

## **CoLRN: A community-based vision for local resilient networks**



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November 2022

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## **Acknowledgments**

This report was authored by Melissa Densmore, TB Dinesh, Naveen Bagalkot, Nervo Verdezoto, Ndinelao litumba, Siddhant Shinde and Deysi Ortega Roman on behalf of University of Cape Town. In producing the report, University of Cape Town has used funds from a grant provided by ITU under Connect2Recover initiative.

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# Executive Summary

The COVID-19 pandemic has foregrounded the role of digital technologies in widening the gap between the rich and the poor. Many propose that universal broadband is the answer; indeed, lower mobile data costs in South Asia have resulted in tremendous growth in networked participation. Yet people at the edge of the Internet still experience unequal access, in terms of relevant local content, costs, device and infrastructure constraints. Our research also shows that communication in these communities is often with users within the same locality. Yet messages destined for neighbours across the street must first travel across the world over expensive data links.

We propose to rethink our approaches to network infrastructure. Community networks offer a means for high-quality communications infrastructure growth. However, we want to look beyond community networks as a means of access to the Internet – and towards community local infrastructures that effectively leverage digital technologies to bring community members together through active participation. For us, to "build back better" is to actively work with communities to co-design and co-deploy their networks: empowering easy deployment of engaging and relevant digital content and services, and to make network management tools that lower the barrier to sustainable maintenance and operation of community networks. In this report, we share our findings from a series of design workshops with community wireless network members and their users in India and Africa to develop a community-based vision for resilient local networks. We simultaneously leveraged existing projects in India and South Africa-around intuitive network management and local content creation to evaluate our design strategies to foster resilience and effectiveness in empowering community networks. Through this work, we identified the challenges and opportunities for innovative approaches to leveraging networked technologies to bring communities together. We highlighted key opportunities, namely, to explore a) infrastructural resilience through community-centred design of network management tools, and b) novel approaches to support content creation tapping community desires to capture local knowledge, through annotation of digital stories and production of radio content.

# 1 Introduction

The report is in response to the Connect2Recover Research Competition organised by the International Telecommunication Union, which sought [“promising research proposals that will accelerate digital inclusion during the COVID-19 recovery globally.”](#) The competition “aimed to:

- Improve research focus on digital resiliency and digital inclusion to build back better with broadband for pandemic recovery;
- Build a global research community of think tanks and academic institutions around digital inclusion; and
- Promote knowledge sharing that informs targeted practices to build back better with broadband.”

Our proposal, titled “CoLRN: A Community-based Vision for Local Resilient Networks” was [one of the 15 winning proposals from across the globe](#). As part of the competition, ITU organised [a three-part series of information sessions with a particular focus on Africa](#), where we presented our early findings about resilience within the community networks that we studied. We have incorporated feedback from these sessions into this final report to offer a detailed account of our motivations and research questions, methods of data collection and analysis, and findings. We conclude our report with highlighting strategies in the form of concrete project ideas, towards more resilient communities through sustainable community networks.

Despite the many ways that networked technology has been a radical global enabler, access to and participation in digitally networked communication remains a vastly unequal endeavour. Advances in technology, from Internet of Things to Meta are consistently failing to consider inclusion of people at the edges of the network; whether through financial exclusion enforced by unequal markets, through unequal deployment of infrastructure, or lack of access to skills and training that is required to make effective use of digital technologies.

This, however, is not merely an issue of digital justice; of ensuring equitable access to digital infrastructure and services. This means that there are communities, many of whom have faced historical exclusion in many non-digital spheres, who are under-represented in the global Internet conversation, that their rich voices are not part of our discussions and we as a global community are less able to benefit from the creativity and cultures represented by those left behind. Our global Internet would benefit from additional representation of these currently under-represented communities. Pursuing this is a necessary step towards equity through fostering diverse participation.

However, we have seen, especially in the last two years of the pandemic, the ways in which disadvantaged communities are being left behind. It is hard to say that they *lack resilience* – rather, we see that the communities themselves are resilient and actively seeking to build back better from the lessons learned during the pandemic. A key lesson here is the importance of digital infrastructure to support community connection; to support the ways in which communities can come together to pool their resources towards strengthening themselves and their neighbours.

Along these lines, we are seeing communities working to build out their own network infrastructures, bypassing Internet service providers to provide locally networked services. This is

one of the models for community wireless networks (CWNs, or CNs). However, while some early CWNs focus on local content sharing, most are about lowering the cost to access or providing last-mile access to the Internet. Yet, the Internet fails to represent people at the edge of networks well; this fosters a core-dependency paradigm in which communities seek out resources from the outside, rather than fostering self-sustenance and resilience from within communities. In other words, the sparse representation of locally relevant and meaningful content in the global Internet becomes perceived, albeit wrongly, as the community holding sparse value. Core-dependency paradigms of networked participation are actively fracturing communities. And yet, we believe that CWNs can be used instead to strengthen communities through fostering of local content and services and digital skills development.

Two networks that have made local content and services the centre of their goals is FOCUS (South Africa) and Janastu (India). For this research, we worked with current and prospective members of the networks – both operators and users – to reimagine directions for CNs and to evaluate our current trajectories. With our participants, we have sought to understand how CWN members understand resilience and envision possibilities for how CWNs can contribute to community resilience; both in a broad sense and more specifically with respect to content creation, infrastructure building, ownership and maintenance.

Our research firstly affirms that resilience is an issue; both in terms of the network itself as well as participation in the network. CNs, as currently executed, are not a panacea. Both of our networks grapple regularly with issues of sustainability and maintenance, as well as the task of fostering community engagement. Through interviews and a series of speculative design and content creation workshops conducted with both networks between January to May 2022, we explored community-based perspectives on these issues and highlighted some key research opportunities to explore resilient communities and resilient community infrastructure through novel approaches to community wireless networks.

## 2 Background

Community Networks (CNs) are organizations or movements formed to provide free, subsidized, or low-cost access to the Internet via wireless means by and for the communities [4, 9]. CNs are recognized as an enabler of sustainable development as they deliver explicit socio-economic benefits by connecting people locally and globally, providing employment and business opportunities and educational and healthcare support [5].

iNethi is a software platform designed to support the management of CNs. It is a flexible platform that allows communities to easily create, curate, and share content and services. Our flagship deployment, iNethi-OV, in partnership with the Ocean View community in Cape Town, supports content and services on a mesh wireless network. During the pandemic, COVID-19 information services were zero-rated, and teachers uploaded their educational resources to a global server, allowing learners free access to this content via 20+ iNethi-OV hotspots. In addition, there are other existing CNs, such as Zenzeleni and Janastu, that offer their community members access to the Internet at low cost. Janastu, in rural Karnataka, India, built and operates the Community Owned Wireless Mesh (<https://open.janastu.org/projects/cowmesh>) along with tools such as



Papad (<http://papad.pantoto.org/>), a hypermedia annotation tool for local-content creation over a community network in regions with low connectivity and low-literate populations.

One of the driving philosophies around the project is recognizing the crucial role of community members, not just as users and managers of the CNs but as experts in local socio-cultural context and content. In our approach to innovation, we work closely with partner communities to co-design and co-deploy locally relevant services, whether it is usable voucher-based payment systems, a music-sharing portal for local artists, or the development and sharing of curricular content [2]. We seek to empower communities to leverage wireless communications on their own terms, understanding that greater empowerment at the local level will lead to more vibrant participation in the global Internet, with communities actively contributing to a rich and diverse discourse in a way cognisant of the importance of their voices. In this research, we invited CN stakeholders to reflect on these terms, using speculative design techniques to foster creative articulation of their visions for current and future CNs.

In addition, this project evaluated these visions in practice by focusing on two critical and current CN challenges to sustainability. The first key challenge is network management. Current CN hardware and software infrastructure requires expertise in networked systems. As a result, CNs struggle to find and retain operators from within the community, perpetuating an unsustainable (and unscalable) reliance on highly skilled network administrators. We propose building a set of community-centered network management tools, simplifying CN operations and content management [9]. The second key challenge is community participation – empowering community members to effectively leverage digital tools and infrastructure to serve the community, whether in terms of digital art production, basic civic services, or in the context of COVID-19, communication and coordination around cloth mask supply chains and vaccinations. Through this research, we planned to demonstrate community empowerment through the use of community-inspired design patterns.

### Research Questions

- **RQ1:** What are community-based visions and requirements for ensuring and fostering resilience and sustainability of community wireless networks?
- **RQ2:** What are community-based visions for the co-production of local content and services?

We are asserting that community-based visions have greater potential to be more resilient because they are situated in deeper understandings of local assets and constraints. Thus, for the purposes of these research questions, we define "community-based visions" as design approaches that emerge from collaborative co-design workshops with a primary focus on community voices, but inclusive of voices of other key stakeholders [12]. To answer RQ1 and RQ2, we will commission speculative design workshops with key CWN stakeholders (Track 1). These workshops will inform vertical deployments of solutions co-designed with the community (Track 2).

- **RQ3:** What design patterns empower CWN operators and community members to manage their CWNs?
- **RQ4:** What design patterns empower community members to contribute to local content and services in a CWN?

In Track 2, we focus on two key verticals in CWNs: CWN management and contribution to local content and services. We expect that our prior research, combined with the outputs of Track 1 and the vertical design workshops of Track 2, will yield several design patterns, or approaches to addressing these verticals. Through critical inquiry and deployment, we propose to evaluate these design patterns on two metrics of resilience: 1) community empowerment, as measured pre- and post-intervention using an existing tool (e.g., capabilities approach and/or self-determination theory) and 2) community-envisioned metrics, as defined in Track 1, and evaluated in Track 2. Thus, we also seek to answer RQ5.

- **RQ5:** How do existing measures of digital resilience align or conflict with community-based visions for measuring digital resilience?

## 3 Methods

The studies were conducted in rural and semi-urban areas of India and South Africa. We reached these areas with the help of our local collaborators operating community wireless networks, FOCUS in South Africa and Janastu in India. FOCUS is the community wireless network offering of Black Equations – a company with the objective of supporting community development in Ocean View, a historically disadvantaged township in Cape Town, South Africa. Their infrastructure leverages the iNethi platform, which supports local content and services specifically designed in partnership with community members to support their community wireless networks. Janastu provides free and open-source software solutions and support to the community and small non-profits organizations.

### 3.1 Site Selection

This project provided us with an opportunity to engage with three different communities, two in India through Janastu, and one in Ocean View through Black Equations and iNethi. We selected these three sites primarily based on existing research relationships with project partners, but also because it allowed us to engage with a diversity of perspectives. The three sites are:

1. The Ocean View Community, South Africa.
2. Devrayanadurga Hills (DD Hills), India.
3. MAYA, Channapatna, India.

**The Ocean View community** has been partnering with iNethi to build a community wireless network since 2015. This is a peri-urban township in the City of Cape Town, in South Africa. As a township – Ocean View was established in 1968 by the apartheid government when people were forcibly removed from their homes in surrounding areas and resettled in a controlled area. In particular, this is a “Coloured” community, including South Africans of Indian, Malay, Chinese, and Khoi descent and separating them not only from the White South Africans but also Black Africans. According to the 2011 census on the population, it has a population of 13,639; however more current reports place the population at about 30,000. The community has fibre Internet to the schools and the library, and residents can purchase Internet through mobile service providers or wireless ISPs. The current community wireless network has 20 Nodes and is at the start of its deployment, but it also builds on our prior infrastructure, which was used to provide access to school resources to learners at the local high school [2].

**Devrayanadurga Hills (DD Hills)** is located North of Bangalore, about 70 Kms away. Janastu has set up a community wireless network in the villages amidst a hilly forest area. 5 nodes drawing from a Fibre Line from Tumakuru (20 Kms away) offer wireless Internet to the farm where Janastu members stay and work from, a crafter's park where crafts people work on basket weaving, a children's activity center in the village next to a public school, and a grocer's shop. The community network came to be during the COVID-19 induced lock-down, serving students doing online courses on their smartphones, as well as people who were visiting family from the cities to work from home. Further on, Janastu is working with the school to make use of the network for education and youth engagement activities.

**Channapatna** is a town located 80 kms south-west of Bangalore. MAYA is a non-profit organisation who has trained and supports about 100 women community Health Navigators (HNs) to offer door-to-door services of monitoring and management of chronic conditions within their communities, out which 25 are based in and around Channapatna town. This community of the HN does not yet have a community wireless network. However, through Design Beku, MAYA Health and Janastu, they are actively seeking to establish network infrastructure to support health worker activities. In particular, they are building a prototype of a Community-Owned Wireless Health Knowledge Infrastructure (COWHKi), which will have 8 wireless mesh nodes and 6 fixed wireless (4G – Long Term Evolution) routers offering Internet, as the underlying infrastructure to support HNs to collect, create and share health content relevant to local needs of their communities. The HNs call it as Channapatna Health Library.

Through this research it became evident that not all CNs are the same; they rely on different hardware and software approaches and have varying levels of available expertise as well as models for innovation and community engagement.

*Table 1: Overview of the community networks included in the project*

Site	Locality	CN Maturity	Internet	Key services	Hardware
Ocean View	Peri-urban	Newly established	Currently free; voucher-based	Internet in a box (Wikipedia, Ted Talks, Khan Academy) Nextcloud	Ubiquiti AC Mesh nodes controlled by Unifi
Channapatna	Rural	Not yet deployed	Not yet available	Health Archive	SIM routers. Raspberry Pi desktop setups
DD Hills	Rural	Since 2014	Since 2021 Free access		Mix, reclaimed routers and

Source: Authors

## 3.2 Participants

We purposefully invited community participants and community wireless operators from each site and used different methods for data collection (see Table 2) to gain insights into their everyday challenges in using and managing community networks platforms, as well as to help them imagine alternative futures of their community networks.

*Table 2: Overview of the different methods used for data collection and participants*

<b>Phase</b>	<b>Method</b>	<b>Session Code</b>	<b>Participants</b>	<b>Geographic Location (no of participants)</b>
Contextual understanding; needs assessment; gathering requirements	Semi-structured interviews	S1	15 <ul style="list-style-type: none"> <li>• 4 prospective network operators</li> <li>• 4 network operators</li> <li>• 4 community network users</li> <li>• 3 managers of community networks</li> </ul>	Ocean View (10) Soweto (2) Khayalitsha (2) Mamaila (1)
		S2	10 <ul style="list-style-type: none"> <li>• 3 community network managers</li> <li>• 7 frontline health workers (1 field coordinator, 6 health navigators)</li> </ul>	Channapatna (7) Devraynadurga (3)
Co-designing Network Management Interface	Co-design workshops	S3	15 community network users  *4 participants from previous session	Ocean View, South Africa
		S4	5 <ul style="list-style-type: none"> <li>• 2 managers of community networks</li> <li>• 3 network operators</li> </ul>	Devrayanadurga, India

	Prototype demonstration workshops	S5	5 community network users	Ocean View
			3 network operators	
		S6	5 <ul style="list-style-type: none"> <li>• 1 manager of community networks</li> <li>• 3 network operators</li> <li>• 1 designer (new)</li> </ul>	Devraynadurga, India
	Asynchronous Feedback	S7	3 network operators	Ocean View
		S8	2 network operators	Devraynadurga
Co-design of Content Creation Tools	Co-design workshops	S9	6 community network users	Ocean View
		S10	11 Health navigators	Channapatna
	Content creation and dissemination workshop with Papad	S11	5 community network users	Ocean View
		S12	11 Health navigators	Channapatna
	Asynchronous Feedback	S13	3 community network users	Ocean View
	Feedback workshop	S14	11 Health navigators	Channapatna
Imagining futures for community networks	Speculative Design workshops – envisioning the future according to 3 premises	S15	15 community network users	Ocean View
		S16	11 Health navigators	Channapatna

			2 community members	Devraynadurga
	Speculative Design Workshops – Exploring Resilience in practice and physical infrastructures in practice	S17	5 community network users	Ocean View
		S18	11 Health navigators	Channapatna

Source: Authors

### 3.3 Phase 1: Contextual understanding, needs assessment and gathering requirements

#### 3.3.1 Semi-structured interviews with community network operators and managers (S1)

We initially engaged with 14 participants (4 prospective CN's operators, 4 CN's operators, 6 CN's managers) through an interview study to understand the context of use and everyday challenges with community networks in semi-urban (6-Ocean View, 2-Soweto, 2-Khayalitsha) and rural (1-Mamaila) areas of South Africa and rural areas (3-Devraynadurga) of India. Each interview started with an introduction of the study and informed consent was given, was conducted in English and lasted for about 33 min in average. The interviews explored the background of the participants in relation to network management, training activities, existing network management interfaces they use, and etc.

#### 3.3.2 S2: Semi-structured interviews with CN users and prospective users of CNs

We also engaged with four community network users from Ocean View, South Africa and seven prospective users of community networks in India (1 field coordinator and 6 frontline health workers called Health Navigators). Interviews were conducted in English in South Africa and Kannada (3) and Hindi (4) in India and lasted for about 30-45 minutes each. During these interviews, we sought to understand how the users perceived community wireless networks, both from a structural point of view (how they are run, and what structures were required to support it) and a services point of view (what services they might use through a community wireless network). We asked about wishes for the community network; what they would like to be able to do within a CN. Finally, we asked about resilience of the community and of community networks more broadly. These interviews helped to inform the refinement of the workshop protocols for the next phases of research.

## 3.4 Phase 2: Co-Designing the Network Management Interface

### 3.4.1 Co-design workshops (S3 and S4)

To follow up on the interviews and to further understand the challenges and experiences of our participants, we additionally conducted one co-design workshop in each site. For the workshops, we planned to introduce participants to network management, by first assessing what they understood as network management, their perspectives on network management, and how they are currently involved in managing their CWNs. For Ocean View, we divided the participants into three focus groups, and we facilitated the participants to collaboratively listen to a video we made that was going through the Unifi Network Management tool that was being used by INethi CWN. In the video that was presented to the participants, the different features that exist on the [Ubiquiti Internet Service Provider](#) (USIP) platform, such as the landing page, the dashboard, the notification, the connected devices and users were explained.

After the participants watched the video, we facilitated discussions in each group about what they understood by network management and how they understood the USIP network management interface. We requested them to engage further on the features and to visualize how network management was taking place in their community. In the next activity, which was about validating some of the early findings from the interviews, we made a list of some of the interesting challenges that emerged during the interviews and shared them with the participants to initiate a discussion on how they feel about these challenges and what new challenges they think have emerged after watching the video.

After the participants identified new challenges, we gave them printed screenshots of existing interfaces, posterboard, stationery, and other materials and asked them to design network management interfaces that would address these challenges. After the co-design activities, we did a cognitive walkthrough with the participants to understand sketched interfaces in more depth. We completed this by describing their sketch solutions to them and asking them if that is what they meant. We then asked our participants to present their prototypes to the other participants. While presenting, we asked participants to share their feedback and to give their thoughts on the other groups' presentations.

### 3.4.2 Prototype demonstration workshops (S5 and S6)

We started the workshops by revisiting the idea of network management in each site with our participants and recalling some of the outstanding outcomes from the first focus group discussions and co-design workshops. We then proceeded to give participants an introduction to the MeshDesk features built into RadiusDesk to support OpenWRT-based mesh wireless networks. In this activity, we showed the participants around the mesh desk Interface and showed them different aspects i.e., how to add access points, users and monitor the devices; and allowed participants to ask questions and discuss about the interface. This was followed by the second activity, that presented a live demonstration on adding devices and clients to the interface and allowed participants to ask questions/have a discussion on the demonstration. In order to not interfere with the existing community wireless network infrastructure, we set up a mini mesh network composed of two Access Point or AC mesh routers, a mini flex switch and NetGate for live demonstrations purposes. During the third activity, we assigned our participants the task to add network devices and clients on the interface themselves. During this activity, we took the

participants through the process of updating the devices with the right router software also known as firmware that is compatible with MeshDesk. Lastly, we conducted a feedback session with our participants regarding their experience in using the interface, adding devices and clients, and their general thoughts on the interface.

### 3.4.3 Asynchronous Feedback (S7 and S8)

We collected asynchronous feedback from some of our participants two weeks after the prototype demonstration workshops. We requested feedback from the MeshDesk demonstration with regards to the challenges that they encountered while trying to use radius desk on their own, and the number of times they used it. The purpose of the feedback was to track the interest and engagement from participants and to gather suggestions towards improving the interface. For asynchronous feedback, we requested six prospective network operators and local network operators from Janastu and INethi/Focus to send us the comments and feedback on using the Mesh Desk interface via WhatsApp and audio recording during the last workshop.

### 3.4.4 Data Analysis

Data analysis was conducted at the end of the project with emerging themes being explored from interviews and workshops. As a team, we met up in Bangalore, India to conduct the analysis together, which started with grouping similar themes from the interview scripts and the workshop recordings. During the workshops, participants co-produced a number of visual drawings that we used to support the analysis. All the transcripts from the interviews and co-designed materials were thematically analyzed. We started the analysis by first reading the transcripts from the interviews and highlighting the themes as they emerged, after grouping all the similar themes together we then compared them to the visual drawings. Some of the themes that we focused on include the background of our participants, their current roles in their community network management, forms of training or education level, how they currently manage the network, the current network management interfaces that they are using, and the resources that they consult when troubleshooting their community wireless network.

## 3.5 Phase 3: Content Creation Workshop (PAPAD)

### 3.5.1 Co-design workshops (S9-S10)

The content creation workshops were designed to understand the community-based visions for the co-production of local content and services. The workshops were directed to identify the local content and find ways, tools, and patterns that can encourage local content creation in the community. We were also trying to identify the gaps between the local content and services on the network. An artifact developed by JANASTU called 'PAPAD' was used to generate audio content with the participants and shared the audio files with other community members to annotate. PAPAD is an application designed to listen to and tag audio files. These tags (the meta information) can then be used to search, sort, and share a large collection of audio files. PAPAD serves as a hypermedia annotation tool for local-content creation over a community network in regions with low connectivity and low-literate populations. Considering the community as experts of their own lives and capable of shaping the technology, we also tried to understand the requirements of the participants for content creation through co-designing PAPAD activities.



We started the co-design workshop by asking the participants what content meant for them, where and in what ways they consumed content. Further, we moved towards the local content that is already available and produced in the community and asked them if they can identify any local content that is being produced in the community. Then we asked them to sketch out the different types of content that they would like to see hosted on the CN. Here we identified the gaps between local content and services that are already present on the network and the way they imagine the local content on the network.

### **3.5.2 Content creation and dissemination workshop with PAPAD (S11 - S12)**

Separating the concept (local content creation) from the artifact (PAPAD), the artifact was introduced to the community as an imperfect application at the early stage of development [7]. Considering the community members' local expertise, we used PAPAD to create content with the community. Through this activity, we tried to understand what content (local knowledge, lived experiences, news, practices, etc.) the participants would want to hear on the CN and what are the ways we can support and foster the development of such local content in the community.

The activity was for each participant to record an audio about any topic that they wanted to share with the community and which they would like to host on the CN. Each participant recorded an audio file, and we then as a group collectively listened to the audio and collectively tagged, and annotated it using the PAPAD. The different audios recorded by the participants included a recipe of pasta, their COVID-19 experiences, promotion of their businesses, gun violence in the community, and football activities in the community – soccer camps. We also collectively listened and uploaded while adding tags and annotations, to the interviews taken by Ocean Times's founder in exploring PAPAD as an interviewing and archiving tool for local news hosting and creating and starting a PODCAST.

### **3.5.3 Asynchronous Feedback (S13 - S14)**

We collected asynchronous feedback from some of our participants two weeks after the workshops. The requested feedback was along the lines of their experience and challenges with using PAPAD as a tool for content creation and what changes they would like to see in the software that can encourage people to use it and create local content on it.

## **3.6 Speculative Design Workshops**

### **3.6.1 Speculative Design workshops – envisioning the future according to 3 premises (S15-S16)**

Informed by the interviews, we created activities and scenarios for alternative world-building and practices, combined with methods from drama and performance arts to facilitate the participants to imagine alternative futures of their community networks. We invited CN stakeholders to reflect using speculative design techniques to foster creative articulation of their visions for current and future CNs.

The first participatory activity we did with the participants was 'day in a life'. The first activity was an exercise to understand their daily practices and to situate the network in their everyday practices

(iNethi or otherwise). The following was to share with other participants the 'highlight of the day' - the time in their daily practices which they enjoy the most.

These activities helped us to conceptualize the framework of the workshop and established the agenda that community members and their practices are at the forefront of the research and not the technology, or the network. Such a framing of the activity was important because based on our past experience, we have seen people try to think or imagine situations beyond their everyday practices, challenges, and struggles; the idea of a distant future can easily become a fantasy and fantastic space where technology solves deep rooted issues magically. While such fantasies are important in their own right, our objective here was to manage a strong connection between imagining better possibilities for the community networks and the specific socio-cultural and economic contexts of their current operations.

As facilitators, we tried to frame the activity in such a way that they don't put the technology or the network at the centre in their narration of the day, but rather keep the focus on their life/community practices. Overall, this first participatory activity was the foundation which provided us with the scenarios of their life and which helped us to build the premises for the next activity.

Following are the three premises for each site --

- *The premises for the second activity in South Africa*
  - Imagine an alternative reality, where the iNethi network has around 300 access points in the Ocean View community and it has covered the entire area with an Internet network. In this reality, the iNethi network managers are selling vouchers for the same prices as they are in the current situation, which is at a lower price than other ISP providers, while other ISPs' prices are increasing. Imagine that it is also offering other services on the network (such as having educational content, local news, etc.). How would you then interact with the network and what are the challenges you think the network would come across? (Utopian)
  - Building on the first premise, the participants are provided with the following scenario. You now have a stable network in the community. It is year 2025 and COVID-19 is back with a new variant, the lockdown is back, and you're in a new pandemic situation. How would you then interact with the network? What were the challenges you faced during the last lockdown, and how can this network help you in such a parallel world? (Dystopian)
  - Again, building on the first two premises, you have a stable network, and you're interacting with the network in different capacities. The people responsible for the development and maintenance of the network - Ganief and Ganeefa - are no longer living in Ocean View. They had to leave the country due to some emergency. What would you do with the network then? Would you keep it alive? If yes, then how?
- *The premises for the second activity in India*
  - Imagine an alternative reality, where the Channapatna Health Library is all built with well curated and annotated audio-video content. How do you see yourself

using all this information and resources in your work? Will such network help you? If yes, then how? (Utopian)

- If there is a new wave of COVID-19 and/or a lock-down in the future, how would you use the Health Library? There is a new wave of COVID-19, and the lockdown happens again, but you have already experienced one round of COVID-19 and now, you have a health library also established, how will you react and respond to a situation like this? (Dystopian)
- The ASHA workers (public community health workers) would have direct access to people's health data. At the same time, they may not approve of some of the local / ground up knowledge that the Health Library holds. How would you respond to this challenge? If this happens, how would you re-establish your role in community health and engage with the concerns of ASHA workers and other Public Health officials?

### 3.6.2 Speculative Design Workshop - Exploring Resilience in practice and physical infrastructures in practice (S17- SA)

After the early analysis of the first Speculative Design workshop in South Africa, we arrived at two larger themes under which the community's 'idea of resilience' can fall-- Technical and Human/Social Property Relationships. During the analysis, we came across some keywords that repeated these themes.

We wanted to dive deeper to understand their 'idea of resilience' of the network. For the second speculative design workshop, we provided the participants with the 20-25 keywords, and asked if they could relate to any of the keywords, if yes, how the keyword(s) are related. The activity was to sketch/write out the manner in which any of the above keywords played a role in their life and daily practices.

This activity also helped to situate the network in the participants' life/practices rather than depending on the assumptions.

The following activity was to speculate on an alternative parallel world where these keywords, if acted upon, would play a role—and what the role will be—in their daily life. These keywords probed them to speculate an alternative world where they could imagine for themselves how their practices are situated in the context of the CNs and their idea of resilience.

#### **The keywords are:**

power cuts, signal strength, affordability, theft, security, weather conditions, availability, load shedding, government, funding, accessibility, unemployment, work from home, entertainment, online shopping, mental health, education, fundraising, community building, mobilization, awareness, and data prices.

### 3.6.3 Speculative Design Workshop - Exploring Resilience in practice and physical infrastructures in practice (S18 - India)

MAYA is in the process of co-developing the physical network infrastructure with the HNs and the community. In the previous SD workshop, through situating the HNs in different premises around digital infrastructure of the network - Heath library, we speculated the struggles and challenges with the digital network side of the infrastructure. The second speculative design workshop was designed to speculate the challenges that might occur while setting the physical infrastructure with the community, and therefore the idea of resilience of the network. For the second speculative design workshops, we used ISP design center software and Commotion Construction Kit to build the co-design of the network infrastructure with the HNs.

The mapping exercise with HNs are summarised as follows:

- Mapped the HNs' houses on the Channapatna map;
- Mapped different institutions around the houses; and
- Tried mapping the tallest building around their house for setting the antenna.

Using the coordinates provided by the HNs of their houses, we mapped them on the software. We also mapped the other important locations such as potential base stations - MAYA office and Craft Park - and public institutions - Public Health Center, and Government Schools.

We visited the HNs' houses in May and June 2022: collecting the coordinates of the locations, checking the site, and also doing the elevation mapping. HNs helped us to get access to their neighbouring buildings to check for the line of sight. With the help of the software, we could demonstrate the overall process of mapping the coordinates, height of antennas, directions of antenna facing each other, and importance of elevation/heights of the antenna for the perfect line of sight.

The basics of wireless mesh network are as follows:

- Types of Routers and Antenna;
- Line of sight; and
- Mesh Network.

## 4 Findings 1: Speculative Design

### 4.1 Community-based vision of resilience and sustainability of community wireless networks

For the purposes of these research questions, we defined "community-based visions" as design approaches that emerge from collaborative co-design workshops with a primary focus on community voices, but inclusive of the voices of other key stakeholders. Following are the early

findings of community-based visions analysed by workshop data using an affinity mapping exercise.

1. Physical infrastructure is important to improve the network. The physical infrastructure can prevent vandalism. Having high-quality devices to improve signal strength and coverage. Back-up generators and solar panels to keep the network up during load shedding.
2. Characteristics of a reliable network. A reliable network was defined as accessible, sustainable, available, affordable with strong network signal and high data speed.
3. Attracting customers and advertising the network. Network advertisement through word of mouth and marketing. Train people as promoters to offer the network and services. Attract customers through different affordable data vouchers, free deals and services.
4. Sponsorship and funding for the network. Attract more funders and look for government fundings.
5. Upskilling is possible through the network. Create tutorials about network development and management on the network so that people can learn and self-train through tutorials.
6. Strategies to make a self-sustainable network. Network for the community, by the community, where the network will be managed and maintained by the community. Activities and workshops were conducted by the iNethi network to train community members. Helpline and chatgroup on the network for the community members are also helpful.
7. Data packages that are affordable (for the community) and lucrative (for iNethi). Availability of affordable, lucrative and low-priced data packages for community members attract new community members to join the network.
8. Signal strength affects the quality of the network. Quality devices can improve signal strength and network traffic. Anticipating bad weather conditions such as wind or heavy rain that effect signal strength and bolstering the quality of network accordingly is an important need.
9. Community usage of the Internet/network. Online shopping, online education, video call, selling online, social media applications are some of the common usages.
10. Job creation through network. Training people and giving them jobs within the network. Hosting job portals on the network for people to find job and apply for new jobs.

## 5 Findings 2: Network Management Interface

### 5.1 Interview results: current practices and understandings of CWNs (situate the findings where some sites don't have current practices)

- Negotiating and tinkering the work-arounds due to lack of access and availability to ideal networking equipment. (I – P1, P2)
  - Such work-around needs training and / or technical expertise

*(I/P1) "So I was like I first need to fix the network and someone has to come forward from the collective and take the responsibility to fix things within the network. Well, it was a slow process, and it was mostly human interaction and knowledge transfer from the team here. "*

*(I/P2) “Right now we are sticking with Libra Mesh and Router. We are limited with their hardware. The routers supply chain limits us. Price point is also debatable. Then I started looking at alternatives.”*

Local community network operators and managers experienced a lot of challenges while developing and sustaining community networks. The sustainability and management of a community network often requires local network operators to seek technical knowledge, repair and troubleshoot breakdowns. Local network operators are often responsible for re-designing and purchasing the recommended equipment to further expand and develop the network, but often they are not able to purchase the intended network equipment. This is because most of the equipment that they have good experience with using is often not available in South Africa and India. Both Janastu and INethi/Focus prefer to use the Unifi wireless network devices especially the AC mesh outdoor router and the Ubiquiti Nanobeams. Sometimes, these devices are not in stock and local network operators end up purchasing similar devices from another brand. This explains how some of these community networks ended up using a combination of Unifi, Ubiquiti, Pfsense, Tp-Link and D-Link. For instance, when the network was deployed with the assistance of university students and researchers, the local network operators received some training to manage the first installed network using Ubiquiti devices, but as the network kept expanding and new devices were added, the management of the network became more challenging. Our study shows that local network operators face plenty of challenges while managing their community networks with different brands of network devices because they each have their own management websites or interfaces, and the network operators require different training or technical expertise to set up the devices and to continuously manage the community network.

- Having access to an ecosystem of experts and technical knowledge (SA-P1, SA-P3, SA-P9, SA-P4)
  - Lack of Ecosystem Support leading to Invisible Work (SA – P1, P4, P9, P3, P8)

From the interviews, some of our participants are community activists, educators, community members interested in food security through local action, and college students who are pursuing teaching and other fields of study that are not related to telecommunications and information technology. Some participants were interested in community networks when they understood the benefits during the pilot deployment phase of the community networks with the help of technical experts. Due to the strong relationships between local network operators and the technical experts that assisted the communities with the technical deployment of community networks, they stay connected with local network operators with the aim of guiding them through managing and sustaining the community networks by sharing knowledge and visiting the sites from time to time to fix major network breakdowns. We found that community networks also received support from organisations such as Internet Society and the Association for Progressive Communications that are working on providing local network operators and prospective network operators with technical knowledge and training through various initiatives such as school of community networks workshops and availing funds for practice equipment. *(SA/P1) “I do not really know much about the network but most of what I*

*know I learned from Dr. David, and next year I am going for some training with the APC association. I am a member of the community networks associations whereby we are busy setting up a school for all community networks around South Africa and kicking the school off, training and education is obviously the first step so the identified community can learn or be empowered on establishing and starting off their own network like from a local level.”* In many interviews, we found that participants struggled to adjust to manage the network and they depended on the network experts that they know, and they get most assistance via telephone and emails with technical experts and researchers.

- Training and Learning a) Formal Training (SA - P6, P7, P2) b) Informal Training through Workshops (SA – P3) c) Learning on the job / in the field (I-P1, P2; SA – P1, P2 P3, P8, P9, P6) d) Lack of Background / Formal Education in Network Management (I— P1, P2; SA – P4, P6)

Several participants indicated that they do not have any formal training or formal education background that can assist them with network management. We found that three of our participants from INethi Ocean View because of their interest in community networks, they decided to get formal training from college institutions and they also joined the training offered by the School of Community Networks that is organized by the APC to develop and expand on their technical skills. Some of our participants indicated that they learned everything about managing networks while on the job or in the field work because they were not exposed to any training before they joined community networks. However, three local network operators from Janastu are engineering graduates and they have information technology skills. They gained the experience with developing website applications as part of their first assignment with Janastu, which was to develop a web application to archive community knowledge.

- Transfer of ones learning across platforms, tools and sites of CN (I – P1, P2)
- Roles & Responsibilities; Beyond Specific Job Descriptions (SA – P3, P4, P7, P8, P6, P9)
- Challenges with NM Interfaces and Tools (SA – P1, P3, P6)

Previous research work [8] on sustainability and development of community networks indicated the challenges faced by community members include being financially sustainable and signal losses due to the network design. In our study, we found that some of the challenges are related to how the local community members, prospective network operators and local network operators understand and monitor the network. We found that local network operators have access to network management tools, and they experience different challenges when using these network management tools. We found that due to the community networks using different network equipment, they end up using different network management tools because each network equipment brand has its own interface that it connects to when deployed. We found that most network equipment brands that our participants are using are similar and most of them are using the Unifi and Ubiquiti's equipment that are managed by UISP interface or network management tool, NetGate that is managed using the P-fsense network monitoring tool and the TP-link access points that are managed using TP-link captive portal link.

SA/P1 “The features for disabling and enabling clients or users should be part of traffic shaping, but it falls under the billing side instead of the monitoring side of things.”

SA/P1 “The interfaces are difficult to understand.”

SA/P3 “The difficulty was to understand the interfaces and platforms without any training.”

SA/P6 “I think our challenge currently is to lose coverage and the network can be slow, and I do not know how to use the NM interfaces, I have not seen any NM tool.”

- Specific Usages (SA – P2, P3, P6, P8, P9) and non-Usages (SA – P4) of NM Interfaces and Tools
- Contextual Challenges Beyond Tools (SA – P2, P4, P8)
- Visions, Futures, and Opportunities
  - Guiding Philosophies and Ideals (I-P2, I-P3)
  - Ideas for distributed Management of CN (I-P2)
  - CN as a realization of Aspiration to a Just Society (I-P3, SA-P1, SA-P7)
  - Ideas for NM Interfaces to be specific to local network needs and settings (I-P1, I-P2)
  - Ideas for Specific Features for NM Interfaces and Tools (SA – P9, P4, P7)

We also discovered some interesting ideas specific to local network needs and settings of our community network sites. Two participants from Janastu India shared with us the ideas they had regarding building a network monitoring tool and some of the tools that they are currently using. They had an idea to create a network monitoring tool that pings device to device. (I/P1) *“But something interesting happened a month ago, we thought why not we build a network monitoring tool, it is not really built and ready to use yet. What it does is, it does node to node ping test with a pi setup, ping test work best from device to device rather than router to router or power beam”*. They thought of this idea because of the current set up at the Janastu [Community-Owned Wireless](#) (COW) mesh farm. The farm Wi-Fi connection is stronger as you move around the farm while you're closer to the access points but gets weaker when you are further away from the access point. (I/P1) *“So when we were trying to debug, say some router doesn't have an Internet that time we used third party tool called Wi-Fi analyser by connecting it to the device and then there was all the other process; that is when we got an idea to think about building a networking tool which says simple things such as if this router is getting Internet or not.”*

## 5.2 Findings from design workshops

For the design workshops in South Africa, the participants are community wireless network users and only two participants that attended the workshop were part of the interviews. We found that all the participants have interacted with the network in the community either at the school or at home through the hotspots in the community, but they have never been exposed to the existing network management tools. It is interesting to note that our participants from Ocean View have never used any network management tools while our participants from DDhills Janastu are involved in the day-to-day network management of their community network.

### 5.2.1 Challenges from Ocean View INethi/Focus

We found some of the challenges that participants centred on the UISP interface. From Ocean View (INethi), some participants discussed that terminology used on the interface is not suitable for them as they are not familiar with most of the terms used on the interface (SA/G1)



“Just like the terminologies, a lot of the terms that were on the display of the interface, we do not know them and that makes it hard for us to understand network management. Like we said, we do not get some terminologies such as DBM, spectrum, topology, API tokens, Gateway, Network SLA Score.” Given that it was the participants’ first time using and viewing a network management platform, we also found that they have difficulties with locating different aspects of the interface. One participant said that “It’s not obvious what the icons are for until you click on each of them.” We also observed this as the participants constantly asked us where to find the hotspots or connected devices. The participants also outlined that tracking the usage of the network is not visible on the interface and that the graphs on the interface are hard for them to interpret. Additionally, participants also commented that the Interface is not popping out with colour etc. “We also said the system to stand out more, so it was not colourful or popping. When we watch YouTube videos or any social media, Instagram, one of the things that catches our attention is graphics and colour so we thought that would be worth following later.”

### 5.2.2 Challenges from DD Hills (Janastu)

From the design workshop with Janastu, we found that participants were struggling with capturing many concepts of network management such as viewing all the connected users and logs. (I/P1) “We are currently not capturing many things at the moment of the network management, and we want to view things like how many users are connected, signal strengths,” (I/P2) “We do not have access to users connected to the network, or logs. How to we capture this, should we have a raspberry pie at every access point or a centralized server?” We also found that our participants are using individual access point captive portals to manage their mesh networks and they have challenges accessing them with their phones. Additionally, we also found that there are power issues such as power outage and low battery voltage that that interferes with the network management. Despite the power issues, there are also harsh weather conditions that change the alignment of devices that often causes the network to go down. This becomes a challenge because when the network is down, it is hard for the local network managers to be aware when they are out of town. This is because you can only access the access point captive portal when you are on site. (I/P2) “I think the power point that was brought up. Power is an active component of this network and I do not think there is an active management for power at each node that captures power related data and I think this is ignored by most people or community wireless networks mostly.”

## 6 Findings 3: Content Creation

### 6.1 Observations during uploading audio on the PAPAD

The HNs are fairly clear and confident with the format of the meta data form for the upload. They discuss and help each other while writing the metadata, and hence, they seem to have arrived together at a standard approach to upload the content on the PAPAD. Initially, there seems to be a bit of confusion with the tags. But after a few rounds of upload, they might arrive at a shared understanding of what tags are, how they are supposed to be developed and used for searching the audio, and making connections with other content. One pain point in the workflow was their

difficulty in identifying the audio file to upload. The default naming convention is something like AUD202204RECO4. Not all of them know how to identify files in this convention and multiple HNs use the same phone which can create a lot of confusion. Typing is very time-consuming, this is because of spellings, language, length of description, and etc. It is also difficult to type in their regional language (Kannada), so some HNs use voice-to-text applications to quickly add annotations and descriptions to save time.

In the case of South Africa, despite mentioning that video medium is more entertaining, the participants found that the voice recordings were very intriguing and engaging, as well. Initially, participants found the concept of PAPAD challenging, especially around the terminology used like “annotation” and “fragments”, and why it needs to be done in this way, but later, they also recognised that this method is also used by YouTube once they saw the result of the exercise. They understood the basic operations like uploading and did not find the use of the platform difficult at all. Participants also requested for images to be incorporated, to help the listener visualise and understand the content better.

Suggestions and modifications that were gathered included:

- Standardizing audio recording and naming conventions
  - o Installing the same app to record audio on all devices
  - o Teaching them how to name and save audio files
- Link Shortcut for PAPAD on the home screen
- Listening to audio files before uploading
- Making tag input more intuitive
  - o Visual feedback for tag inputs
- Visual hierarchy on Audio and annotation page

## 6.2 VISIONS of HNs for Content creation

- HNs are looking for different content they can record for the health library with their clients.

*“I want to get more information about diseases. This information can be fed to the Health Library.”*

*“Ayurveda and its benefits.”*

*“I want to understand what more information I can get from people, more about what people know and don’t know.”*

- HNs are also looking at different ways to produce content and move beyond the limitations of audio recording.
- Books and magazines for the audio and video content for the clients and the community members.

*“If people are bored with audio and video content in the library, we can create books also.”*

*“Serials/drama/performances as education materials.”*

- The HNs also developed strategies around how the local content can be shared with their peers and other community workers like ASHA workers and Aaganwadi workers.

*“In case Asha workers ask us about videos, we tell them that all this is a real experience.”*

*“All the videos are directly from our client’s experience. If any Asha workers don’t believe that it is true, we can give them the contact information of any client so that they can validate themselves.”*

### 6.3 VISIONS of South Africa’s community member for Content creation

In the content creation workshop held in Ocean View, the participants demonstrated that they have a clear understanding of what content is and the various forms it can take. They also creatively identified local opportunities for sources of content creation.

The discussions taking place amongst the participants demonstrated that content creation is not just for entertainment purposes, but should be used as a tool to build and grow the people of the community.

For these participants, they wish to use their content to find and communicate with like-minded people through forming and strengthening their own forums and communities. Content creation is also a means to represent those who cannot speak for themselves, especially on taboo issues (same sex relationships, changing religion or beliefs, drug addictions, mental health issues, and etc.). In addition, positive content that is pushed into the community will help the people to build self-confidence and a better state of mind. The feeling of acceptance and approval by the community was also discussed as being important for the development of its people. The group also displayed an understanding that their environment, as compared to neighbouring communities, is harsh towards those seeking a better quality of life. Hence, content creation could be used as a means to motivate people to rise above the social norm; where those who venture outside their boundaries meet strong social criticism and are pressurised to succumb under the pressure to conform, or face rejection and isolation.

They also see it as an opportunity to reinforce positive activities and stimulate or normalise positive behaviour. For example, the local influencers could promote growing their own food, environmental awareness, success through education, healthy life-style choices, and etc. They alluded that from these topics, various youth projects will flourish to keep the kids busy as opposed to allowing them to gravitate towards a life of gangsterism and crime, or get caught in the crossfire of these activities.

Local content creation was also identified as a means for communal and business brand building, to change the perception that the locals have of themselves firstly, and then, the perception of the rest of the world.

### 6.4 Challenges

The participants felt safe enough in the workshops to express how they feel and identified various challenges and constraints they currently face and foresee to actualize their vision of using content creation as a positive tool in the community.

The biggest limiting factor that came through was the emotion of fear. Participants highlighted what the content should be used for, but also expressed their concerns, that creating and posting content makes one vulnerable, and the creator risks negative comments and cyberbullying that could lead to physical altercations and social rejection. When looking at the design of a platform for the community, the request for rules and moderation was also made, to keep children safe, and on the subject of inclusivity, being mindful of elders and appropriate content.

It was also noted that people “loves” the video format (it is more entertaining) and live streaming; hence, the content needs to be of good quality, relatable and the story telling must be interactive. This brings about the limiting high cost of Internet access and the equipment that a content creator needs. Despite the fact that there are already many locals pushing their content, it was also inferred that many people do not know how to go about creating the various forms of content, and that content (tutorials) should be created to educate and inform them with this regard. Though local content creators produce content for their immediate community, it is mostly supported and consumed by other communities that are not limited by data and Internet constraints. As far as equipment goes, smartphone cameras are the main tool that are used for images and video, often leading to poor sound and shaky footage.

## 7 Discussion

### 7.1 What is a community network?

Our findings firstly show that there is significant variation in how community networks are structured, and used. Likewise, what is a community network varies and depends on factors, such as state of implementation, community use and engagement, and a collective vision about community infrastructure. The Ocean View community network is ahead in its implementation, with a range of community members actively participating in maintaining it as well as users engaging with the Internet services offered. In contrast, the DD Hills network came about only during the COVID-19 pandemic induced lock-down driven by Janastu and their ambition of setting up alternative infrastructure for equitable Internet access in the surrounding villages. However, they are gradually getting the community members, particularly the younger populations to engage with the network and think of potential services together. Meanwhile in Channapatna, the network is a conceptual idea, still being realized, yet being driven by the community health workers with a desire to collect, curate and make use of locally relevant health content.

A community network hence took multiple forms in our sites, but the underlying commonality was the community engagement. Across all the three sites, the desires, intentions and ambitions of key community members, and their actions of conceptualizing, setting up, maintaining, and using the network and its services held the network together.

### 7.2 Who gets to decide about who decides?

One of the central framings of this question came about while having a long conversation with the JANASTU team about who and how can one define “what is a community network?” This led us to discuss the power structure in the collectives and networks and the agency to make decisions. It is not just about who mediates agency in these programs; but often, there is another person or group of persons at a higher level that define the terms by which these decisions should be made.

Who decides who decides should have the agency to make decisions, and how such intertwined power structures on the lines of caste, class, gender, and education play an important role in the development of the network. This conversation made us reflect on the methods and methodology we are adopting for our research. What other radical methods and approaches can help us to dismantle such hierarchical decision-making structures and move towards more horizontal decision-making structures?

### 7.3 Challenges to Resilience

With respect to the concept of “resilience”, many of the challenges to the resilience of community network infrastructure are already well-known: power outages, availability of local expertise, and cost of equipment. Some of these things we can address; but as for others, we can only mitigate. Programs such as APC’s Community Network School are directly intended to address the issue of expertise. However, this approach underscores the technical gap – systems that should be easily learnable by a community are simply not usable, necessitating significant training. This training forms not only a barrier to entry, but also introduces risk, as trained individuals become more employable and are able to seek other opportunities elsewhere.

Another key challenge to resilience, particularly in South Africa, is community attitudes towards resource constraints. Where funding is a challenge, there is not necessarily precedent in the community towards innovating approaches to these problems; there is a tendency rather to operate only around immediate needs rather than long-term planning. For us, this underscores the importance of ongoing community engagement around building ownership in the network, its services, and the ways in which the network can foster local creativity and communication. For research – this points to an agenda around truly community-based approaches to content creation, that are simultaneously, well-situated in the realities of financial and structural constraints.

In Channapatna, the idea of resilience came about in how the health workers valued the health content that they were gathering and its usage value for the communities. As long as there was this value, they will figure out a way to keep it going in different forms. This means that they are not entirely dependent on the Internet as the only infrastructure, but they actively use other traditional modes of storytelling and community engagement. We need to embrace this idea of resilience as not dependent on one monolithic infrastructure, but to enable multiple structures for local content collection, curation and engagement.

Based on our findings we suggest some strategies towards addressing the challenges mentioned above.

1. Upskilling through network
  - Create tutorials about network development and management on the network so that people can learn and self-train through the tutorials.
2. Strategies to make a self-sustainable network
  - Network for the community, by the community, where the network will be managed and maintained by the community. This includes activities and workshops to train community members towards ownership and maintenance, as well as co-design of tools enabling networking management, including a helpline and chatgroup on the network for the community members.

## 7.4 Reflections on Methods

Prior studies have highlighted how challenging it is to engage with community participants especially from low-income communities in rural areas of the Global South. On the one hand, a potential limitation might relate to the fact that our participants were recruited from particular community networks in South Africa and India in smaller communities that might raise the concern that our results might be limited to a narrow set of community perspectives and resilience practices. However, on the other hand, our analysis of resilience practices of community networks suggests the opposite and the richness of involving not only two geographically distinct regions in the Global South, but also how the community familiarity was helpful not only to identify challenges but also to co-design potential user interfaces and solutions for different realities. Grounding the different speculative scenarios to the existing practices of CN's participants was helpful when engaging in the co-design activities. For example, for the Speculative design workshops, we built three alternative world premises based on three scenarios of the existing practices of the participants. In Channapatna, we have been working with the 'Health Navigator' for more than a year in different capacities. With the long-term engagement and understanding of their daily practice, the scenarios for the activities came very naturally and easily to us. However, in Ocean View, it would have been difficult to engage with the CN's participants without the local knowledge of their existing practices. Thus, understanding the existing challenges and situating the speculative scenarios within the existing practices was helpful to move away from creating out of the context scenarios that would have taken away the situated/located(ness) of the network, away from the practices, challenges, and realities of the community participants. In addition, the co-design readiness of the community participants we worked with was also an important aspect to consider. As we have engaged with these communities through several projects, and some participants might have been exposed already to other co-design activities, while for others, it might have been difficult to engage on the first place. Here, in planning the workshops and design and feedback activities, we considered different materials and activities where the community participants could easily and freely express their concerns, needs and challenges as well as potential ideas for content and solutions even if they have not been familiar with a technology. In particular, our project highlights the importance of considering sociocultural practices and oral participation during co-design sessions to fully engage with community participants and avoid common failures of traditional design processes. Furthermore, we have used PAPAD as technology probe, valuing the current use of this tool within the community that helped us to conceptualize and study resilience using a local technological resource. Last, but not least, our strong connections with the communities were helpful to study resilience within the context grounded in the local sociocultural environment that influence resilience practices. We would like to highlight the importance of community participation, involvement and reciprocity and how these need to be considered and enhanced to better engage in research with low-income communities in the Global South.

## 8 Conclusion and Future Work

As with the best research, our research uncovers more questions in the process of seeking answers. We propose a community-centred research agenda for making more resilient community wireless networks and on leveraging CNs for building resilient communities. This project also sets a good example of how we can closely collaborate with communities to identify research problems

and to ideate approaches, as well as a good example of the importance of enabling CN projects to learn from one another.

Based on this research, some key projects are emerging:

- INethiRadio: with Black Equations and content creators in the Ocean View community, the iNethi team is developing a digital radio service. This service will provide a platform for local artists, producers, and activists to share their knowledge and engage with the community. To complement this platform, we will explore sustainability by also co-designing an advertisement platform to allow businesses to market themselves on the CN website and the digital radio, and a music sharing platform to allow artists to track interest in their music, and potentially participate in revenue sharing with the digital radio producers.
- PICKLE with PAPAD: Emerging from this research, we have proposed and are developing a re-narrative storytelling feature that will help content creators to make new content through mixing and matching different audio fragments from the repository.
- Community-Centred Network Management: One of the key features of iNethi going forward will be the ongoing re-design of CN management interfaces from the community's perspective. Through this work, we have identified key challenges. While at the start of the project, we hoped that this would be a simple task of redesign; it is apparent that there is an opportunity to explore deeper in community-centred network management as well as the community's perspectives on communication infrastructure, more broadly. We invite researchers in Human Computer Interactions (HCI) and in systems/networking to take a cross-disciplinary approach to the design of networked systems and the software that is needed to support these communities.

These projects are just the beginning. Our community-centred approach to problem identification and ideation has helped us to identify new strategies for exploring the ways in which CNs can be more effectively leveraged to support community resilience. We reiterate the need for community-centred approaches to content creation and network management, and offer these findings as a step towards building back better not only the community infrastructure, but also the ways in which we do research and explore problems.

## 9 References

[1] Academy of Science of South Africa (ASSAf), (2019). Building Profitable and Sustainable Community Owned Connectivity Networks. DOI 10.17159/assaf.2019/0065

[2] Andre van Zyl and David Lloyd Johnson. 2020. INethi: locked down but not locked out. XRDS 27, 2 (Winter 2020), 54–57. DOI: <https://doi.acm.org/10.1145/3434359>

[3] Harrington, C., & Dillahunt, T. R. (2021). Eliciting Tech Futures Among Black Young Adults: A Case Study of Remote Speculative Co-Design. In Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (pp. 1-15).

[4] Leonardo Maccari and Renato Lo Cigno. 2015. A week in the life of three large Wireless Community Networks. Ad Hoc Networks 24, PB (2015), 175–190. DOI: <https://doi.org/10.1016/j.adhoc.2014.07.016>

- [5] Luca Belli. 2017. Introducing the Evolving Community Network Debate. In Book- Community Networks: The Internet by the People, for the People. Official Outcome of the UN IGF Dynamic Coalition on Community Connectivity. Publisher: Fundação Getulio Vargas Law School and Internet Society
- [6] Melissa Densmore, Ben Bellows, John Chuang, and Eric Brewer. 2013. The evolving braid: how an organisation in Uganda achieved reliable communications. In Proceedings of the Sixth International Conference on Information and Communication Technologies and Development: Full Papers - Volume 1 (ICTD '13). Association for Computing Machinery, New York, NY, USA, 257–266. DOI: <https://doi.org/10.1145/2516604.2516620>
- [7] Maletsabisa Molapo, Melissa Densmore, and Limpho Morie. 2016. Designing with community health workers: Enabling productive participation through exploration. ACM Int. Conf. Proceeding Ser. 21-25-November-2016, (2016), 58–68. DOI: <https://doi.org/10.1145/2998581.2998589>
- [8] Nicola Bidwell. 2020. Wireless in the Weather-world and Community Networks Made to Last. In Proceedings of the 16th Participatory Design Conference 2020-Participation(s) Otherwise-Volume 1. 126–136
- [9] Pantelis A. Frangoudis, George C. Polyzos, and Vasileios P. Kemerlis. 2011. Wireless community networks: An alternative approach for nomadic broadband network access. IEEE Commun. Mag. 49, 5 (2011), 206–213. DOI: <https://doi.org/10.1109/MCOM.2011.5762819>
- [10] Peng Ou and Zhishu Li. 2011. A variant betweenness centrality approach towards distributed network monitoring. Proc. - 2011 4th Int. Symp. Parallel Archit. Algorithms Program. PAAP 2011 (2011), 340–344. DOI: <https://doi.org/10.1109/PAAP.2011.53>
- [11] Lorini, M. R., Densmore, M., Johnson, D., Hadzic, S., Mthoko, H., Manuel, G., ... & van Zyl, A. (2018). Localize-it: Co-designing a community-owned platform. In International Development Informatics Association Conference (pp. 243-257). Springer, Cham.
- [12] Rosner, D. K., Kawas, S., Li, W., Tilly, N., & Sung, Y. C. (2016, February). Out of time, out of place: Reflections on design workshops as a research method. In Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing (pp. 1131-1141).
- [13] Porcia Vaughn and Cherie Turner. 2016. Decoding via Coding: Analysing Qualitative Text Data Through Thematic Coding and Survey Methodologies. J. Libr. Adm. 56, 1 (2016), 41–51. DOI: <https://doi.org/10.1080/01930826.2015.1105035>



