at risk of being lost will be preserved in an electronic database. In reaction to this, is a listening room housing a computer to store the stories, listening devices for personal use, speakers for large group listening and a space for meetings and in-person storytelling. Learning more about the community first hand has been the basis of all decisions made in the design proposal.

The community hosts a variety of large events and gatherings so loud speakers are a component within this program. A small storage room and recording room help store and create new stories told by community members.

FIRE PIT

This 3m radius area can seat 20 people. Women are the story-tellers in traditional Kenyan communities pre-colonial era. Stories are often told as a form of education and last the duration of meal prep and cook time.

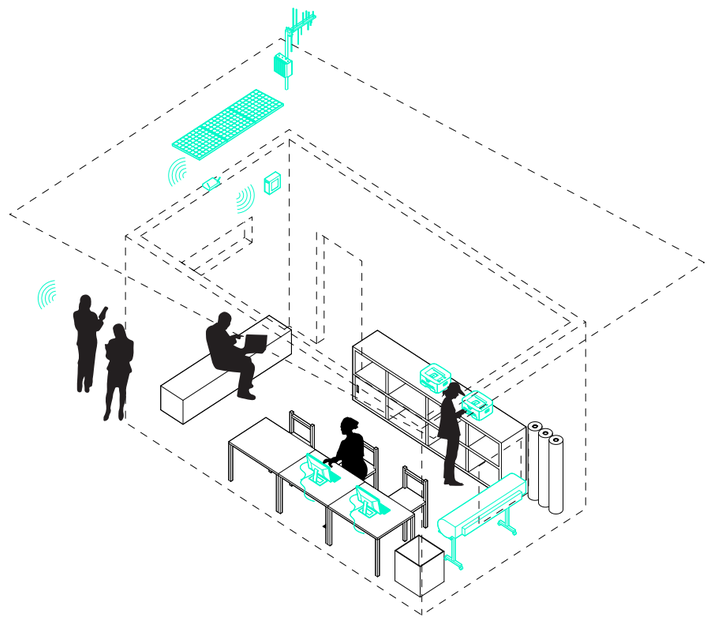


LIBRARY

The library contains books in addition to a digital library. Two computers for this are shown, but there is room for expansion if needed. Computers are connected online and contain a large resource library containing e-health, e-government and knowledge of many different subjects determined by local educators, community members and government.

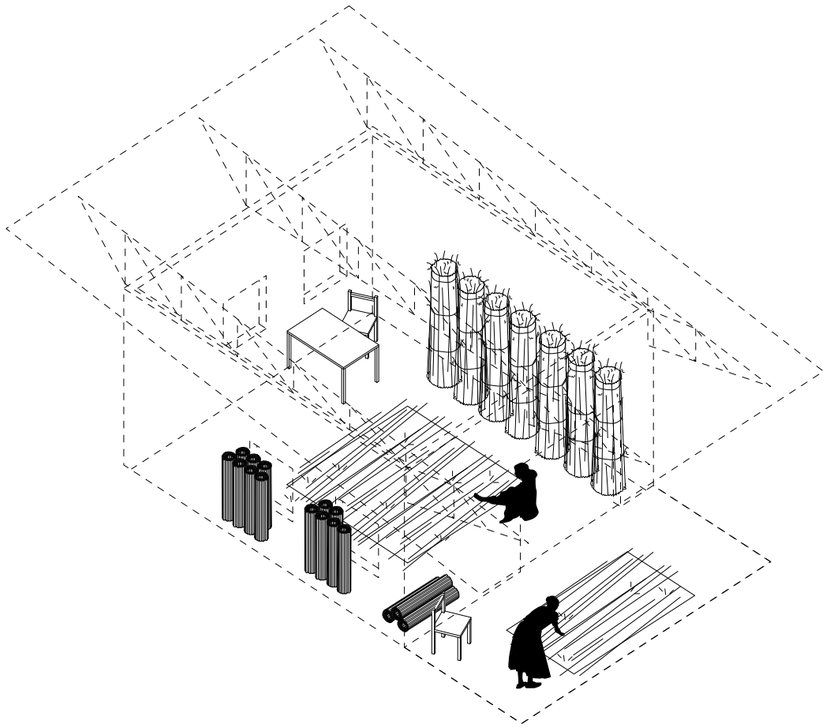
The seating area can be reconfigured to accommodate for small gatherings and meetings. A pull-down projection screen allows for videos.

A covered outdoor space with a stationary wall computer, WiFi, and electrical outlets is open 24/7 with lighting for security. The wall computer is also outfitted with internet and information databases such as e-health and e-government.



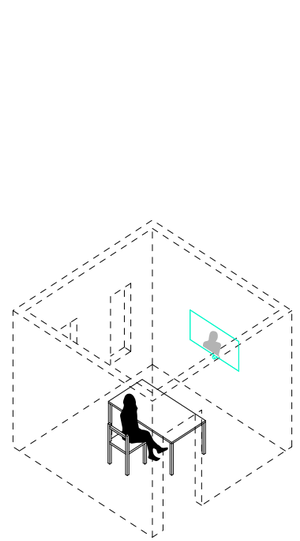
CYBER PRINT SHOP

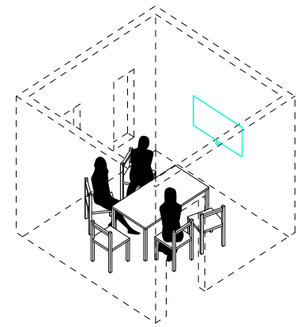
The Cyber Print Shop provides the community with printing, computer use, and WiFi. The gallery, schools, businesses, and individuals rely on the shop for its printing capabilities. Those without smart phones (which are many), can come here for accessing internet services. A gallery may have its own print-shop for adding income to the education it offers. WiFi allows the shop to use many computers and printers at once, and can make the shop more money by charging for the WiFi password.



WORKSHOP SPACE

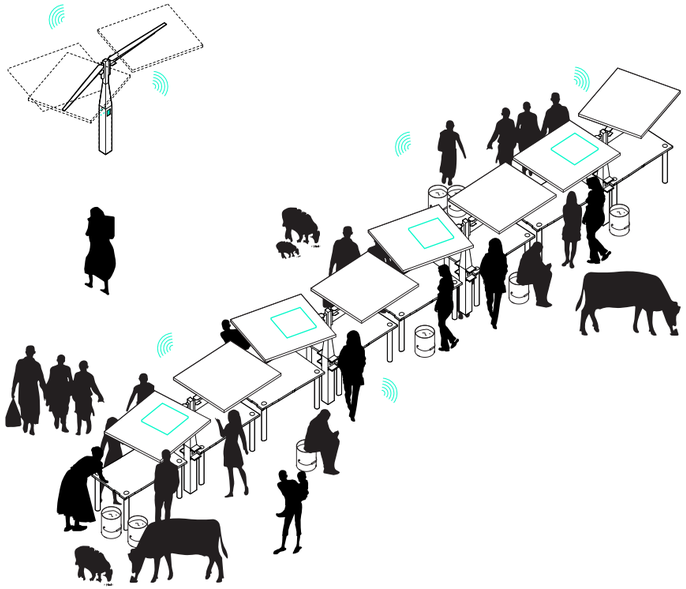
Also important in this ICT network, is the incorporation of traditional trades within the community. A workshop space can accommodate a number of different activities, and the ICT allows its users to market their products, gain information online, and offer charging and WiFi services as another potential income.





VIDEO MEETING ROOMS

Some students attending schools is Eldoret bike two hours one way. Video meeting rooms within the rural network allow students to cut down on lengthy commutes, but also give this video conferencing ability to other members of the community. Online video content can be viewed here, and the space accommodates small ground meetings.



E-MARKET

A market is something many people make use of in the community either buying or selling vegetables. A new market would allow people to sell food in one place rather than walking from neighbour to neighbour or having to walk to the distant Mosoriot market. This time saved from eliminating the commute, could allow time for accessing information at the ICT hub, working a few hours at an online job which the government believes is where the job market is going, or gathering data to help their crops or personal health. The e-market shown could be funded by M-Pesa and outfitted with power at each stall allowing vendors to keep their cellphones charged to permit the use of M-Pesa money transfers. This is ideal for rural communities where banks are hours away and on-hand cash is limited.

TREED AREA/OUTDOOR SPACE

This space is used for a number of traditional games and cultural practices. Spiritual places in traditional culture were often held in outdoor areas, lush with plant growth. The trees help in Kenya's goal to increase the country's tree cover aiding in soil retention and water purification. The trees provide combinations of open and covered spaces for a variety of gathering spaces.