Volume **8** (1) 2026 https://doi.org/10.5204/lthj.4165

A Critique of the Emancipatory Promise of Open-Source Software in Digital Health in LMICs

Tatenda Chatikobo and Sharifah Sekalala
University of Warwick, United Kingdom

Abstract

Digital health innovation through open-source software (OSS) is often presented as a critical response to the health system crises that low- and middle-income countries (LMICs) face due to inadequate public health infrastructure. Proponents of OSS argue that it offers a more sustainable, economical, and democratic approach to developing health solutions in underresourced contexts. Drawing on the experiences of software developers in East Africa working on digital health initiatives, this article argues that the potential of OSS to be transformative in LMICs is constrained by different infrastructural problems and its continued reliance on a middle-class elite who rely on technological fixes over health system solutions. This, we argue, is because OSS innovation is entangled in extractive legal regimes, digital ecosystems and persistent knowledge hierarchies. By foregrounding these epistemic and political dynamics, we call for renewed attention to the structural conditions that shape OSS innovation, particularly to the practices of software development in LMICs.

***Keywords**:* Open-source software; low and middle-income countries; techno solutionism; digital health; technology incubator; digital inequalities; ICT-for-development.

1. Introduction

Open-source software (OSS), which is conceptualised as code designed to be publicly accessible for people to review, modify, copy and distribute, promises greater transparency, collaboration and fairness by enabling developers greater control and flexibility in developing solutions. At the global level, OSS is seen as an opportunity to advance the digitalisation of government services and promote social good. The United Nations Economic and Social Council (UNESCO) adopted a resolution recognising the potential of open-source technologies for overcoming infrastructural barriers to social development, particularly in low- and middle-income countries (LMICs).[1] Similarly, the UN's 2024 Global Digital Compact framework for digital cooperation and governance of artificial intelligence highlights the opportunities that OSS and other Open Science infrastructures present for empowering societies to develop solutions aligned to their specific needs and priorities.[2] The African Union promotes the adoption of open standards in the design and implementation of digital services as part of its Digital Transformation Strategy for Africa 2020–2030.[3]

In African contexts, countries such as South Africa, Egypt, Nigeria and Kenya are increasingly recognising the potential of OSS for public service development. For instance, South Africa has a policy for OSS, passed in 2007, which establishes a preference for open-source options over proprietary ones.[4] Similarly, Kenya's National ICT Policy of 2019 and the Government ICT standards underscore the country's stance on utilising OSS over proprietary systems in public administration.[5] Kenya, together with Trinidad and Tobago, was recently selected by the International Telecommunication Union and the United

[1] UNESCO, "Open-Source Technologies for Sustainable Development."
[2] UN, "Digital Compact Framework."
[3] AU, "Digital Transformation Strategy."
[4] South African Government, "Policy on FOSS."
[5] Government of Kenya, "ICT Policy Guidelines."; Kenya ICT Authority, "ICT Standards."

Nations Development Programme to host an Open Source Programme Office to support OSS development and enhance digital public service capacity at the national, regional and global levels.[6]

The rise of digital health in LMICs has led to the emergence of open-source solutions as a transformative approach for addressing healthcare challenges. Across the Global South, countries have increasingly implemented OS-powered digital health solutions such as electronic health records (EHRs), health surveillance platforms and health information systems for strengthening healthcare delivery through cost-effective, scalable, interoperable and locally customisable alternatives to proprietary systems. Notable OSS digital health platforms in Sub-Saharan Africa (SSA) countries include District Health Information Systems 2 (DHIS2), OpenMRS and Bahmni.[7] These health platforms are used to collect and manage health data from medical records to surveillance and analyse the impact of interventions while ensuring adaptability across contexts.[8]

OSS has garnered significant academic and policy attention with proponents pointing to its potential benefits for social development. In resource-constrained settings, the dominant scholarly discourse often portrays OSS as an essential mechanism for developing cost-effective and flexible public service digital infrastructure solutions, particularly in health information systems and educational technologies.[9] However, this scholarship continues to focus largely on a cyber-optimistic view of OSS's potential at the policy level, with limited empirical work on the political economy of software development in an increasingly globalised and integrated Information and Communication Technology (ICT) environment.[10] Therefore, in this piece, we seek to fill this gap by arguing that locating OSS in LMICs enables us to analyse how contemporary global infrastructural dynamics reproduce extractive and inequitable relationships through digital ecosystems.

In this article, we examine the use of OSS for digital health solutions in LMICs. We contribute to critical scholarship on data colonialism and surveillance capitalism in two ways.[11] First, we challenge the dominant view of OSS in literature which portrays LMICs through a deficit model. This view often overlooks the ever-expanding influence of big technology corporations (Big tech) in social domains. Big tech is increasingly shaping what social innovation entails in the context of public services. Big tech is also shaping how such innovation is conceived, understood, legislated and implemented by tech experts in LMICs. Second, we problematise the assumption that OSS inherently democratises digital infrastructures. While OSS is often seen as opening specialised software development environments to diverse groups, its technical environments remain very elite. Software development continues to depend on elite labour, which undermines the emancipatory promises often associated with OSS. Our attention in this article is therefore on exploring the epistemic implications of OSS in digital health innovations in LMICs. We situate our analysis against the backdrop of commercial logics, global legal standards, labour regimes and values about digital data. This is particularly relevant due to the increasing prominence of artificial intelligence (AI) in digital health innovation.

Using selected sample journal entries from six early-career freelance designers working on a digital health data project in SSA on using OSS, we analyse the design and methodological choices and experiences of developers and designers in LMICs as they navigated and balanced the need for democratised, cost-effective and localised public health solutions with some of the digital infrastructural realities. We also rely on interview data from senior software developers working on digital health solutions to supplement the perspectives of early-career designers (See more in the methods section). The article is structured as follows: first, we provide a brief overview of the OSS as a movement and as an alternative model to the dominant Intellectual Property Rights (IPR) model in software development. Secondly, we discuss some of the methodological considerations for our empirical approach. Thirdly, we present our findings under broad themes linked to legal and digital enclosures, epistemic inequalities and techno-solutionism in OSS. Finally, we contextualise the findings in broader debates on the political economy of digital technologies in LMICs.

2. Background: Open Source as a Movement

The OSS community consists of two competing political movements, Free Software and Open Source, both of which are historically linked to the hacker culture of the 1960s. This culture was steeped in values of individual liberty, creativity,

[6] ITU, "Open Source is Reshaping the Digital Future."
[7] Zerfu, "Unveiling the Role of DHIS2"; Mamuye, "Health Information Exchange"; Verma, "OpenMRS as a Global Good."
[8] Meessen, "Role of Digital Strategies"; Maglogiannis, "Towards the Adoptions of Open Source."
[9] Syzdykova, "Open Source Electronic Health Record Systems"; Paton, "Open Source Digital Health Software"; Hewapathirana, "Open Source Adoption in Health Sector"; Chigwada, "Open-Source Software Use in Libraries."
[10] Sahay, "Free and Open Source Software as Global Public Goods?"
[11] Couldry, "Data Colonialism,"; Zuboff, "Surveillance Capitalism."

problem-solving, and technical solutionism.[12] Free Software and Open Source are often used interchangeably but consist of fundamental differences. The Free Software movement, which dates back to the 1980s, emphasises the idea of freedom to distribute and run software over cost. Thus, Free Software refers to software that enables users to access the source code with the ability and freedom to study, copy, run, modify, distribute and update the software. Open Source is considered a denomination of the Free Software movement, which gained prominence in the 1990s and emphasises the unobfuscated availability of source code for further experimentation and development of programs, centring the idea of the commons. Since the categories of software that Free Software and Open Source designate are the same, we use the term OSS to avoid making a preference between the two movements.

OSS is seen as an alternative model to the dominant Intellectual Property (IP) model as it is based on a different set of principles, which are: source code must be available to anyone; all users must contribute to the development of the source code, ensuring that the model is based less on access and more on creative input.[13] There is thus less focus on proprietary control to avert piracy and more on openness, sharing, and cooperation, with users being part of the community that owns the open-source projects, rather than the dominant IP model based on exclusivity and corporate control.[14]

While challenging traditional configurations, OSS still relies on IP protections to manage the relationships between different types of users (e.g., contributors, community leaders, and end-users). For example, copyleft licensing, a legal mechanism that protects the freedom to use, modify, study, and distribute software, can be used to ensure that modified and extended versions of a program are also free. Using alternative copyright models, such as the GNU General Public License, individuals can share and build upon each other's knowledge, expertise and creativity, leading to a new form of collective and social value.[15] More fundamentally, the use of OSS is premised on challenging software enclosures by developing collective ownership models of software as alternatives to individualistic and proprietary ownership.[16]

OSS is informed by the idea that software is more than just a set of instructions for computers. Instead, it is a socio-technical, legal, and political infrastructure that can enable or disable certain kinds of imperatives, values, and outcomes.[17] As a resistance platform to code hegemony, OSS can thus aid the emancipatory project of promoting social liberties, creativity and social solutions. Having a software programme whose inner workings are open for review, adaptation and modification also brings into focus the dynamic relationship between constructions of technical expertise and politics of solutionism.[18] The transparency of the OSS process can be an important tool in recalibrating power imbalances between various social actors.[19] In this piece, we engage in a sociolegal critique of these transformational claims by focusing on the political economy of OSS infrastructure and the designers of digital health solutions.

3. The Experimental Incubator: Methods and Findings

The article employs a mixed-methods approach, beginning with a review of the literature, which was supplemented by research diaries, interviews, and observations from an experimental incubator as part of an interdisciplinary research project conducted from 2021 to 2026. Primarily, we relied on the diaries of six designers who were taking part in an experimental incubator to design a digital health tool using OSS from 2023 to 2024. The diverse team of freelance designers consisted predominantly of early-career professionals. We complemented the diary findings with interview data from eight senior developers working in Kenya's tech health industry. [20]

3.1 Experimental Incubator

The experimental incubator provided capacity building from mentors based on specific requests from the designers. Mentors were based in Kenya and the UK, working in tech design, public health, law and entrepreneurship. The experimental incubator was managed primarily by the Open Institute, which has an excellent track record in digital health, with the assistance of two Kenyan collaborators with backgrounds in entrepreneurship. The designers were recruited through an open call and were hosted

[12] Powell, "From Open Software to Open Hardware."
[13] Halbert, "Open Source Alternative."
[14] Thiruthy, "Open Source—Is It an Alternative to Intellectual Property?"
[15] Sullivan, "Software Freedom as Social Justice."
[16] Coleman, "Code is Speech."
[17] Chopra, Decoding Liberation.
[18] Jordan, "Hacking and Power."
[19] Prokakis, "Free and Open-Source Software."
[20] Interviews were conducted between June and August 2025. Ethical approval to carry out the research was obtained from the University of Warwick (HSSREC161/21-22) and the University of Nairobi (NACOSTI/P/24/41949).

by the Open Institute for the duration of the project. The incubator sought to challenge the dominant commercial model - often criticised for individualism, exploitation, and colonial inequities - by promoting a socially centred, co-creative approach focused on public health benefits. While the designers could and indeed focused on proprietary models, the predominant focus was on working with public health officials to create a digital health app that was viable through the use of OSS, ensuring long-term sustainability and openness.

As freelancers working three days a week, the designers had flexibility in their working hours and were remunerated for their work on the project. They were supervised by a long-term tech specialist who was also employed by the project and had weekly check-ins with her and monthly check-ins with a staff member from the Open Institute. The designers presented their progress on the digital health app and got bi-monthly feedback from the entire team. They presented their work in specific forums, including to other health tech specialists, public health professionals, civil society organisations and insurers in preparation for the universal health insurance system in Kenya. They also participated in an online reading group on digital colonialism and incubators in Africa, alongside the project team based in the UK, Kenya, Uganda, and South Africa, to gain a deeper understanding of the project's overarching themes. It is in this context that the designers relied on the research diaries to document their experiences of using OSS to design a digital health application.

3.2 Research Diaries

As a research tool, diaries enable researchers to explore respondents' experiences, meaning-making and activities over a specified period, especially where contextual variables are bound to change or evolve, such as in software and product development.[21] This allows researchers to track such changes, patterns and personal reflections as they occur and develop a longitudinal understanding of contextual processes.[22] The diaries enabled researchers to understand designers' experiences of the product development life cycle from the initial requirements and specification phases to the development of a minimum viable application. Diary entries were used to record activities and progress, as well as to document personal reflections on a weekly basis. The documentation of the process and experiences was also complemented by regular follow-up discussions with researchers on the design process experiences.

3.3 Interviews

The interviews explored senior developers' experiences with OSS in the Kenyan context. We focused on understanding what they found helpful and challenging about this development approach, particularly within digital health projects, and how such challenges could be addressed. The senior developers included project managers working in and heading tech start-ups in Kenya, as well as those employed in established commercial organisations. By combining data from both the experimental incubator and these additional interviews, we sought to gain a deeper understanding of the varying motivations, practices and challenges across an entire design trajectory within the Kenyan tech health space.

4. Analysis

4.1 Freedom/Flexibility, Creativity and Enclosures

The often-cited advantage of using OSS for digital health innovation is the elimination of licensing fees or upgrade costs, which can facilitate the innovation of solutions for improving public health outcomes.[23] In addition, OSS use enables extensive customisation in contexts with ICT infrastructural barriers, such as supporting offline and low-resource functionalities. Most designers found this flexibility useful in developing cost-effective, customisable, and scalable solutions that are compatible with contextual needs while equipping them with new skills for innovation. For example, they could use open-source medical LLMs tuned to domain-specific data, making them compatible for deployment on low-resource devices. Using open-source solutions also allowed the designers to maintain greater control over the application data, as one of the designers stated their discomfort with using LLM solutions with data over which they did not have control, citing issues of bias and unexpected access controls. The agility that OSS presents was also acknowledged by senior developers. For example, one senior developer stated:

> You can't keep reinventing the wheel when you're building software. So … someone has solved a problem for you, the easier for you to build and deploy fast. Building on top of [OSS] libraries and making your process smoother and faster is always a plus. (SD5 25/07/2025)

[21] Wiseman, "Using Diaries Data in Resource-Poor Settings."
[22] Day, "I'm Really Embarrassed That You're Going to Read This."
[23] Akanbi, "Use of Electronic Health Records in Sub-Saharan Africa"; Syzdykova, "Open-Source Electronic Health Record Systems for Low-Resource Settings."

However, the increasing role of commercial companies in the open-source ecosystem has led to licence ambiguities that are incompatible with open-source principles, even though they appear compatible at face value. For example, some designers sought to utilise Meta's proclaimed open-source LLaMa LLM model but encountered challenges when attempting to fine-tune it for their projects, as they were unable to access and assess the foundational datasets. The Open Source Initiative (OSI), recognised globally as the leading authority on open-source, disputes that LLaMa does not meet the definition of open-source due to its restrictive licensing agreements.[24] Researchers have noted that the strategic misuse of the term 'open' in the case of the LLaMa model is a deliberate attempt to co-opt the credibility of open-source movements into software enclosures that require proprietary licenses for access.[25] For young developers working in low-resourced settings, these practices of 'open washing,' which is the misleading practice of claiming a product or service is open when in fact it does not adhere to the principles and spirit of openness, are not readily apparent without investing a significant amount of time to study the code. The fact that OSS presents little to no start-up financial costs is already a sufficient motivation for buy-in for developers with limited resources. However, additional costs for studying, understanding, and evaluating code are rarely factored into the economic considerations of OSS. For us, this exposed a deeper tension between using open source in the liberatory sense - that is, as freedom and challenging the dominant technological perspectives, aligned with the ethos of the free software movement - over the idea of practical efficiency that access to source code presents for developers.

Software enclosures also extend to software version control and code-sharing platforms, such as GitHub, which the majority of the OSS community relies on. Big tech corporations such as Alphabet's Google, Apple, Amazon, and Microsoft host public versions of their software development packages and code. However, advanced functionality is only accessible through paid accounts and subscriptions on GitHub. Similarly, one of the designers described needing AWS credits to access training resources for the Llama LLM model as part of developing digital health applications:

> I faced challenges when delving into the training of the Llama LLM model using Amazon services. This aspect seemed promising but complex, particularly due to the need to acquire AWS credits for the training process. (D1, 07/08/2023)

Commercial entities play a gatekeeping role in software development, making it virtually impossible to design and deploy outside of commercial tech, given their monopoly over software and increasingly over platforms previously used for equitable source code sharing. With Microsoft having brought GitHub in 2018, there are also concerns that this might lead to a lock-in of projects on the site through new terms of service, which would further enclose GitHub and lock out OSS developers.[26] Similarly, Red Hat has recently changed its terms of service to Enterprise Linux (RHEL), which is technically considered OSS, limiting access to code only to customers with paid subscriptions and forbidding the distribution of code.[27] Although designers in low-resource contexts appear to hold epistemic agency through the reuse and adaptation of code, this agency is limited by epistemic and infrastructural asymmetries that reinforce big tech's authority.

For senior developers, especially those who head or own tech organisations, the perceived freedom and democratisation of OSS come at a cost, and in the process, constrain another kind of freedom. Given that some of the licensing terms of OSS, such as copyleft, would make it prohibitive to black box the code and develop proprietary software, it makes better business sense to either build code from scratch if you have the necessary resources or to utilise other options. One of the senior developers stated:

> When [we did] not have resources, we did [use OSS], but it has got its own challenges. You find that as an innovator, you don't want to find limitations. Because open source has got its own rules … that you should adhere to. But as an innovator, I want to be free. I want to innovate freely. I don't want to some extent [be told] this is how I cannot commercialise the open source. I want to be independent, absolutely independent, as an innovator. (SD7 13/08/2025)

Other senior developers also found that OSS can be quite limiting if you already have the experience and resources to develop your own projects. This was echoed by one of the senior developers:

> I personally find it easier to start from scratch than using open source. I know it's not a lot of people [who] say this, but I prefer that am I'm able to get my thoughts together. And, you know, with open source, there are some things you just have to settle on. (SD6 23/08/2025)

[24] Maris, "Meta's LLaMa License is Still Not Open Source."
[25] Wiggins, "LLaMa 4 Deception."
[26] Vasudevan, "Share and Share Unlike."
[27] Rendek, "From Freedom to Profit."

4.2 Skills Training, Employability and Educational Inequalities

There is an assumption that developers are already familiar with the diverse programming approaches and can seamlessly navigate and utilise different tools for different needs. This assumption is rooted in Eurocentric constructions of a software developer, typically imagined as a cosmopolitan, highly educated individual with technical aptitude and economic access to tools and resources for upskilling and self-training. In instances where skills gaps exist, there is an expectation that individuals can easily address these.

While digital media has brought opportunities for self-directed and peer-to-peer skills training, there are still significant challenges in terms of early career professionals accessing opportunities, specifically those tailored for OSS.[28] For developers in the Global South, a combination of resource constraints and limited exposure means they face trade-offs in choosing the software to use. Adopting open-source frameworks entails a steep learning curve and brings about compatibility complications. For example, most designers noted that using open-source tools often required learning how to use programming languages independently, which slowed down their progress and presented new complexities related to compatibility with existing designs, resulting in additional time and monetary costs. One of the designers illustrated this additional cost:

> Understanding Elixir, which is a new language is a process that takes time and effort, currently, I am working on creating the necessary time to learn the language so that I can make steady progress and deepen my understanding of Elixir's capabilities over time. (D4, 30/06/2023)

With the need to dedicate some time to learning new programming skills, this can often impact contracted project hours to fulfil objectives, as highlighted by one designer:

> We will have to put in more than 40hrs[29] a week we may end up putting upto 80hrs a week to be able to fully develop the application. (D6, 21/07/2023)

Switching between open-source and proprietary frameworks, which can address a lack of expertise, requires considerable adjustments to development workflows. As one developer mentioned, this can be quite challenging, especially when working on time-bound projects with limited funding. This process of switching also highlights an often-overlooked reality of digital labour in contexts with resource constraints and the ways this reproduces extractivism in all its forms. Developers in LMIC often have to shoulder disproportionate burdens of adaptation, troubleshooting and limited access to infrastructure and institutional support for using OSS.

For instance, the designers reported some of the costs of adopting OSS, quantified in both time and labour spent redoing certain iterations, such as rewriting the project's backend from .NET to the open-source framework Node.js. This is particularly problematic in LMIC contexts such as SSA, where digital work has already been linked to exploitation.[30] While there is emerging research on the egregious impacts of low wages and the emotional and psychological harms on digital content moderators,[31] there is still very little on the hidden labour dimensions caused by technological architectures such as OSS on developers who already have the least infrastructural support.

Invisible labour was also highlighted as an issue by senior developers, with one stating:

> The first idea that most people have that open source [is it] equals to free. It still needs development hours to fit it to your current situation, because most open source tools are not [an] exact fit to the problem that you are facing. So they will need some bit of configuration and a bit of development to get it to the intended purpose. [It is a] challenge trying to explain to someone, or trying to have the management side to understand that open source is not exactly cost-free. (SD3, 15/08/2025)

Developing digital health solutions in a resource-constrained context requires thinking about the immediate benefits that OSS can provide during development and considering future issues. Our findings demonstrate an awareness of the potential of OSS upskilling, as noted by one of the designers who stated that:

> The knowledge gained and the experience of transitioning to an open-source solution [would] be valuable in future endeavours. (D3, 01/07/2024)

[28] Liang, "Understanding Skills for OSS Communities on Github."
[29] Reference to 40hrs is used as illustrative of the amount of time development takes rather than in reference to contracted hours on the project.
[30] Arora, "Risk and the Future Of AI."
[31] Regilme, "Artificial Intelligence Colonialism."

However, skills training, mentorship, and capacity-building opportunities are very limited for developers in the Global South working on specialised projects that require technical, contextual, and legal expertise, such as in the context of digital health. For example, while some of the designers identified key areas for technical training such as data model development, data selection, interoperability and scalability mechanisms, other key areas such as legal knowledge and skills in terms of understanding the related IPR implications were often missing from such requests, despite causing contention in the latter stages of the incubator fellowship when design problems emerged. The skills gap is exacerbated by the limited technical and specialised training interventions offered by higher education.[32] Where skills training interventions exist, the curriculum is often based on proprietary tools, knowledge and mainstream software development standards due to career development trajectories and the corporate funding structures of the training programs.

While it is true that the free nature of OSS code enables designers to teach themselves new skills and use online communities to troubleshoot, those working with OSS are usually confronted with methodological challenges in searching for relevant and valid software documentation, given the wide array of sources.[33] The lack of technical knowledge often leads to new dependencies on external experts and other proprietary software.[34] For instance, some designers had to rely on the technical expertise of more experienced team members for OSS support. While seeking advice and guidance from others can be an opportunity for collaboration and cross-learning, as evidenced by the diary entries, it also presents the danger of reinforcing inequitable relationships in a tech space that has a history of inequities. In the Kenyan and broader African contexts, technical skills development programs, such as hubs and incubators, along with associated funding schemes, have often been used to maintain Western dominance over local innovations, promote extractivism, and perpetuate gendered exclusions.[35]

4.3 Datasets, Ethics and Techno-Solutionism

OSS is often presented as a solution-oriented approach to innovation, particularly for addressing developmental needs such as public health, and through an economic efficiency rationale. This was amply illustrated by one of the designers who stated that:

> With so many meaningful problems to solve within our inefficient and problematic healthcare system, I have an opportunity to leverage an AI tool in use cases that matter and have a direct and positive impact on the most vulnerable patient populations. Those who need it the most. (D2, 02/06/2023)

This problem-solving paradigm has resulted in increased piloting, as developers can test new ideas, iterate rapidly, and refine solutions in real-time with minimal technical overhead.[36] The solutionist approach has also led to the rise of commercial enterprises significantly influencing OSS projects through collaborations, partnerships, and incentives, such as access to Application Programming Interfaces (APIs) for integrating and connecting two or more software programs. The growing number of pilot initiatives has introduced sustainability challenges within certain OSS projects. When funding ceases, many OSS libraries that previously supported developers in building new solutions fall out of maintenance, making them suitable to leverage. This tendency toward experimentation, often described as *pilotitis,*[37] is particularly prevalent in digital health initiatives across SSA, with broader adverse implications for universal health coverage efforts due to the fragmentation of approaches and the crowding out of local actors.[38] This problem was highlighted by some of the senior developers who stated:

> Most of [OSS] projects fail due to lack of funds, and if we are relying on these open source tools and the support for them, or there are no further developments, then we also get stuck, and we now have to find new tools, or even develop our own. I think that has been an outstanding issue whereby a very nice project that is solving a real issue for developers suddenly stops because of lack of funding. So this gets us back to the cycle of always finding new tools, going back to the drawing board, trying to find a way to match the old open source to a new open source. (SD3, 15/08/2025)

While public and open-source datasets are available for highly specific solutions such as digital health, such data is not always available or relevant to particular contexts, presenting methodological challenges for developers. Given that patient data is highly regulated within healthcare systems, this can present some tensions with developers who often view this as a way of gatekeeping that is counterproductive to the ethos of open-source development, especially when such solutions are meant for

[32] Guàrdia, "Graduates' Employability Skills in East Africa"; Nanjala, "Mentorship and Incubation Program Using Project-Based Learning."
[33] Stol, "Integrating Open Source Software and Inner Source Software."
[34] Steinmacher, "Overcoming Social Barriers to Open Source Software Projects."
[35] Okune, "Becoming an African Techpreneur"; Anwar, "Gender Dynamics of Digital Labour in Africa."
[36] Richterich, "Can't Fix This?"; Sætra, Technology and Sustainable Development.
[37] Egermark, "Overcoming Pilotitis in Digital Medicine."
[38] Neumark, "Digital Health in East Africa."

the general public. One designer stated that the gaps in accessing anonymised patient data for developing digital health solutions have:

> [stifled] the rate of growth and innovation desperately needed to solve some of the challenges in healthcare that technology can now resolve. It is possible now, but we risk being left behind if we don't leverage the recent advances being made in the field of AI in Healthcare. (D2, 18/08/2023)

Within this framing, the imperative to 'catch up' or risk 'being left behind' reproduces colonial temporalities that equate technological adoption with progress, modernity, and legitimacy. In the context of health innovation, such narratives obscure the structural conditions that constrain local innovation and instead valorise imitation of dominant technological paradigms as identified in recent critical scholarship on digital health in LMICs.[39] OSS, often framed as a democratising alternative, thus becomes entangled in these same logics, with its deployment reinforcing a mode of participation premised on alignment with global norms of innovation rather than giving autonomy to developers.

Some digital health solutions developed using open source, especially those relying on LLMs and AI, often require access to training data to build models and prompt engineering. Limited access to contextual datasets for developing LLMs for digital health applications has also led to a reliance on unverified options, even when the designers knew about data biases and non-representativity issues. Some of the proposed solutions, when primary health data was not available, included using AI-generated synthetic data as training data. However, this still also requires access to patient data in the first instance to generate reliable predictions. Given that a significant amount of data is currently in private hands, the promise of openness can potentially lead to an infrastructure of extraction that relies on the harvesting of patients' data for commercial gain. Therefore, if we must consider digital health in terms of social value, we need to ask who the real beneficiaries of openness are in the assemblage of actors, including developers, commercial organisations, funders, governments and society. Secondly, we must identify the tensions between the narratives around OSS as a software development approach versus a social justice project. One of the designers summed up this data extraction succinctly:

> This made me aware of the players in this space who should like to have the solutions we have for their own gain, which makes me wonder: outside of the bounds of the project, who can we trust to see the solution as a way to help people and not the next method to milk money off the poor? (D5, 02/07/2023)

While the quote above illustrates a critical ethical perspective on data, most young developers working independently or in small organisations in LMICs operate in an environment where outcomes are often prioritised over process. This can lead to high rates of non-compliance and unintentionally reinforce ethical risks, including bias, exclusion, and harm. Our findings indicate that assessments by designers of the appropriate open datasets and open LLM models for their projects primarily focus on relevance, interoperability, and, in some instances, validity. Although noted by some designers, ethical compliance rarely played a principal role in their choices. Foundational models are often trained on large volumes of copyrighted materials, including images, research articles, books and text from websites.[40] Developers may not always be able to determine the provenance of data in such foundational models, which can hinder compliance with copyright laws.[41]

Some of the senior developers limited the use of OSS altogether for digital health solutions to comply with the local laws on data. For example, one of the senior developers stated that:

> Because the Kenyan digital health framework requires all data to be stored within the country, we try to reduce using open source because most open source softwares are hosted on Cloud out of Kenya. So that means we will be going against our regulatory framework that guides us. If it were not for regulation, then you could have used a lot of [OSS]. (SD8 08/08/2021)

The statement reflects a common sentiment that regulation constrains innovation. While increasing emphasis is being placed on fostering open standards, further regulatory clarity is still needed, especially on OSS and data. Concerns around using OSS for digital health solutions also centre around data privacy issues, with proprietary options being preferred. For instance, in discussing some of the challenges of using OSS, one of the senior developers also noted:

> I guess the… biggest challenge is that you are dealing with healthcare data and it has a lot of privacy concerns. Using an Open source tool might slightly jeopardise privacy and most people will strive to look for applications that are paid for and

[39] Sekalala, "Coloniality in the Digital Health Agenda."
[40] Rosenblat, "Beyond Public Access in LLM Pre-Training Data."
[41] Henderson. "Foundation Models and Fair Use."

> maybe to a certain extent certified. It makes things slightly slower but it depends if you have, you know, money in your pocket. (SD4 09/07/2025)

4.4 Hidden Costs

Often, the OSS ecosystem is perceived to centre on the role and autonomy of the developer as the principal agent, rather than on the role of other actors, especially in development-oriented solutions. For areas such as health, development included specialist resources and expertise, which might entail collaboration with government departments, public health institutions, researchers and funders, each with their interests and interpretations of objectives. In one of the solutions, the developers collaborated with a hospital, which led to some tensions regarding the nature and purpose of the proposed digital health solution. The hospital wanted exclusive access to the digital health solution and for it to be configured and customised to support profit ventures. While the basic tenet of OSS is based on freedom and creativity, it is mostly idealistic and fails to consider other interest groups involved in the development process who might alter development methodologies and software choices to gain legal ownership. Apart from institutional actors, there are also systemic tensions propagated by the desire to conform to the idea of 'global standards' and the 'global market,' which have an impact on the software choices developers make. For example, one of the designers opted for solutions that were more compatible with some of the big tech infrastructures, as this would provide more opportunities for scalability and potentially lead to future employment opportunities. Similarly, another designer also stated:

> I have been reading on design methods and came across design systems of different companies like Microsoft and Apple. I have decided to update our system to match Microsoft's Fluent Design System. (D5, 09/06/2023)

Given the market dominance of big tech corporations, such narratives often entail commercial value propositions for digital health solutions that might also limit understanding of OSS as an efficient approach to development rather than a social justice project aimed at developing localised solutions.

Apart from human resource costs, additional assets may be required to develop solutions, often including other proprietary software, hardware, and storage capabilities, which can introduce considerable hidden costs.[42] The developers stated that they lacked the necessary computing resources to implement some of the digital health solutions, which relied on extensive processing power and storage capacity. For example, the developers needed a dedicated server environment to deploy a locally hosted LLM model. Similarly, hosting the LLM model in the cloud, which could be more cost-effective, would require proprietary options such as those from Amazon or Microsoft. This would, in turn, reintroduce new forms of enclosures through IP from commercial entities. For example, one of the developers stated:

> The local environment in which I am testing open-source frameworks is limited. I will need access to a powerful server environment to be able to carry out these tasks, and to develop and test the application. (D2, 07/07/2023)

Given that computational power and cloud storage are offered as Platform-as-a-Service (PaaS), such costs are not one-off and often involve being locked into subscriptions, which can bring about sustainability complications on time-bound projects.

Additional costs to OSS use, especially for digital health solutions relying on LLMs, also include the acquisition of relevant datasets, which are very difficult and often expensive to acquire, as highlighted by one of the developers:

> Leading approaches in developing LLM applications are notoriously data hungry. However, acquiring the electronic health records needed to fine-tune a model is expensive and time-consuming, more so in settings with low adoption of electronic health systems. While the challenges facing adoption of EHRs in Sub-Saharan Africa are well documented, the solutions proposed to these challenges often have long-term horizons, require the involvement of NGOs, international organizations, and governments in multiphase project implementations. None of these solutions address my immediate need for high quality datasets that reflect the diverse healthcare landscape in Sub-Saharan Africa. (D2, 04/08/2023)

The need to access existing data, such as electronic health records, for the development of LLM applications can often come into tension with priorities for data privacy and security. Nonetheless, the mere existence of such data raises concerns about who controls and benefits from it, as powerful actors - often those who fund or collaborate on these systems in LMICs - may already have privileged access,[43] effectively marginalising local tech professionals wanting to leverage existing infrastructure to develop local digital health solutions. With the increasing interest of development and donor agencies in data from LMICs, often without transparent methodologies for its collection, analysis, and storage, or explicit articulation of purpose and

[42] Foote, "Myth of Free."
[43] Lynch, "Tears Don't Give You Funding."

accountability mechanisms, there is growing concern that such practices may foster unhelpful dependencies and perpetuate colonialities.[44] In terms of local innovation, this often leads developers to rely on free and open datasets, which can introduce their own legal and ethical complications.[45] Moreover, the emphasis on data completeness and abundance can also be read through the lens of data colonialism, with the assumption that innovation must follow the same data-rich pathways and positioning Western data regimes as universal standards of validity.[46]

5. Discussion

Our findings reveal law's centrality in propagating these tensions through proprietary rights, whether corporate (through big tech) or collective (through OSS). We argue that there is a paradox in the promise of OSS for social innovation in LMICs. While OSS is often positioned as an approach to democratise and liberalise software development from proprietary constraints and commercial gatekeeping, the underlying technological infrastructure environment remains fundamentally structured by corporations.[47] Power dynamics enabled by underlying intellectual property systems within OSS, as illustrated by the open washing practices and the gatekeeping of computational resources and datasets by big tech corporations, cannot be understood through a singular lens of implementation or infrastructural gaps in LMICs. Instead, they represent the systematic reproduction of platform power by big tech corporations that have consolidated control not only over the material infrastructure of software development. Platform power also manifests through the way in which law is mobilised to define what constitutes innovation, efficiency and progress in ICT-for-development, specifically in digital health, now with highly regulated health data.

Our findings demonstrate that developers in LMICs, despite possessing forms of technical agency and contextual expertise, navigate an increasingly enclosed digital infrastructure where openness often obscures deepening dependencies on proprietary for-profit ecosystems. This new infrastructure reality means that OSS is analysed and understood through its increasing entanglement with commercial logics. It is only in this contextualisation that we can unveil the ways the promise of freedom and flexibility is becoming contingent on: conforming rather than confronting commercial platforms; adopting rather than adjusting global design standards as envisioned by big tech corporations; and accepting rather than challenging the labour costs, both visible and increasingly invisible, that fall disproportionately on developers already operating with the least institutional resources and support.

There are also epistemic implications to OSS adoption in LMICs. Constraints faced by LMIC developers are often framed as technical problems which can be solved through capacity-building programs or incremental pro-OSS policy reforms. However, this understanding risks obscuring the ways that OSS participation itself functions as an elite project that reproduces rather than challenges the hierarchies of technological knowledge production and control. OSS is viewed as merely a methodology for advancing one's technical expertise and a stepping stone towards more financially rewarding opportunities, rather than a means of encouraging interest in social innovation and public service solutions. In the case of LMICs, and indeed Kenya, the real incentive, given employment precarity due to a highly competitive software development space, is often working on closed systems or commercial projects.

Our findings reveal that OSS remains premised on assumptions about developer autonomy, seamless knowledge transfer, and economic efficiency that align poorly with the lived realities of developers in LMICs. This has meant that developers are positioned within complex dynamics as both aspirational middle-class professionals and precariously employed freelancers, navigating contradictory terrains where technical skills offer pathways to economic mobility, yet simultaneously have the potential to configure relations characteristic of colonial dependencies. Developers often have to navigate not only technical complexity but also data governance requirements and institutional interests. As less experienced developers usually seek support from their more experienced counterparts when using OSS, this can inadvertently reinforce lateral inequalities and dependencies that OSS was initially intended to address through its democratisation of software development.

Global norms, established through multilateral treaties such as the Trade-Related Aspects of Intellectual Property Right (TRIPS) agreement and institutions like the World Intellectual Property Organization (WIPO), have played a crucial role in protecting the rights of software copyright holders. These legal mechanisms have often been used for claiming patent rights in Africa by multinational corporations in ways that are stifling local capacities and innovation, a move commonly termed the "intellectual land grab."[48] This process of enclosure is enabled by the fact that the filing and granting of patents often take place

[44] Qato, "Reflections on 'Decolonizing' Big Data in Global Health."
[45] Rosenblat, "Beyond Public Access in LLM Pre-Training Data."
[46] Couldry, "Data Colonialism."
[47] Barron, "Free Software Production as Critical Social Practice."
[48] Byrne, "Free and Open Source Software-Development as Freedom."

outside the preview of the public and due to limited resources for opposing some of the claims to property by the multinationals.[49] Thus, the promise of freedom as liberty aligned with OSS has limitations in the broader normative environment due to the 'TRIPS Trap.'[50] The need to develop digital health solutions that use widely recognised software and processing models from big tech presents a unique challenge in that while these options are currently open source, there is a real risk that this is likely to change in the future, leading to new forms of enclosures and lockouts of developers from their own solutions. The rapid technological developments and evolving financial landscape make it challenging to predict these changes from 'free' to enclosures. This threat is highlighted through one of the software choices made by the developers, who opted to use Bio GPT, an LLM based on biomedical information. This decision was made because customising an existing model proved to be more time-efficient than creating a new one. For OSS, IP law is crucial in safeguarding projects, enforcing compliance with licensing terms, resolving disputes over ownership, and supporting a collaborative environment. However, IP law has also been used to frustrate the democratisation of OSS use and the opening up of avenues for innovation that align with the philosophical traditions of freedom.

6. Conclusion

Rather than accepting OSS as a solution-oriented fix for development challenges in digital health, we need to ask critical questions about whether and how OSS can serve as a genuinely emancipatory project in LMICs, or whether it has instead become another mechanism for infrastructural capture by commercial interests. This distinction between OSS as a technical approach to software development versus OSS as a social justice project becomes urgent precisely in contexts where digital health solutions are increasingly framed as essential to public welfare. Our analysis reveals how the often-cited promise of OSS to 'leapfrog' infrastructural limitations in LMICs is far more complex than its optimistic rhetoric suggests, particularly in the context of health. While OSS ostensibly offers for developers in LMICs a pathway towards technological autonomy and collaborative innovation, it has the potential to reinforce epistemic inequalities. We therefore conclude that if we are to take agency seriously in a broader imagination of the discourse of OSS, we need to be more attentive to the ways design/development expertise, and its implications for health innovation, are shaped and constrained by contextual political economy dynamics of software development.

Positionality Statement on the Incubator Project

Sharifah Sekalala was the overall lead of the project, and although a Global South scholar, she acknowledges her position as a full professor, based at a UK university. Tatenda Chatikobo was a postdoctoral researcher on the project, and although a Global South scholar, he acknowledges his positionality as a scholar based at a UK university. We acknowledge that although the project was designed in collaboration with our partners, it was always part of a larger research project with defined deliverables. This might have affected the designers' approach to developing a viable digital health solution. Furthermore, although the designers were paid a salary for their role on the project, this was only temporary and without any guarantees of further employment opportunities. This, in effect, put the designers in a precarious position and may have contributed to their vulnerability, impacting on their interactions with the project. We hoped that by focusing on diaries rather than on interviews with the designers on the incubator project, we could at least minimise reproducing some of the power dynamics.

Acknowledgements

This research was made possible due to funding from the Wellcome Trust (grant number: 224856/Z/21/Z). We would like to thank the Open Institute, Mr Mark Irura, Dr Ben Mkalama and Prof Bitange Ndemo for facilitating the experimental incubator. We also want to thank Ms Brenda Wakaba for her assistance with the interviews with senior developers.

[49] Byrne, "Free and Open Source Software-Development as Freedom."
[50] Ghafele, "TRIPS Trap Revisited."

Bibliography

African Union (AU). *The Digital Transformation Strategy for Africa (2020-2030).* African Union, 2020. https://au.int/sites/default/files/documents/38507-doc-dts-english.pdf.

Akanbi, Maxwell O., Amaka N. Ocheke, Patricia A. Agaba, Comfort A. Daniyam, Emmanuel I. Agaba, Edith N. Okeke and Christiana O. Ukoli. "Use of Electronic Health Records in Sub-Saharan Africa: Progress and Challenges." *Journal of Medicine in the Tropics* 14, no 1 (2012): 1. https://pmc.ncbi.nlm.nih.gov/articles/PMC4167769/.

Anwar, Mohammad Amir. "Platforms of Inequality: Gender Dynamics of Digital Labour in Africa." *Gender and Development* 30, no 3 (2022): 747-764. https://doi.org/10.1080/13552074.2022.2121059.

Arora, Anmol, Michael Barrett, Edwin Lee, Eivor Oborn, and Karl Prince. "Risk and the Future of AI: Algorithmic Bias, Data Colonialism, and Marginalization." *Information and Organization* 33, no 3 (2023): 100478. https://doi.org/10.1016/J.INFOANDORG.2023.100478.

Barron, Anne. "Free Software Production as Critical Social Practice." *Economy and Society* 42, no 4 (2013): 597-625. https://doi.org/10.1080/03085147.2013.791510.

Bostan, Sarah, Owen Johnson, Lena Jaspersen and Rebecca Randell. "Contextual Barriers to Implementing Open-source Electronic Health Record Systems for Low-and Lower-Middle-Income Countries: Scoping Review." *Journal of Medical Internet Research* 26 (2024): e45242. https://doi.org/10.2196/45242.

Byrne, Elaine, and Bob Jolliffe. "Free and Open Source Software-Development as Freedom?" Conference Paper. 9th International Conference on Social Implications of Computers in Developing Countries. São Paulo, Brazil, 2007. https://www.researchgate.net/publication/232595145_Free_and_Open_Source_Software_-_Development_as_Freedom.

Chigwada, Josiline Phiri. "Open-Source Software Use in Libraries in Developing Countries." In *Technological Advancements in Library Service Innovation*, edited by Manika Lamba, 215-236. New York: IGI Global Scientific Publishing, 2022.

Chopra, Samir, and Scott Dexter. *Decoding Liberation: The Promise of Free and Open Source Software*. New York: Routledge, 2008. https://doi.org/10.4324/9780203942147.

Coleman, Gabriella. "Code Is Speech: Legal Tinkering, Expertise, and Protest Among Free and Open Source Software Developers." *Cultural Anthropology* 24, no 3 (2009): 420-454. https://doi.org/10.1111/J.1548-1360.2009.01036.X.

Couldry, Nick, and Ulises Mejias. "Data Colonialism: Rethinking Big Data's Relation to the Contemporary Subject." *Television and New Media* 20, no 4 (2019): 336-349. https://doi.org/10.1177/1527476418796632.

Day, Melissa and Joanne Thatcher. " 'I'm Really Embarrassed That You're Going to Read This …': Reflections on Using Diaries in Qualitative Research." *Qualitative Research in Psychology* 6, no 4 (2009): 249-259. https://doi.org/10.1080/14780880802070583.

Egermark, Mathias, Agata Blasiak, Alexandria Remus, Yoann Sapanel, and Dean Ho. "Overcoming Pilotitis in Digital Medicine at the Intersection of Data, Clinical Evidence, and Adoption." *Advanced Intelligent Systems* 4, no 9 (2022): 2200056. https://doi.org/10.1002/aisy.202200056.

Foote, Amanda. "The Myth of Free: The Hidden Costs of Open Source Software." *Dalhousie Journal of Interdisciplinary Management* 6 (2010). https://doi.org/10.5931/DJIM.V6I1.31.

Ghafele, Roya and Adam Chaddock. "The TRIPS Trap Revisited." *Penn State Journal of Law and International Affairs* 12, no 1 (2024): 5. https://insight.dickinsonlaw.psu.edu/jlia/vol12/iss1/5.

Government of Kenya. *National Information and Communication and Technology Policy Guidelines.* The Kenya Gazette, 2020. https://www.ca.go.ke/sites/default/files/CA/Statutes%20and%20Regulations/National-ICT-Policy-Guidelines-2020.pdf

Guardia, Lourdes, Federica Mancini, Pedro Jacobetty, and Marcelo Maina. "Graduates' Employability Skills in East Africa." *Journal of Teaching and Learning for Graduate Employability* 12, no 2 (2021): 169-184. https://doi.org/10.21153/jtlge2021vol12no2art988.

Halbert, Debora. "The Open Source Alternative: Shrink-Wrap, Open Source and Copyright." *Murdoch University Electronic Journal of Law* 10, no 4 (2003). https://hdl.handle.net/10535/5906.

Henderson, Peter, Xuechen Li, Dan Jurafsky, Tatsunori Hashimoto, Mark A. Lemley, and Percy Liang. "Foundation Models and Fair Use." *Journal of Machine Learning Research* 24, no 400 (2023): 1-79. http://jmlr.org/papers/v24/23-0569.html.

Hewapathirana, Roshan, and Sundeep Sahay. "Open Source Adoption in Health Sector: Understanding the Stakeholder Relationships in a Resource Constrained Setting." *The Electronic Journal of Information Systems in Developing Countries* 81, no 1 (2017): 1-21. https://doi.org/10.1002/j.1681-4835.2017.tb00593.x

International Telecommunication Union (ITU). *Open Source is Reshaping the Digital Future of Kenya and Trinidad and Tobago.* Digital Impact Unlocked, 2025. https://www.itu.int/itu-d/sites/digital-impact-unlocked/open-source-is-reshaping-kenya-and-trinidad-and-tobagos-digital-future/

Jordan, Tim. "Hacking and Power: Social and Technological Determination in the Digital Age." *First Monday* 14, no 7 (2009). https://firstmonday.org/ojs/index.php/fm/article/view/2417/2240.

Kenya ICT Authority. *Government ICT Standards*. Kenya ICT Authority, 2019. https://cms.icta.go.ke/sites/default/files/2022-02/Systems%20and%20Applications%20Standard.pdf.

Liang, Jenny T., Thomas Zimmermann, and Denae Ford. "Understanding Skills for OSS Communities on Github." Paper presented at the 30th ACM Joint European Software Engineering Conference and Symposium on the Foundations of *Software Engineering*, Singapore, November 14-18, 2022. https://doi.org/10.1145/3540250.3549082.

Lynch, Renee, Jason C. Young, Chris Jowaisas, Joel Sam, Stanley Boakye-Achampong, Maria Garrido, and Chris Rothschild. " 'The Tears Don't Give You Funding': Data Neocolonialism in Development in the Global South." *Third World Quarterly* 44, no 5 (2023): 911-929. https://doi.org/10.1080/01436597.2023.2166482.

Maglogiannis, Ilias. "Towards the Adoption of Open Source and Open Access Electronic Health Record Systems." *Journal of Healthcare Engineering* 3, no 1 (2012): 141-161. https://doi.org/10.1260/2040-2295.3.1.141.

Mamuye, Adane, Tesfahun Yilma, Ahmad Abdulwahab et al. "Health Information Exchange Policy and Standards for Digital Health Systems in Africa: A Systematic Review." *PLOS Digital Health* 1, no 10 (2022): e0000118. https://doi.org/10.1371/JOURNAL.PDIG.0000118.

Maris, Jordan. "Meta's LLaMa License is Still Not Open Source." *Open Source Initiative*, February 18, 2025. https://opensource.org/blog/metas-llama-license-is-still-not-open-source.

Meessen, Bruno. "The Role of Digital Strategies in Financing Health Care for Universal Health Coverage in Low-and Middle-Income Countries." *Global Health: Science and Practice* 6, no Supplement 1 (2018): S29-S40. https://doi.org/10.9745/GHSP-D-18-00271.

Nanjala, Ruth, Festus Nyasimi, Daniel Masiga, and Caleb Kipkurui Kibet. "A Mentorship and Incubation Program using Project-based Learning to Build a Professional Bioinformatics Pipeline in Kenya." *PLoS Computational Biology* 19, no 3 (2023): e1010904. https://doi.org/10.1371/JOURNAL.PCBI.1010904.

Neumark, Tom, and Ruth Prince. "Digital Health in East Africa: Innovation, Experimentation and the Market." *Global Policy* 12 (2021): 65-74. https://doi.org/10.1111/1758-5899.12990.

Okune, Angela, and Leonida Mutuku. "Becoming an African Techpreneur: Geopolitics of Investments in 'Local' Kenyan Entrepreneurship." *Engaging Science, Technology, and Society* 9, no 1 (2023): 81-103. https://doi.org/10.17351/ESTS2023.1095.

Paton, Chris, Jørn Braa, Andrew Muhire, Luis Marco-Ruiz, Shinji Kobayashi, Hamish Fraser, Luis Falcón, and Alvin Marcelo. "Open Source Digital Health Software for Resilient, Accessible and Equitable Healthcare Systems." *Yearbook of Medical Informatics* 31, no 01 (2022): 067-073. https://doi.org/10.1055/s-0042-1742508.

Powell, Alison. "Democratizing Production Through Open Source Knowledge: From Open Software to Open Hardware." *Media, Culture and Society* 34, no 6 (2012): 691-708. https://doi.org/10.1177/0163443712449497.

Prokakis, Emmanouil. "Free and Open-Source Software: Freedom, Transparency and Efficiency in the Digitalization Era." *Journal of Politics and Ethics in New Technologies and AI* 1, no 1 (2022): e31230-e31230. https://doi.org/10.12681/JPENTAI.31230.

Qato, Danya. "Reflections on 'Decolonizing' Big Data in Global Health." *Annals of Global Health* 88, no 1 (2022): 56. https://doi.org/10.5334/aogh.3709.

Regilme, Salvador Santino. "Artificial Intelligence Colonialism: Environmental Damage, Labor Exploitation, and Human Rights Crises in the Global South." *SAIS Review of International Affairs* 44, no 2 (2024): 75-92. https://dx.doi.org/10.1353/sais.2024.a950958.

Rendek, Lubos. "From Freedom to Profit: Red Hat's Latest Move - An In-Depth Review of Its Impact on Free Software and Open Source Values - Linux Jobs & Careers." (blog) July 4, 2023. https://www.linuxcareers.com/resources/blog/2023/07/from-freedom-to-profit-how-red-hats-latest-move-reveals-a-shift-in-free-software-and-open-source-v/.

Richterich, Annika. "Can't Fix This? Innovation, Social Change, and Solutionism in Design Thinking." *Media and Communication* 12 (2024). https://doi.org/10.17645/MAC.7427.

Rosenblat, Sruly, Tim O'Reilly, and Ilan Strauss. "Beyond Public Access in LLM Pre-Training Data." *arXiv preprint arXiv:2505.00020* (2025). https://arxiv.org/html/2505.00020v1.

Sætra Skaug, Henrik. *Technology and Sustainable Development: The Promise and Pitfalls of Techno-Solutionism*. Routledge, 2023.

Sahay, Sundeep. "Free and Open Source Software as Global Public Goods? What are the Distortions and How do we Address Them?" *The Electronic Journal of Information Systems in Developing Countries* 85, no 4 (2019): e12080. https://doi.org/10.1002/isd2.12080.

Sekalala, Sharifah and Tatenda Chatikobo. "Colonialism in the New Digital Health Agenda." *BMJ Global Health* 9, no 2 (2024). https://doi.org/10.1136/BMJGH-2023-014131.

Silva, Domingos, Carlos Coutinho, and Carlos Costa. "Exploration of Open Source in Low-Income Countries: Review and Future Research Directions." Paper presented at the International Symposium on Sensing and Instrumentation in 5G and IoT Era (ISSI), Lagoa, Portugal, 2024. 10.1109/ISSI63632.2024.10720490.

South African Government. *Policy on Free and Open Source Software Use for South African Government.* South African Government, 2007. https://www.gov.za/sites/default/files/gcis_document/201409/fosspolicy0.pdf.

Steinmacher, Igor, Marco Gerosa, Tayana Conte, and David Redmiles. "Overcoming Social Barriers when Contributing to Open Source Software Projects." *Computer Supported Cooperative Work (CSCW)* 28, no 1 (2019): 247-290. https://doi.org/10.1007/s10606-018-9335-z.

Stol, Klaas-Jan, Muhammad Ali Babar, Paris Avgeriou, and Brian Fitzgerald. "A Comparative Study of Challenges in Integrating Open Source Software and Inner Source Software." *Information and Software Technology* 53, no 12 (2011): 1319-1336. https://doi.org/10.1016/J.INFSOF.2011.06.007.

Sullivan, John. "Software Freedom as Social Justice: The Open Source Software Movement and Information Control." In *Media and Social Justice*, edited by Sue Curry Jansen, Jefferson Pooley, and Lora Taub-Pervizpour, 159-175. Palgrave Macmillan, 2011. https://doi.org/10.1057/9780230119796_12.

Syzdykova, Assel, André Malta, Maria Zolfo, Ermias Diro, and José Luis Oliveira. "Open-source Electronic Health Record Systems for Low-resource Settings: Systematic Review." *JMIR Medical Informatics* 5, no 4 (2017): e8131. https://doi.org/10.2196/MEDINFORM.8131.

Thiruthy, Narendran. "Open Source—Is it an Alternative to Intellectual Property?" *The Journal of World Intellectual Property* 20, no 1-2 (2017): 68-86. https://doi.org/10.1111/JWIP.12074.

United Nations Economic and Social Council (UNESCO). *Open-source Technologies for Sustainable Development: Resolution, Adopted on 22 July 2021, Agenda item 18(b)*. UNESCO, 2021. https://docs.un.org/en/E/RES/2021/30.

United Nations (UN). *Digital Compact Framework*. UN, 2024. https://www.un.org/global-digital-compact/sites/default/files/2024-09/Global%20Digital%20Compact%20-%20English_0.pdf.

Vasudevan, Roopa. "Share and Share Unlike: Reciprocity, Corporate Power, and the Open Source Ethos." *New Media and Society* 25, no 11 (2023): 2981-3001. https://doi.org/10.1177/14614448211038350.

Verma, Neha, Burke Mamlin, Jan Flowers, Soumyadipta Acharya, Alain Labrique, and Theresa Cullen. "OpenMRS as a Global Good: Impact, Opportunities, Challenges, and Lessons Learned from Fifteen Years of Implementation." *International Journal of Medical Informatics* 149 (2021): 104405. https://doi.org/10.1016/J.IJMEDINF.2021.104405.

Wiggins, Dion. "The LLaMA 4 Deception: How Meta Hijacked the Open Source Label and Why It Matters." *LinkedIn*, April 6, 2025. https://www.linkedin.com/pulse/llama-4-deception-how-meta-hijacked-open-source-label-dion-wiggins-mjjrc/.

Wiseman, Virginia, Lesong Conteh, and Fred Matovu. "Using Diaries to Collect Data in Resource-poor Settings: Questions on Design and Implementation." *Health Policy and Planning* 20, no 6 (2005): 394-404. https://doi.org/10.1093/HEAPOL/CZI042.

Zerfu, Taddese Alemu, Moges Asressie, Zenebu Begna, Tigist Habtamu, Netsanet Werkneh, Tariku Nigatu et al. "Unveiling the Role of DHIS2 in Enhancing Data Quality and Accessibility in Primary Healthcare Facilities: Evidence from Ethiopia." *PLoS One* 19, no 12 (2024): e0314505. https://doi.org/10.1371/JOURNAL.PONE.0314505.

Zuboff, Shoshana. "Big Other: Surveillance Capitalism and the Prospects of an Information Civilization." *Journal of Information Technology*, 30, no 1 (2015): 75-89. https://doi.org/10.1057/jit.2015.5.