

THE MISSING DATA PROJECT Living Data Hubs: Nairobi, Kenya



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Since 2019, the Dar Group and MIT have collaborated on an initiative to catalyze innovative, interdisciplinary research that addresses the design and planning of new and existing urban landscapes in the MENA region, and other comparable arid, semi-arid regions. Through the Dar Group Urban Seed Fund at MIT Norman B. Leventhal Center for Advanced Urbanism and organized through two seed grant calls, the Dar Group has supported nine research projects undertaken by faculty and students from MIT's School of Architecture and Planning. In the first seed grant cycle, projects presented a wide range of research interests addressing equitable heat-resilience at the neighborhood scale to advanced manufacturing of structurally optimized concrete housing. In the second seed grant round research focused on various facets of the recovery, planning, and reconstruction effort in Beirut. These reports share the findings of the nine research projects.

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THE MISSING DATA PROJECT Living Data Hubs: Nairobi, Kenya

- data



EXECUTIVE SUMMARY

Co-developed a locally deployable social-tech network that provides low-income communities like Kibera access to internet and data collection schemes

Initiated capacity building and digital literacy workshops to ensure the longevity and sustainability of the LDH model in underserved communities

Coordinated partnerships with local internet providers and community organizations to co-create, fund, install, and manage four data collection points and community internet access across Kibera

Installed sensors to enable communities and their partners to collect local environmental and health-based

Instructed community members on how to analyze, manage, and apply sourced data via LDH workshops

Analyzed and confirmed the potential of the LDH model to be scaled up for application across the world and detailed findings and deployability mechanisms in illustrated, multi-step guidebook

1.1 INTRODUCTION

The advent of the internet has revolutionized data access, information sharing, and community relations worldwide. It is so critical to facilitating life today that the UN General Assembly declared internet access a human right in 2016. With the global onset of COVID-19 in 2020 and the physical distancing imposed to mediate it, the internet has continued to prove essential in keeping systems like education, business, and health afloat. Today, internet accessibility is thus one of the greatest determinants of social, economic, and political opportunity. Regardless of its singular importance though, internet availability remains scarce in many communities, all of which continue to be underprivileged in relation to their inability to aet online.

Lack of control over data collection and analysis is also a major issue in these communities. Despite knowing their own challenges best, residents themselves are often left out of data aggregation efforts. Instead, they often suffer through extractive research processes that afford them few opportunities to control their own narratives and ultimate-

ly contribute little to the improvement of their quality of life. Reclaiming the right to data and ownership over its aggregation is crucial for their personal and collective empowerment. Data today represents the knowledge and power to speak with

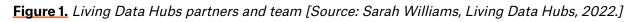
remains scarce in many communities, all of which continue to be underprivileged precisely because of their inability to get online.

Internet availability

evidence and advocate with ownership. The internet's role in collecting, managing, and sharing these findings makes its accessibility imperative to community improvement and self-determination.

Especially cognizant of these internet and data-related challenges, this project has been developed to help deploy community-based internet and data hubs in at-risk areas suffering from gaps in hard and soft infrastructure. The creation of these hubs is premised on co-design with community actors who can together push for access, ownership, and control over local data streams. Engaging





and training select organizations local to the communities in guestion on the installment, management, and financing of Wi-Fi networks has been carried out alongside education on the benefits of gathering, analyzing, sharing, and deploying community data.

We began designing the first iteration of this project for deployment across Nairobi, Kenya's Kibera District in 2020. Mediating the community's lack of access to the internet through our Living Data Hub (LDH) model was planned for with the following objectives in mind:

Key Objectives

- **1.** Apply a co-design model for technology development and stewardship that promotes the design of digitally and physically networked public space
- 2. Facilitate capacity building to support digital literacy, financial management, and network sustainability through the LDH model in underserved communities
- 3. Ascertain the feasibility and sustainability of scaling up the LDH model for application elsewhere in the world
- **4.** Develop a guidebook that instructs on the establishment of future LDH systems

Objectives in Detail

More than anything, the LDH experience is meant to fortify advocacy for equitable access to internet services and the use of data to amplify the voices of vulnerable and marginalized peoples. The LDH model aims to be community owned and operated. In order to achieve this, the research included three phases.

Networking Pilot Initiation

 Create partnerships using a codesign approach and a Request for Proposals (RFP) process with community-based organizations (CBO) in order to encourage members to be owners and stewards of this hub

DAR URBAN RESEARCH SEED FUND REPORT

HUBS

CITY INFRASTRUCTURE

EQUITY LAB

Tunapanda

Vera Bukachi

Talib Manshur

Joe Mulligan

Regina Opondo

Josephine Miliza

Alphonce Odhiambo

Ibra Maina

KENYA PARTNERS:

- Leverage local community networks for help in setting up Wi-Fi and basic networking training for this prototype
- Scale up the network and explore the sustainability of the prototype through a business model developed in collaboration with CBO members and their partner organizations

Community Data Collection Co-Design

- Research and create a data plan by hosting interactive workshops with community members
 - Determine what kind of data collection would be useful in the daily lives of said residents
- Develop the necessary software and sensors required of the LDH to best serve this data need
- Train community representatives on uses and benefits of the LDH
- Begin collecting data following a training period

DIY Kit Development

 Compile documentation and information into a detailed guidebook for application of LDH models in other communities and geographies. Information should include: network technology setup; community engagement strategies; and data collection methodology

The LDH experience is meant to fortify advocacy for equitable access to internet services and the use of data to amplify the voices of vulnerable and marginalized peoples.

1.2 PROCESS

As a small-scale information, communication, and data management system, our Living Data Hub model was designed for flexibility. Kibera is amongst the largest informal settlements in the world and is the largest in Kenya itself. It hosts a population of at least 270,000 inhabitants and is characterized by limited access to basic services and infrastructure like water, drainage, waste management, sanitation, stable electricity, and affordable Wi-Fi access. The settlement is also vulnerable to climate risks such as flooding and poor air guality, all of which pose additional health risks to the residents. Paradoxically, Kibera also happens to be one of the most thoroughly documented informal settlements in all of Africa. While the continued presence of NGOs and researchers in Kibera has culminated in the publication of thousands of articles and studies over the past few decades, this externally funded and guided research often overlooks the needs and interests of the residents themselves.

With that in mind, we worked to install the LDH model as a community-based wireless network across four community public spaces in Kibera. The chosen locales invite contributions from people of various identities, ages, literacy levels, backgrounds, and motivations. This diversity in information helps the community-based internet and data hub shift the power in who designs, implements, owns, and maintains infrastructure in resource-poor communities. It prompts new ways forward by uplifting local partnerships dedicated to co-designing the network and its various applications. Establishing robust partnerships with several key community actors was the first step we made towards fostering a successful and sustainable community data and internet network.

ABC	Andolo Bridge Community	
Anwa	Anwa Junior Academy	
СВО	Community-based Organization	
KDI	Kounkuey Design Initiative	
KPSP	Kibera Public Space Project	
KPSPIN	Kibera Public Space Project Internet Network (name given to the LDH by participating CBOs)	
LDH	Living Data Hub	
TNET	TunapandaNET	
VUMA	VIjana Usafi Na Maendeleo	

Table 1. List of Acronyms + Abbreviations

A) Building Partnerships and **Making Connections Within** the Community

In the case of this iteration, Living Data Hub Kibera, we initiated an international collaboration between Kounkuey Design Initiative (KDI), community-based organizations (CBOs) in Kibera, TunapandaNET (TNET), and the Massachusetts Institute of Technology (MIT). KDI is a design non-profit with community partners on the Kibera Public Space Project (KPSP). KPSP is itself a network of eleven public community sites that CBOs and Kibera residents use for meetings, organizing, celebrations, and other physical, social, and economic programming. KDI leads community engagement with CBOs who own and operate the public spaces that comprise the KPSP. Having KDI on the team, a trusted community partner, helped facilitate connections and interactions with CBOs. For the LDH, KDI led community engagement with the CBOs based on their experiences from previous projects in Kibera.

TNET is a community Wi-Fi network and social enterprise that has been coordinated by the Tunapanda Institute in Nairobi since

2018. TNET advocates globally for community networks through their work in facilitating technology, design, and business training courses across all of East Africa. When our LDH prototype was launched, TNET had already started providing free internet to schools and organizations in Nairobi and was expanding and developing a business and payment model dedicated to the amplified provision of internet across the city. In their capacity as collaborator on this project, TNET not only provided internet to the LDH's selected sites, but also supported the construction and maintenance of their respective infrastructures and systems.

The team at MIT consisted of two labs in the Department of Urban Studies and Planning. The Civic Data Design Lab (CDDL) works with data for the public good and develops alternative practices to make data and imaging richer, smarter, more relevant, and responsive to the needs and interests of citizens traditionally on the margins of policy development. CDDL had already been

	CBO Name	Description
-	Vijana Usafi Na Maendeleo (VUMA)	VUMA is an entrepreneurial youth site features a community hall, wa that builds on and upgrades existi to address flooding issues and cre have been actively building their of development processes to suppor community. Vijana Usafi na Maen
	Anwa Junior Academy (Anwa)	Anwa, KPSP 8 , is a primary schoo with KDI through a participatory p responding to the need for improv goals designed to promote sustain building has been operational sind pleasant learning environment for
	SUN Centre: Ndovu Development Group & Usalama Bridge Youth Reform	KPSP 4 , the SUN Centre is a site to respond to flooding, youth uner sanitation center, a childcare prog a youth group working to establish the Kibera community. Ndovu is a various other income generation p along the riverbank, cultivate land to reduce flooding.
	Andolo Bridge Community (ABC)	ABC runs KPSP 10 , a space desig Space model as a comprehensive incorporating the community's wi flood-protected landscape, playgr a community space to host activit

successful at working toward the generation of missing transportation data through their work on the Digital Matatus project in Nairobi. The City Infrastructure Equity Lab (CIEL) focuses on the governance and financial architecture behind urban infrastructure projects and how it matters to the distributional fairness of benefits and the health of marginalized communities. To do so, it identifies practical policy levers that better foreground equity in both processes and outcomes of local urban development interventions. CIEL has worked with local authorities, national governments, and international organizations in Africa, Asia, and Latin America. Bevond KDI, TNET, and the CBOs, all of which were based in Nairobi, MIT teams were based in the United States and worked remotely to support the project through management, training development, design, research, and codina.

Four of the eleven community sites on the KPSP network participated in the LDH pilot:

h group that co-designed and manages **KPSP 11**. The ater kiosk, water tank, playground, and sanitation block ting facilities operated by the youth. VUMA works hard eate job opportunities for community members. They capacity to manage complex, people-driven, sustainable rt a more prosperous future for themselves and their ndeleo means Youth for Sanitation and Development.

ol founded by a group of mothers in Kibera. They worked process to engage local youth. Providing skilled labor and ved learning facilities in Kibera were among their major inable development across the city. Their new school nce 2017, and continues to provide a safe, flexible, and or 400 children ranging from 2 to 14 years of age.

run by two CBOs, Ndovu and Usalama. It is designed employment, trash, pollution, and insecurity. It hosts a gram with a playing area, and office space. Usalama is sh a new boda boda taxi service to improve mobility for a women's group that operates a baby care collective and projects. Together, the groups lead community clean-ups dscaped recreational areas, and improve drainage channels

gned to test, evaluate, and refine the Productive Public e strategy to reduce flood risk in informal settlements while ider economic and social priorities. The site features a round, water tank, laundry area, shaded seating, kiosks, and ities and events.

Table 2. List of communities invited to participate in LDH Pilot.

CBOs were selected through a request for proposals (RFP), a democratic decision-making process used by KDI to facilitate the launch of all new projects.

The following steps guided our RFP process:

- 1. All CBOs within the KPSP were invited to apply through a RFP
- 2. KDI held meetings with interested CBOs
- **3.** CBOs submitted their proposals
- **4.** Applications reviewed by jury
- **5.** Follow-up interviews conducted with groups on the shortlist
- **6.** Five CBOs from four KPSPs were selected

Winning proposals excelled in the following criteria:

Area: The project sensitively contends with the chosen locale's existing land conflicts and local politics

Proposal Strength: All parameters proposed are logical, coherent, and credible

Project Potential: The project is of appropriate scope and scale, and is impactful, equitable, and sustainable

Site and Technical Feasibility: Accessibility, safety, user thresholds, and existing services are empowered, and lines of sight as well as group agreements are respected

Group Capacity: A positive group track record and history of community cooperation and leadership are expressed

To best manage expectations provoked by the project and its RFP, timelines of implementation were conceived of in tandem with these early decision-making processes. Meetings were held in both Swahili and English, the two most spoken languages in Nairobi, to ensure that everyone understood the project's core goals and values. The meetings built a collective understanding around what could reasonably be accomplished within the two-year scope of the project. All partners were assured that the proposed LDH network would be a community internet service provided via a shared bandwidth, meaning that

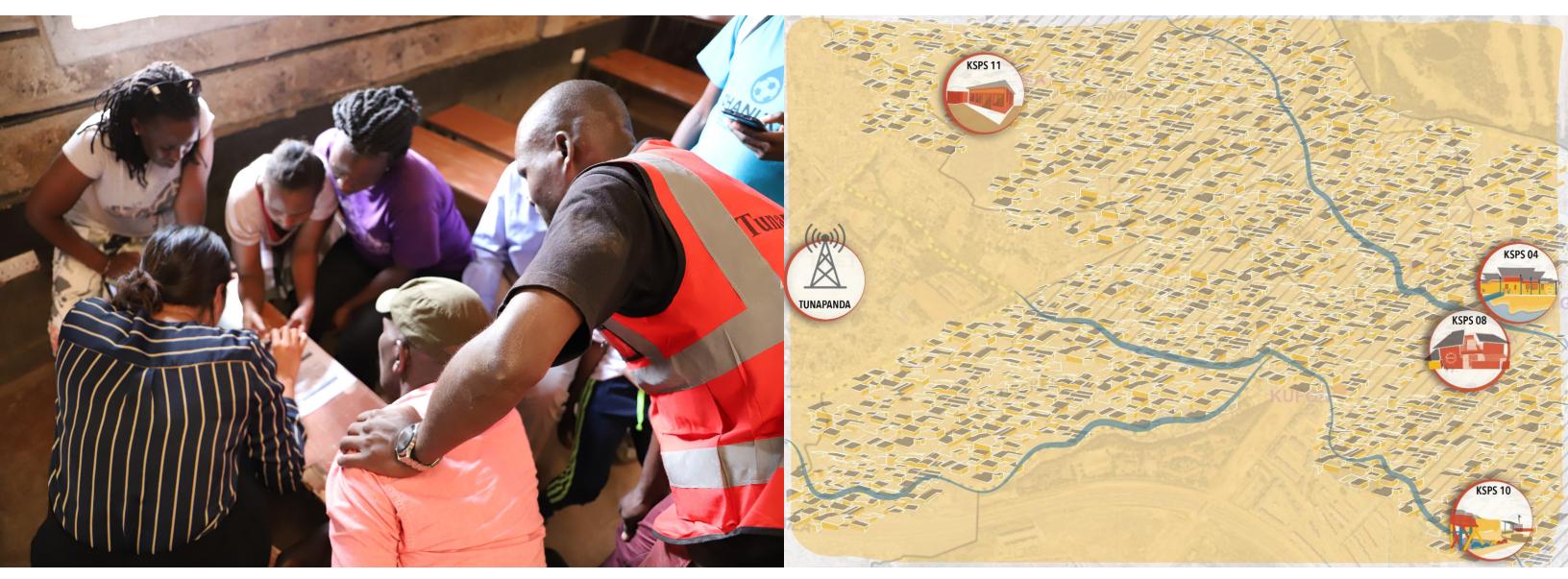


Figure 2. Meeting with local community members to discuss interests and expectations [Source: Sarah Williams and Gabriella Carolini, Living Data Hubs, 2022.]

[Source: Drawn by Sarah Rege, Living Data Hubs, 2022.]

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service would not be monopolized by cyber cafes or video streaming collectives.

In terms of capacity building and sustainability, it was clarified that key information would be provided to the entire cast of CBOs, but that only three members of each team would be fully trained. These three trainees would be charged with training the rest of their own teams. Most importantly, we agreed that access to the internet network would be free of charge for CBOs during the testing phase but would require payments thereafter.

Despite the initial conversations and agreements, several challenges emerged throughout the project. Internal changes in

Figure 3. Four public sites chosen across Kibera for the installation of internet and data hubs

organizing structures and turnovers greatly impacted the project timeline. We also learned that expectations changed as the project progressed. The proper documentation of information and structures for knowledge transfer eventually helped ease these transitions. Offering regular trainings proved essential for sustained capacity building and community involvement.

B) Building Capacity and **Understanding for Effective Network Planning**

To get a sense of what types of data the community was interested in and to help plan the network, several meetings were hosted with our chosen partners. CBOs were invited to collectively brainstorm how data has been and could be used daily. Importance was given to data that facilitated education, business transactions, microfinancing schemes, record-keeping, communication, and transportation. The LDH model's potential to alleviate information sharing hurdles, low business income, theft and security risks, and exorbitant internet costs were also emphasized. Considering how internet connection could help enliven shared public spaces was another major point of discussion.

Both the findings of these meetings as well as the RFP process were used to define key data priorities. Feedback and ideas shared by CBOs that were not selected for the pilot were also taken into consideration. All feedback revealed that the community of Kibera was primarily interested in aggregating and deploying data about public health and the environment. Residents required that more be shared about trends in local weather conditions, air quality, rain expectancy, and flood risks. It was also hoped that health-related surveys could be used to determine the most favorable locations for future health centers. Further to that, it was collectively agreed that heavy-attention apps and websites, individual movie downloading, racketeering, and other malicious or improper activities be limited and restricted. CBOs planned to affix use standards on such sites, deploy website blocking, and regularly monitor networks to discourage such usages.

The findings of these initial meetings helped formulate the *Community Data Plan*, a document designed to integrate the opinions and preferences of the community into the prospective network system. The plan focused on environmental and health data and considered project limitations such as ease of maintenance of the system and relevance to the donor.

With community data and internet interests successfully ascertained, work commenced on imparting a comprehensive technical understanding of computing networks to our partners. A thorough survey of both the built and natural features populating the sites proposed across Kibera revealed that a mesh topology would be the most appropriate for the proposed network. It would allow for the distribution of wireless communications across vast areas without requiring extensive wiring. This makes mesh systems ideal for community hub applications.

TunapandaNET was selected as the internet network provider because it had already reliably installed internet to more than ten key institutions across Kibera. Their organization connects to KENET, a government internet supplier that provides subsidized internet in support of community-based and educational internet initiatives. Following a round of calculations, it was confirmed that four internet hubs could be powered with TNET bandwidth running at 15mbps per site.

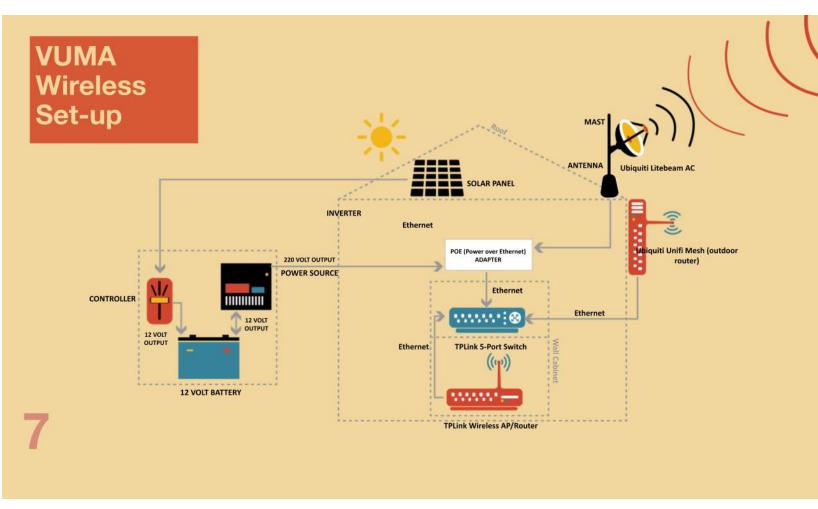
TNET played a lead role in specifying the equipment to be used on site. The first contextual consideration was to use equipment procured in Nairobi and often used by TNET, all of which could allow for easy maintenance and updating. A Wi-Fi antenna was installed at each site as a signal receiver, with two indoor and outdoor routers then used to distribute internet access.

To best determine the roles and responsibilities of each actor going forward, a schematic chart illustrating four different structures that could potentially well serve the various KPSPIN roles was presented at each site. CBOs were tasked with discussing and deciding which structure could comfortably be adapted to their existing organizational structures. Each CBO selected members to assume the role of the organizer, the techie, and the handyperson for the KPSPIN committee. It was established that each role would undergo a new selection process annually. Since Usalama Bridge Youth Reform

and Ndovu Development Group were to share a site and would thus be sharing equipment, they teamed up as a shared committee and had an additional techie and organizer to ensure both CBOs receive proper representation. Similarly, ABC opted to add a vice organizer and combine the techie and handy person roles.

While it was important to have this structure of roles organized across the CBOs, those holding each position changed periodically to accommodate shifts in local politics. Ensuring that structures for knowledge transfers were made available to CBOs when these shifts occurred proved integral to the lifespan of the project.

Network planning included understanding the infrastructure ecosystems of the locations we planned to install our network.





It was imperative that everyone understand the strengths we could together leverage in service of the network, identify the factors that could potentially affect it, and define mitigation strategies to protect it. In Kibera, we performed a survey to understand electricity usage and space availability across the KPSPIN. Information was collected based on observation and personal interviews with at least two respondents per site. It was important to clarify some terms used in the survey to avoid misinterpretations.

The survey revealed that some KPSPs had full connection to legal electricity, while others had no access or were connected via an unofficial connection. It was decided that all sites had to acquire reliable electricity via solar panels prior to the installation of any Wi-Fi infrastructure. It was an imperative step, but one that considerably delayed the project's timeline. Protecting both systems against vandalism and theft also required

Figure 4. Wireless network designed for the site managed by the CBO VIjana Usafi Na Maendeleo (VUMA) [Source: Drawn by Sarah Rege, Living Data Hubs 2022.]

time and attention. At most sites, the router and solar battery were placed in securely locked boxes.

In terms of legal regulations, Kenya reguires profit-based internet providers to pay four major fees: a one-time incorporation of CBO fee, a yearly business permit, a licensing fee, and an operating fee. After some deliberation, it was ascertained that non-profit organizations like the CBOs in the KPSPIN only needed to be formally registered as community-based organizations to avoid the majority of these payments.

C) Installing the Wireless Network

After a series of trainings, discussions, and agreements meant to formalize use and management of the community hub, physical infrastructure was ready to be installed. An

abridged summary of the installation process is offered below:

The Captive Portal: Wireframing

A team of programmers from the University of Nairobi were enlisted to build the captive portal. The developers created a web application optimized for mobile devices of various models. The first goal was to brand the network to ensure the community-facing internet access point was recognizable across all sites. Data collection was then integrated into the opening digital portal.

Core Capabilities - Login, Survey/ Payment, and Free Information

The interface was divided into three sections: the home screen, designed to integrate the login and sign-up page; the survey

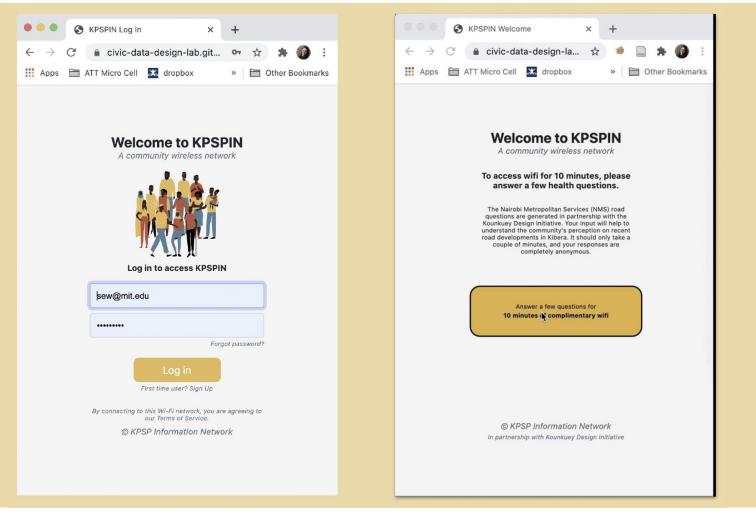


Figure 5. KPSPIN landing page with survey request [Source: Kounkuey Design Initiative, 2022.]

section, made to collect information about health or education within the community; and the landing page, incorporated to allow exploration of the data amassed via the sensors installed across the settlement. If users opt to take a survey, they receive complimentary 10 minutes of browsing time. If not, they are redirected to a page that facilitates the purchase of a Wi-Fi plan through M-Pesa.

Platform Considerations - Typeform Survey and Payment

It was imperative that the survey platform be user-friendly for both the participants and the survey creators. For the participants, this meant offering support in the form of multilingual surveys, mobile friendliness, and varied embedding options. Survey creators, however, required the ability to interact with results via an API or visualization set, to export findings, easily create new surveys, and to track user participation metrics (completion rate, time spent per page, etc.) across the system. Typeform met these needs and was chosen to facilitate this stage of the project.

To ensure the sustainability of our network's business model, it was necessary to create a way for users to pay for network

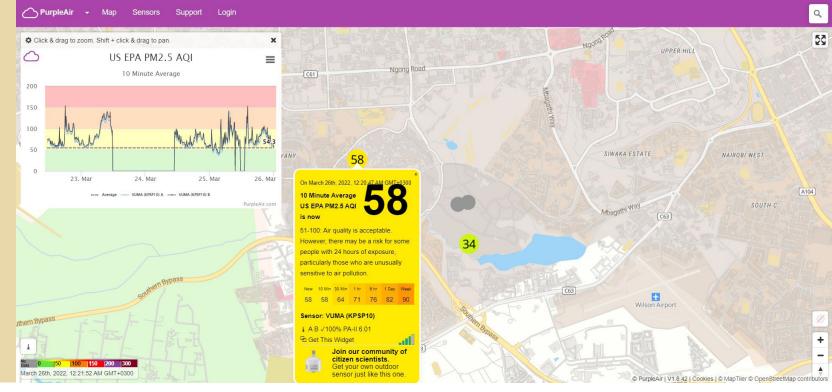


Figure 6. Air quality data collected in 2022 through PurpleAir [Source: Sarah Williams and Gabriella Carolini, Living Data Hubs, 2022.]

access reliably and securely. M-Pesa, a Kenyan electronic payments service, was chosen, as it is almost ubiquitous across Nairobi. It allowed for tokens to be issued for secure network access. However, negotiation with Safaricom, the Kenyan mobile network company operating M-Pesa, proved lengthy and costly and significantly impacted our project timeline. Alternatively, while waiting for goahead, some CBOs opted to give passwords to designated persons in their communities and collected cash payments. This made it difficult to control users and required constant changes of network passwords.

Sensor Installation

In tandem to network installation, PurpleAir sensors were deployed in response to the existing demand for health and environmental data in Kibera. While typical sensors can gather about three months of data, we used a PurpleAir PA-II sensor, a device that lasts approximately one year and can be easily installed, monitored, replaced, and connected to the Open AQ platform. It was agreed that the techie or manager of each CBO be responsible for updating and downloading the air quality data on the first of every month. They would then be tasked with using the

provided handbooks to download the collected PurpleAir data into a Google Sheet and visualize it for the community.

Business Model Development

Defining a sustainable and effective business model has been essential to the upkeep of community-based networks. After much deliberation, a non-profit model was ultimately chosen for the LDH network. It proved to be the least expensive option in that there would be less probability of a price increase in the foreseeable future. Through it, a few key costs could also be shared across the whole network. LDH covered the initial upfront costs to build the network and the monthly fees for all the CBOs during the pilot phase, including equipment, internet, and systems. As nonprofits, CBOs only needed to be formally registered as community-based organizations to initially participate. Security costs were jointly negotiated within the monthly internet fee with TNET. It was also necessary to pay for a contract with Safaricom to enable the M-Pesa platform. In terms of labor, it was left to the discretion of each CBO to decide whether or not to pay the member responsible for taking care of the network.

Field Research

Field research and support made this entire process possible. Although the advent of COVID-19 made it difficult to visit Kibera for some time, the MIT team managed to conduct in-person research in January 2020, prior to when most major travel restrictions were imposed. This included an initial site visit to the Kibera Public Space System and initial meetings with then-prospective partners TunapandaNET and the like. With Nairobi-based partners KDI and TNET, site surveys were also conducted in May 2020 to investigate the geographic and social factors of each public space site and their suitability for hosting an LDH. Following that research and various phases of training and

Figure 7. Meeting to bring all partners up to speed on finalized app [Source: Sarah Williams and Gabriella Carolini, Living Data Hubs, 2022.]



implementation, we managed to also visit the project in January and March 2022 to explore future steps and applications.

Summary of Process

- **1.** Built partnerships and made key connections with the community; this included connecting and outlining essential agreements with local CBOs and collaborators like TNET
- 2. Met with locals to determine their datarelated interests
 - **a.** Determined health and environmental data to be of primary interest
- 3. Scaffolded a common understanding of community data and internet networks among CBOs and local community at large
 - **a.** Equalized knowledge about data and community internet networks among partners via trainings and workshops
 - b. Charted community patterns and challenges to better design a functional, useful, and meaningful network for the residents
- **4.** Paired theoretical understandings of digital networks with trainings on physical installation and management of said networks
 - Four sites chosen for installation of the а. LDH prototypes
 - **b.** Equipment requirements studied comprehensively based on need and intended outcomes
 - Determined a mesh typology to be the c. most favorable network for Kibera
- **5.** Mapped existing infrastructure and site challenges for consideration prior to equipment installation
 - Natural barriers like water bodies and trees were taken into account as were obstacles posed by buildings and weather-related conditions
 - Social obstacles like vandalism were also b. taken into consideration for safety and security reasons

- 6. Installed network with TNET once all planning was completed
 - **a.** Worked with local university partners to design the captive portal (wireframing)
 - b. Assigned core capabilities (login, survey/ payment, and free information)
 - **c.** Considered platform requirements
 - **i.** Enlisted Typeform for survey purposes and M-Pesa for payment
- 7. Installed PurpleAir sensors around the community to start collecting data on health and climate-related conditions like air quality
 - **a.** All data collected made readily available through automatic browsers linked to each user's Wi-Fi enabled device
- 8. Advocated for the establishment of sustainable business models through the LDH prototype
 - a. Determined that Kibera's LDH network would best perform through a not-forprofit model
 - **b.** Collaborated with TNET to share security costs for internet accessibility
 - c. Reaffirmed partnership with Safaricom to use the M-Pesa platform and process Wi-Fi payments from users
- **9.** Maintained and managed the network by demonstrating importance of equipment upkeep by community partners
 - a. Made two site visits in 2022 postinstallation to help fortify care for the installed systems
 - **b.** Discussed further opportunities to strengthen the existing network with other actors in Kibera like MRCK's Moja Wi-Fi in Mathare

1.3 OUTCOMES

Overview of Major Outcomes

- **1.** Internet access points set up at 4 community hubs in Kibera
- 2. Network installed in collaboration with the community
- 3. Major capacity building achieved through extensive trainings and workshops
 - **a.** Community members educated about the network, its usage, installation, management, and maintenance
- **4.** Robust partnerships set up through the project with local, onsite partners including: Kounkuey Design Initiative (a non-profit design think tank). TunaPandaNet (a community internet network), and Community Based Organizations in Kibera
- 5. Air quality sensors successfully installed at all pilot sites and local community trained on how to monitor the air quality
 - a. Community members now have access to health and climate-related data
- 6. Community members now have access to internet for various educational, entrepreneurial, and social activities
- 7. Possible backhaul connection sources explored and network architecture alternatives drafted
- 8. Detailed guidebook produced on the LDH model
 - a. Instructs on deployment of communitybased internet and data hubs worldwide: https://livingdatahubs.cargo.site/Guide
 - **b.** Network management, troubleshooting quides and air quality sensing guides were also developed
 - c. Project website published: https:// livingdatahubs.cargo.site/Home-Set
 - d. Drafting of academic articles for dissemination across fields of interestincluding urban planning, development, and computer science
- 9. Modest businesses supported locally through the introduction of these data hubs

Outcomes in Detail

Kibera's LDH was successfully installed and continues to provide the community with reliable, secure internet connection and data aggregation opportunities. In summer 2020, LDH and KDI launched the Request for Proposals (RFP) process to select the sites for the pilot. Various workshops and trainings were carried out for the CBO members throughout the course of the project to help community members develop capacity and manage the network independently. These included community data meetings focused on explaining community networks and the use of data and internet for the community. Other meetings included network installation training, network equipment maintenance and network management, network administration and user management, business model and network sustainability training, and internet and power supply troubleshooting.

Beyond this community engagement work, LDH also successfully conducted site surveys for the internet structure with TNET. explored possible backhaul connection sources, and drafted iterations of the network's architecture. Challenges experienced throughout the Networking Pilot program included the onset of COVID-19 pandemic slowing communication with possible backhaul internet service providers, and the need to adapt for socially distanced implementation and training. Over the summer of 2021, we successfully established internet at the 4 sites through 5 CBOs in Kibera. We used a mesh network for our Wi-Fi, which is powered by solar panels to avoid disruption of internet due to power cuts and lack of legal power sources. Through the rest of 2021, we worked with a team of local programmers on developing a web portal to help the CBOs manage the users on the network and develop a business plan for community internet usage. We also worked with the programmers to develop a login portal (captive portal) for users to login to the network and for hosting surveys to collect data. This was augmented with environmental data collected through our installation of Air Quality sensors at all the sites above the designated Wi-Fi routers.

We have since produced a fully illustrated, six-step guide that reproduces this entire process. It is offered as a resource for other practitioners and community members working to tackle similar data scarcity issues around the world. As a free, open-source manual, it is available via the Living Data Hubs website, which we also managed to launch in 2022 alongside the conclusion of this prototype. The project itself has connected various leaders and service providers across Kibera and has stimulated business opportunities and social activity across the settlement. Since the launch of Kibera's four hubs, the models have evolved to meet the needs of their users. The sensors installed around the settlement continue to effectively report health and climate-related data to users. The trainings and workshops organized throughout this project have successfully instilled within local actors the requisite knowledge and know-how for the upkeep of the hubs. It has also helped generate interest and expertise in the processing and handling of the aggregated data. Locals now have agency over their own data-driven narratives.

Apart from the generous funding provided by the DAR Group Urban Seed Fund, this project was also awarded recognition by the Adaptation Research Alliance Microgrant (awarded to KDI to conduct further community engagement workshops in 2022), the Department of Urban Studies and Planning Rodwin Travel Grant (awarded to Surbhi Agrawal to support travel to and community

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work in Nairobi), and the MIT Priscila Grey Public Service Fellowship (awarded to Surbhi Agrawal to support travel to and community work in Nairobi).

Next Steps

In future iterations of this project, we aim to strengthen existing network setups and engage with community members and local partners to promote shared knowledge building. In Kibera itself, we will explore other ways in which people are accessing the internet and meet with various internet providers to gain a better understanding of the backhaul options available. Bringing in new CBOs and hosting further workshops and trainings will help expand the scope and impact of the existing hubs. Consistently identifying new partners capable of hosting new hubs will also be key to ensuring the endurance and longevity of the project. Developing new means of data analysis among the local community and exploring the application of aggregated information still bears exploration and refinement as well.

Outputs

Project Website: Williams, Sarah and Gabriella Carolini. "Living Data Hubs." Dar Group Urban Seed Fund, 2022. https://livingdatahubs.cargo.site/Home-Set.

Living Data Hubs Guidebook: Williams, Sarah, and Gabriella Carolini. "Guide." Living Data Hubs, 2022. https://livingdatahubs. cargo.site/Guide.

Agrawal, Surbhi, "Environmental Injustice: Air Pollution and Data Inequity in Kibera, Nairobi." In Negotiating Resilience with Hard and Soft City, edited by Binti Singh, Tania Berger, and Manoj Parmar. Milton Park, Oxon: Informa Law from Routledge India, 2023.

"Being there without being there: decolonizing international development practice during COVID-19" (paper drafted and in preparation for publication)



Broader Impacts

- The Living Data Hub prototype proves that the model is ready for application elsewhere in the world
 - Guidebook detailed with enough ideal and troubleshooting scenarios to deploy a new hub in any context or territory
- The enthusiasm of existing users can be extended to activate and connect new sites in neighboring communities
 - The project can be advanced and expanded to connect increasingly larger user groups
- LDH models can be employed to safeguard data autonomy in developing countries
 - It can be used to counter and combat data extraction by foreign actors
- Local open-source data aggregated via installed sensors can augment existing data streams operating at municipal, urban, and even national scales
- Getting communities online positively impacts all service sectors
 - LDH directors can curate trainings and workshops to best leverage internet access towards improving educational, financial, and even health-related services of choice
- Internet and data hubs can be incorporated into schools and recreational institutions to help strengthen community relations across the public domain

Figure 8. Reviewing network installation details [Source: Sarah Williams and Gabriella Carolini, Living Data Hubs, 2022.]





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