ICT4D Sustainability as Generativity

Terje Aksel Sanner

Department of Informatics, University of Oslo
terjeasa@ifi.uio.no

Abstract. In the wake of "the mobile revolution", there has been an immense surge in mobile phone-based health innovations. Scholars and industry specialists have found a large portion of such innovations in less developed economies unsustainable beyond pilot projects. However, "sustainability" is a difficult aspiration to operationalize. Based on insights from recent literature on digital innovation, the paper suggests an alternative focus on *generativity* – a perspective on longevity that emphasizes the continuous facilitation of innovation over stewardship and control. To illustrate the relevance of generativity to ICT4D, the paper draws on examples from a mobile phone-based implementation to strengthen routine reporting of public health data in Malawi. By foregrounding generativity as an ICT4D aspiration, the paper begins to consider implications at the level of projects, national policy and international development collaboration.

Keywords: mHealth, ICT4D, sustainability, generativity, digital innovation

1 Introduction

The rapid expansion of mobile networks and the proliferation of mobile phones have put digital information and communication technologies (ICTs) in the hands of people who lack access to proper roads, clean drinking water, basic health services, electricity and major sources of publicly relevant media such as television and newspapers. Market competition has fueled the penetration of mobile networks, while aid and development agencies have been able to "focus on tools and services for the poor built atop these networks" (Zuckerman, 2010, p. 100).

Mobile phone-based innovations have catered to information and communication needs at the periphery of national health systems (Sanner, Roland, & Braa, 2012). However, with a recent surge in mHealth projects, it has become increasingly difficult for governments to consolidate disparate efforts into overarching health information system architectures (Estrin & Sim, 2010; Norris, Stockdale, & Sharma, 2009). Ministries of health in developing economies often lack the means and skills to develop appropriate policies and routines and to monitor, prioritize, and maintain numerous ICT initiatives (Kimaro & Nhampossa, 2005; Lucas, 2008).

The high failure rate associated with donor funded mHealth projects has led researchers and industry specialists to diagnose the field with "pilotitis" (Curioso & Mechael, 2010; Germann, Jabry, Njogu, & Osumba, 2011; Labrique, Vasudevan,

adfa, p. 1, 2011.
© Springer-Verlag Berlin Heidelberg 2011

Chang, & Mehl, 2013). Pilotitis can be articulated as "the unfettered proliferation of lightweight mHealth 'solutions' which fail to translate or scale into health systems" (Labrique et al., 2013, p. 2). The failure to sustain technology innovations, although symptomatic of ICT for development (ICT4D) (Ali & Bailur, 2007; Best & Kumar, 2008; Kleine & Unwin, 2009) and health information systems in general (Heeks, 2006; Kimaro & Nhampossa, 2005; Kreps & Richardson, 2007), has been particularly pronounced when these domains have been conflated into mHealth ventures (Mechael et al., 2010). However, "sustainability" is a difficult to operationalize at the level of ICT4D projects and in relation to particular ICT capabilities. The paper considers generativity as an operational ICT4D aspiration.

Generativity, has been defined by Zittrain (2006, p. 1980) as "a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences". Hence, the notion of generativity, reviewed in the next section, emphasizes the interplay between innovative ICT capabilities and available human capacities to leverage and extend those capabilities. Section 3 presents the methods and context of the empirical study. Section 4 describes an mHealth innovation that concerns routine data collection and reporting from public health facilities in Malawi. The discussion, in section 5 considers the generative potentials of mobile ICT capabilities in resource sparse settings. Section 6 offers concluding reflections.

2 The problem of sustainability

The global discourse on "sustainable development" gained momentum with the 1987 United Nations Brundtland Commission report. The report reconciles economic growth with an ecological rationale and defines *sustainability* as meeting "the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 43). Since then, "sustainability", with strong connotations to resource management and stewardship, has become embedded in international development agendas, sometimes with perverse and contradictory consequences (e.g., Blaikie, 2006; Swidler & Watkins, 2009). Sustainability has emerged as a key aspiration in both ICT4D (Heeks, 2008; Mansell & Wehn, 1998; Tongia & Subrahmanian, 2006), and mHealth (Akter & Ray, 2010; Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013).

ICT implementations in health in less developed economies have been deemed *unsustainable* due to factors such as short-term donor funding, lack of development of local capacity, and too much focus on technological rather than social and institutional issues (Avgerou, 2008; Kimaro & Nhampossa, 2005; Lucas, 2008). ICT implementations often succumb when project money runs out or foreign experts resign from projects (Lewis, 2006). Stansfield et al. (2008, p. 7) point out that the uncoordinated surge in health information system funding has "created a plethora of tools, methods and practices for data collection and analysis that have placed a counterproductive and unsustainable burden on front line health workers". mHealth projects exacerbate this burden as they often target the same cadre of peripheral health workers. To address sustainability challenges, researchers have called for new modes of stakeholder collaboration (Pfeiffer, 2003), business models (Kaplan, 2006; Kleine & Unwin, 2009), project

and governance principles (Jensen & Winthereik, 2013). Yet, exactly what sustainability entails in the context of ICT4D often remains unclear.

Ali and Bailur (2007) criticize the use of the term "sustainability" in ICT4D altogether. To them sustainability is an unrealistic concept. Instead, they point to Ciborra's (2002) notion of *bricolage* and suggest that ICT4D needs to be more open to *local improvisation* and "accept the changing nature of the ICT artifact and the unintended consequences of technology" (Ali & Bailur, 2007, p. 1). Bricolage constitute locally apposite improvisation through the expedient combination of resources at hand (Ciborra, 2002). However, Ali and Bailur (2007, p. 1) also note that "since the majority of ICT for development projects still continue to be funded by donor agencies and multinationals, improvisation faces many practical challenges". This paper takes Ali and Bailur's (2007) concern with the operationalizability of sustainability in ICT4D as a starting point and proposes generativity as an operational amendment to the sustainability doctrine. Generativity may be a useful construct to foreground the value of improvisation, but it also points to the importance of extant technologies and human capacities as stable and enabling foundations for innovation.

2.1 The Generative Potential of Digital Technology

According to Zittrain (2006, p. 1980), generativity is defined as "a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences". Generativity describes a technology from which its users draw an ability to generate, or produce new capabilities without additional input from the original creators (Sørensen, 2013; Tilson, Lyytinen, & Sørensen, 2010). The TCP/IP and http protocols of the Internet and the PC are exemplary generative technologies that have enabled "self-reinventing" ICT capabilities like the World Wide Web, emails and blogs.

Specifically, Zittrain (2006, 2009) identify five characteristics that constitute the generative potential of a technology, namely: capacity for leverage, adaptability, ease of mastery, accessibility and transferability. *Leverage*, describes the extent to which the technology assists in performing a task otherwise not possible or difficult. *Adaptability* refers to the breadth of a technology's use without change and its readiness to broaden use through modification. A technology's *ease of mastery* reflects how easy it is for broad audiences to adopt and adapt it, regardless of whether the technology was designed with those tasks in mind. *Accessibility* – the more readily people can come to use and control a technology, along with what information might be required to master it, the more accessible the technology is. Finally, *transferability* refers to how easily changes and improvements made to the technology, through skillful adaptation, can be conveyed to others, thus allowing for a community of development and use.

Smith, Spence and Rashid (2011) specifically consider the generative potential of mobile phones in the context of ICT4D. They argue that mobiles embody four out of Zittrain's five characteristics: they provide significant *leverage* in communication tasks, they are easy to *access* and *master*, and mobile technology innovations are easily *shared* with others. However, they argue that "the relatively basic models of mobiles used in a majority of developing country contexts, and the often rather controlled nature of the infrastructure on which they run, limit the upper end of adaptability" (Smith et

al., 2011, p. 83). Although, generativity relates to a particular technology, it is essentially a socio-technical construct. Generativity does not emanate from the properties of a technology alone, but represent potential outcomes from creative interactions between technology, people and organizations. In particular, Avital & Te'Eni (2009) found that the extent of digital innovation depends on a generative combination of a technology and an active community of skilled users and developers.

In general, digital technologies possess more generative potential than their analog counterparts do. Digital services, applications and content can be reused and recombined and increase in breadth and value with the number of people involved in their production and consumption. This paper considers how generativity may help us foreground ways to balance digital ICTs' potential for further appropriation and innovation with skills and capacities to leverage that potential in resource sparse settings.

3 Methods

This paper consider post-hoc the applicability of generativity to empirical observations from a mobile phone-based implementation in Malawi. The aim is to illustrate the relevance of generativity as an operational ICT4D aspiration. In accordance with the primary health care mantra of "health for all" (Unicef & others, 1978), the implementation in Malawi focuses on routine reporting of public health data, such as confirmed malaria cases and number of pregnant women with HIV receiving antiretroviral therapy.

The implementation in Malawi uses the open source District Health Information Software (DHIS2). Countries in Africa, Latin America and Asia use DHIS2 for reporting, analysis, and presentation of routine health data. The Health Information System Programme (HISP), with the University of Oslo, coordinates DHIS2 development. Software development and participatory implementation research have gone hand in hand since the inception of the program in 1994 (see Braa & Hedberg, 2002). With the rapid uptake of mobile technologies in the Global South, HISP has embraced the opportunity to bring ICT capabilities to health workers where there are no computers and limited or unstable power supply. To this end, HISP Oslo has coordinated the development, testing, piloting and implementation of DHIS Mobile – a suite of mobile phone-based functionalities that extend DHIS2 capabilities. The author has been involved with DHIS Mobile implementation research since 2009.

The implementation in Malawi received initial financial and technical support from a grant funded research project coordinated by HISP Oslo. The ministry of health in Malawi, by the Central Monitoring and Evaluation Division (CMED), hosted and owned the implementation. CMED envisioned that they could enhance their current use of the DHIS2 national data warehouses with mobile reporting, but lacked the technical capacity to manage the customization and implementation processes.

The author's filed notes from participant observation have been the primary source of data. The main body of data was collected during on-site fieldwork from September 2011 to December 2011 (three months) and from April 2012 to May 2012 (one month). This include observational visits, focus group discussions and interviews of staff at nine health facilities, two health area hospitals and one district health office. Furthermore,

the author conducted ad-hoc interviews with medical officers, monitoring and evaluation officers, and health information managers at districts and national level. Additional empirical data stem from interaction with fellow DHIS Mobile implementers, DHIS2 and DHIS Mobile software developers, local DHIS2 software customizers and mobile network operators in Malawi. Participant observation centered on practical tasks such as facilitation of mobile trainings, configuration of mobile phones and server, pilot evaluation, and project management. The author has maintained longitudinal correspondence via teleconferences and emails with CMED concerning the continuation of the mobile phone-based reporting.

Sustainability challenges were a key theme informing data collection and data analysis for this study. The focus on sustainability was motivated both by the author's practical interest in the long-term value of mobile phone-based routine health data reporting and by the general problem of mHealth and ICT4D "pilotitis". However, sustainability proved difficult to operationalize in research and practice at the project level. During the implementation in Malawi, the author noted the important balance between malleable digital ICT capabilities and the capacity among local stakeholders to leverage that malleability along with the financial resources, mandate and responsibility to do so. Through engagement with literature on digital innovation (e.g., Sørensen, 2013; Tilson et al., 2010; Yoo, Henfridsson, & Lyytinen, 2010), generativity, as a socio-technical construct, was identified and employed in data analysis post-hoc to sort observations concerned with local digital adaptation and innovation in relation to mobile reporting ICT capabilities. The next section describes how the implementation in Malawi enabled local adaptation and innovation.

4 Mobile-phone based routine reporting in Malawi

During autumn 2011, the Ministry of Health in Malawi represented by CMED, the Lilongwe district health office (DHO), and HISP Oslo agreed on the scope of a pilot project for mobile reporting from health facilities. The solution, called DHIS Mobile, had been developed through previous iterations of HISP implementation research in India, Tanzania, Nigeria, the Gambia and Zambia.

At the time, health workers collected data during the provision of essential health services such as child immunization and antenatal care and recorded it in paper registers and tally sheets. Health service provision was coordinated from health facilities. Routine health data reports were collated monthly. However, the submission of reports to districts were done quarterly across the country due to transportation challenges and general resource constraints. Computers were available at districts and higher organizational levels, where data clerks entered data into the web-based DHIS2 national data warehouse. Unfortunately, health information system assessments found reported data to be incomplete, inconsistent and inaccurate (Bhana, 2013).

At health facilities, lack of stationery was impeding health workers from collating information correctly and efficiently. Overshot district budgets for printing and distribution contributed to the lack of printed forms. At some health facilities, staffs were

drawing columns and rows on paper to produce forms. This, however, led to inconsistencies between facilities and haphazard omissions of some data. Despite challenges that affected the accuracy and reliability of routine health data, the *timeliness* of data reporting was perhaps the greatest concern to health program managers in Malawi.

In order to submit reports, health facility staff would for instance hand them over to ambulance drivers or await personal trips to the district center. During rainy season, the transportation of paper forms from some health facilities was simply not feasible due to flooded roads. Reports that failed to reach decision makers on time did not help inform the distribution of limited resources and equitable prioritization of health care interventions. CMED envisioned that mobile phone-based reports could mitigate some of the challenges experienced with paper-based reports.

4.1 Pilot implementation in Lilongwe

The DHIS Mobile solution allowed health facility staff to open a mobile web-form, enter data, and submit it to a DHIS2 server. The HTML5-based solution supported offline data entry and automated data integrity and form validation checks. Mobile data connectivity allowed for report submissions from mobile phones and form updates from the DHIS2 server whenever mobile network coverage was available.

The Lilongwe DHO initially targeted 17 health facilities in two health areas, called Kabudula and Area 25, for implementation. Each health facility in the two health areas received staff training and either one or two preconfigured Nokia feature phones. Each mobile phone was bundled with MK500 (USD 1) worth of airtime per month for three months. Facility staffs were informed that they would need to use their own money to buy airtime after three months due to the limited availability of project funding and the complicated logistics of reimbursement. Facility staffs were encouraged to maintain the phones for both work and personal use.

The implementation initially covered only two reports. One was a weekly report for communicable disease surveillance. The other report, called HMIS-15, constituted a monthly summary of essential data for key health programs in Malawi. Before training of end-users could commence, the two forms had to be set up for mobile reporting on the national DHIS2 server. Consequently, the DHIS Mobile implementers established contact with the local DHIS2 coordinators located at the Malawi College of Medicine in Blantyre, about 300 kilometers from CMED's headquarters in Lilongwe. However, the DHIS2 coordinators in Blantyre did not immediately embark on form customization, as they were behind schedule with other DHIS2 related tasks.

As CMED did not have sufficient IT expertise to manage the national DHIS2 server and other mundane IT-tasks, the DHIS2 coordinators in Blantyre were responsible for all DHIS2 implementation and maintenance activities, including system customization and end-user training. In order to commence with mobile reporting the DHIS Mobile implementers received administration rights to configure the two forms for mobile reporting on another DHIS2 server instance, which had been set up for training purposes.

At the start of the pilot, the Lilongwe DHO and the health area offices at Kabudula and Area 25 did not have reliable Internet connectivity and were unable to monitor

mobile reports. The offices received USB Internet modems and orientations on how to monitor reports and provide basic technical support to health facilities.

4.2 Further adaptation and innovation

Following the initial implementation, focus group discussions and interviews were conducted at health facilities over a period of one and a half years. These interactions revealed that health workers would prefer mobile reports to replace all paper-based reports. As the two health-area offices and the DHO in Lilongwe had noted improvements in timely availability of data, the DHO decided to embrace mobile reporting from all the 44 government health facilities in Lilongwe. At the time, the mobile reporting function was moved from the demonstration server to the national DHIS2 production server and the team of local DHIS2 coordinators became more actively involved.

Steps towards long-term technical support and further customization of DHIS Mobile in Malawi were taken through the employment of a project-funded technical assistant working out of CMED's offices. The arrangement was seen as a step towards the creation of a new IT position within CMED, which for bureaucratic reasons could take several years. The technical assistant was to work closely with the aforementioned DHIS2 coordinators who were relocating from Blantyre to Lilongwe. Furthermore, DHIS Mobile implementers contributed to the development of terms of reference (TOR) for future engagement of CMED in-house IT positions. A key motivation with the TOR was to tie accountability for mobile phone-based reporting to organizational roles rather than specific project individuals.

By 2014, local customizers and the technical assistant with CMED had set up 14 additional health program reports for mobile reporting. Reports covered areas such as antenatal care, family planning, newborn health, sexual transmittable diseases, nutrition, disease surveillance and child immunization. The customization work commenced without support from the original DHIS Mobile implementers as project funding had expired. By 2016, mobile reporting had expanded to seven more of the 28 districts in Malawi with support from development partners. An organization called Support for Service Delivery Integration (SSDI) opted to replace the worn Nokia feature phones in Lilongwe district with Android Smartphones and retrained health facility staffs.

Some of the health facility staffs in Lilongwe, who were part of the original implementation, had not been informed about the 14 new reports that started to appear on their mobile phones due to server side updates. Despite this lack of sensitization, follow-up visits revealed that some staffs had taken it upon themselves to study the mobile forms and train their colleagues on filling them. A social media page, "Repoti Mufoni", (Eng. mobile reporting) was created on Facebook to allow DHIS Mobile users in Malawi to share experiences and interact with the technical assistant at CMED.

5 Sustainability as Generativity

Sustainability is an often-touted aspiration with ICT4D. However, it often remains unclear *how* sustainability may be achieved and *what* exactly is to be sustained and for

whom? Is it a mobile technology, a software product, the activities of a development partner, a new work routine or facets of a "Western centric and universalist model of economic growth and development" (Mansell, 2014, p. 2)? As Unwin (2009, p. 365) recognize, sustainability is primarily a problem with "externally situated ICT4D programmes, and in part reflect a desire by those who create them to guarantee their continued success after the initial period of investment is over". Sustainability challenges, which are considered endemic to mHealth and ICT4D, may be associated with the need to demonstrate impacts within the short duration of grant funded pilot projects (Sanner & Sæbø, 2014), whereby immediate quantifiable deliverables receive priority over collaboration and harmonization with extant arrangements.

In this paper, the struggle for ICT4D longevity is seen in relation to *ICT capabilities*, which cannot easily be discerned from the human activities, skills and values they are infused and intertwined with. Generativity, as an operational ICT4D aspiration, highlights the interplay between available skills and innovative ICT capabilities. This interplay is enabled through a combination of stakeholder alliances, capacity building, legislations, policy revisions and technical configurations. In the following, empirical observations concerning the mobile reporting in Malawi is drawn on to exemplify the generative potential of mobile digital ICT capabilities along Zittrain's five dimensions: leverage, adaptability, ease of mastery, accessibility and transferability.

Leverage*: describes the extent to which a technology helps in performing an otherwise difficult or impossible task.* Mobile phones excel as information sharing and communication technologies even in areas where infrastructures are generally unstable or unavailable. In Malawi, mobile phone-based reports replaced vulnerable paper-based transmission of health data. As the solution relied on a web-based platform, people traditionally involved in the paper trail were brought on board by the provision of internet connectivity and login credentials to the online database. Mobile reporting supported the key task of making timely data available to public health managers.

Adaptability: Zittrain (2006, 2009) describe *adaptability as the breath of a technology's use without change and its readiness to broaden use through modification*. In relation to ICT4D, Smith et al. (2010) point out that the adaptability of basic mobile phones and the controlled nature of mobile networks restricts adaptability. However, in the context of primary health care alone, simple feature phones have been adapted to support areas such as treatment compliance, routine data collection and disease surveillance, point of care decision support, health promotion and disease prevention, and emergency medical response (Mechael et al., 2010).

With the mobile phone based reporting in Malawi, the lack of relevant capacity within CMED to configure and maintain novel ICT acquisitions informed a minimalist approach to implementation. This involved implementation of only two forms across 17 health facilities and the initial use of a server instance originally set up for teaching purposes. These arrangements were made with the awareness that, if managed carefully, the solution could be adapted to accommodate more specialized health program reports, more reporting health facilities and be shifted to the production server. Indeed, local DHIS2 coordinators and the project funded technical assistant took such measures as health facility and district health staff started to express an interest in replacing other paper-based reports. To strengthen CMED's long-term capacity to maintain and further

develop the mobile reporting solution, DHIS Mobile implementers participated in the development of relevant terms of reference for future in-house IT-positions.

Ease of Mastery: *A technology's ease of mastery reflects how easy it is for broad audiences to adopt and adapt it.* Mobile phones have become the user friendly and ubiquitous PCs of the Global South. ICT4D initiatives are able to leverage rapid growth in mobile literacy. With a mobile client-server infrastructure, the limited available technical capacity could be centralized with CMED and focus on supportive tasks such as server management and form customization, while end users could focus on the primary tasks of data collection, information consumption and decision-making. Vis-à-vis paper, digital technology offers a range of real time support such as automatic updates, hiding irrelevant data entry fields in forms and validation rules that prompts the user about potentially erroneous data. Recent advances in support for offline work such as the new HTML5 standards further strengthens this advantage over paper forms.

Accessibility*: The more readily people can come to use and control a technology, along with what information might be required to master it, the more accessible the technology is.* While only 11% of the population in Malawi has access to the national power grid, mobile network coverage soared at 93% already in 2011 (Foster & Shkaratan, 2011). Mobile ICT4D and mHealth capabilities inherit accessibility from the ubiquity of mobile networks and devices.

With the implementation in Malawi, a few health facility staffs who mastered the mobile reporting took it upon themselves to teach their colleagues how to report on new forms made available from the server. Furthermore, DHIS Mobile implementers ensured that the mobile phone-based reporting did not sideline the traditional custodians of routine health data at the Lilongwe DHO and the two health areas offices. USB Internet modems were provided along with training on how to access and inspect the electronic reports submitted from mobile phones. The creation of a social media page called "Repoti Mufoni" for interaction with the central technical team and peer support further exemplify the advantage of having digital access to the shared experiences of collaborative network.

Transferability: According to Zittrain (2009), *transferability* refers to how easily changes and improvements made to a technology can be shared with others. The DHIS Mobile solution implemented in Malawi emanated from the transfer of technologies, open-source code and skilled people across settings in India, Tanzania, Nigeria, the Gambia and Zambia. This led to the development of an increasingly generic solution. However, as the generic qualities of digital technologies increase, so does the knowledge and practical work required to facilitate their appropriation (Suchman, 2002). Unfortunately, in the context of less developed economies, the need for local adaptation often puts an unrealistic burden on local (government) organizations to maintain, integrate and innovate on top of interventionists' many uncoordinated ICT innovations. One way to mitigate some of these challenges may be to decide on a few national priority areas for mHealth and ICT4D intervention and develop *minimum requirements* to ensure that innovations can be harmonized and maintained through reuse and sharing of devices, physical networks, software and human capacities.

Overall, generativity is sensitive to how the characteristics of particular digital technologies interplay with human capacities to enable appropriation and innovation. Given

the rapidly changing landscape of mobile devices, networks, services, applications and content, generativity may be a useful operational mHealth and ICT4D aspiration. Generativity constitute five interdependent socio-technical dimensions. If one of the five dimensions falters, it constrains the total generative capacity of an ICT capability or system. Most likely, tradeoffs will occur along the different dimensions to match digital ICT capabilities with available skills and resources. At the level of health systems, the problem of mHealth pilotitis is not that there is too little "unprompted change driven by large, varied, and uncoordinated" stakeholders, but that the extant foundation of skills and technologies are not able to adapt and master those innovations, and hence generativity is limited.

6 Conclusion: Generativity in Policy and Practice

Generativity has been applied post-hoc to illustrate its applicable to an mHealth implementation in Malawi. How can generativity inform future implementation planning and policy? The surge of mHealth innovations in developing economies puts pressure on information system managers and policy makers to develop strategies that emphasize coordination and harmonization over short-term impacts. In particular, strategies need to identify ways to balance the innovative use of ICT capabilities at the fringes of national health systems with the governance of a robust foundation of skills and IT services such as an integrated national health data warehouse. This balance is necessary to facilitate the long-term and steady pursuit of national goals, without causing unnecessary disruptions to existing work practices, career trajectories and information flows.

Generativity may at once be both a useful framework and an aspiration informing the development of ICT strategies that are sensitive to this balance. In practice, international donors and NGOs can play an important role by providing much needed long-term financial, strategic and technical assistance, rather than brief bursts of external support. Not only is there a dire need for local capacity to maintain solutions, but also to leverage an extant ecology of ICT acquisitions, networks and databases for further innovation. One way to strengthen the local capacity to absorb ICT innovations may be to pool donor funding to finance local technical assistance beyond the scope of individual projects. This was the case, to some extent, with ad hoc partner arrangements to support the mobile reporting in Malawi. Generativity provides a perspective on how different stakeholders extend, replace and reproduce ICT capabilities over time.

At the level of ICT4D projects, stakeholders may try to balance the malleability of new ICT capabilities with the local capacity to alter those capabilities by applying generativity as a pilot evaluation framework. However, far from all challenges to the longevity of ICT4D and mHealth implementations can be resolved at the level of projects. Systemic challenges such as *pilotitis* require significant international collaboration where both donors and governments harmonize ICT-oriented development activities. This can for instance involve the development of international evaluation criteria and incentives structures that emphasize intra-project collaboration to develop a foundation for generative ICT capabilities.

7 References

Akter, S., & Ray, P. (2010). mHealth-an ultimate platform to serve the unserved. *Faculty of Commerce-Papers*, 94–100.

Ali, M., & Bailur, S. (2007). The Challenge of "Sustainability" in ICT4D–Is Bricolage the Answer? In *Proceedings of the 9th International Conference on Social Implications of Computers in Developing Countries, São Paulo, Brazil*.

Avgerou, C. (2008). Information systems in developing countries: a critical research review. *Journal of Information Technology*, *23*(3), 133–146.

Avital, M., & Te'Eni, D. (2009). From generative fit to generative capacity: exploring an emerging dimension of information systems design and task performance. *Information Systems Journal*, *19*(4), 345–367.

Best, M. L., & Kumar, R. (2008). Sustainability failures of rural telecenters: Challenges from the sustainable access in rural india (sari) project. *ITID*, *4*(4), pp–31.

Bhana, J. (2013). Situation analysis of the Ministry of Health's Central Monitoring and Evaluation Department in Malawi. HMST.

Blaikie, P. (2006). Is small really beautiful? Community-based natural resource management in Malawi and Botswana. *World Development*, *34*(11), 1942–1957.

Braa, J., & Hedberg, C. (2002). The struggle for district-based health information systems in South Africa. *The Information Society*, *18*(2), 113–127.

Brundtland, & others. (1987). Our common future: Report of the World Commission on Environment and Development. *UN Documents Gatheringa Body of Global Agreements*.

Ciborra, C. (2002). *The labyrinths of information: Challenging the wisdom of systems*. Oxford University Press, USA.

Curioso, W. H., & Mechael, P. N. (2010). Enhancing "M-health"with south-to-south collaborations. *Health Affairs*, *29*(2), 264.

Estrin, D., & Sim, I. (2010). Open mHealth architecture: an engine for health care innovation. *Science(Washington)*, *330*(6005), 759–760.

Foster, V., & Shkaratan, M. (2011). Malawi's infrastructure: a continental perspective. *World Bank Policy Research Working Paper Series, Vol*.

Germann, S., Jabry, A., Njogu, J., & Osumba, R. (2011). The Illness of "Pilotitis" In mHealth – Early Lessons from the KimMNCHip Partnerships in Kenya.

Heeks, R. (2006). Health information systems: Failure, success and improvisation. *International Journal of Medical Informatics*, *75*(2), 125–137.

Heeks, R. (2008). ICT4D 2.0: The next phase of applying ICT for international development. *Computer*, *41*(6), 26–33.

Jensen, C. B., & Winthereik, B. R. (2013). *Monitoring movements in development aid: Recursive partnerships and infrastructures*. Cambridge, MA: MIT Press.

Kaplan, W. A. (2006). Can the ubiquitous power of mobile phones be used to improve health outcomes in developing countries? *Globalization and Health*, *2*(1), 9.

Kimaro, H. C., & Nhampossa, J. L. (2005). Analyzing the problem of unsustainable health information systems in less-developed economies: Case studies From Tanzania and Mozambique. *Information Technology for Development*, *11*(3), 273–298.

Kleine, D., & Unwin, T. (2009). Technological Revolution, Evolution and New Dependencies: what's new about ict4d? *Third World Quarterly*, *30*(5), 1045–1067.

Kreps, D., & Richardson, H. (2007). IS Success and Failure—The Problem of Scale. *The Political Quarterly*, *78*(3), 439–446.

Labrique, A., Vasudevan, L., Chang, L. W., & Mehl, G. (2013). H_pe for mHealth: More "y" or "o" on the horizon? *International Journal of Medical Informatics*, *82*(5), 467–469.

Lewis, D. (2006). *The management of non-governmental development organizations*. Taylor & Francis.

Lucas, H. (2008). Information and communications technology for future health systems in developing countries. *Social Science & Medicine*, *66*(10), 2122–2132.
Mansell, R. (2014). Power and interests in information and communication and development: Exogenous and endogenous discourses in contention. *Journal of International Development*, *26*(1), 109–127.
Mansell, R., & Wehn, U. (1998). *Knowledge societies: information technology for sustainable development*. United Nations Publications.
Mechael, P., Batavia, H., Kaonga, N., Searle, S., Kwan, A., Goldberger, A., … Ossman, J. (2010). *Barriers and gaps affecting mHealth in low and middle income countries: Policy white paper*. Columbia university. Earth institute.
Norris, A. C., Stockdale, R. S., & Sharma, S. (2009). A strategic approach to m-health. *Health Informatics Journal*, *15*(3), 244–253.
Pfeiffer, J. (2003). International NGOs and primary health care in Mozambique: The need for a new model of collaboration. *Social Science & Medicine*, *56*(4), 725–738.
Sanner, T. A., Roland, L. K., & Braa, K. (2012). From pilot to scale: Towards an mHealth typology for low-resource contexts. *Health Policy and Technology*, *1*(3), 155–164.
Sanner, T. A., & Sæbø, J. I. (2014). Paying Per Diems for ICT4D Project Participation: A Sustainability Challenge. *ITID*, *10*(2), pp–33.
Smith, M. L., Spence, R., & Rashid, A. T. (2011). Mobile phones and expanding human capabilities. *Information Technologies & International Development*, *7*(3), pp–77.
Sørensen, C. (2013). Digital platform and-infrastructure innovation. *Mobile Strategy Challenges (In Japanese). H. Higashikuni (Ed). Nikkan Kogyo Shimbun Ltd. Tokyo*.
Stansfield, S., Orobaton, N., Lubinski, D., Uggowitzer, S., & Mwanyika, H. (2008). The Case for a National Health Information System Architecture; a Missing Link to Guiding National Development and Implementation. *Making the eHealth Connection, Bellagio*.
Suchman, L. A. (2002). Practice-based design of information systems: Notes from the hyperdeveloped world. *The Information Society*, *18*(2), 139–144.
Swidler, A., & Watkins, S. C. (2009). "Teach a man to fish": The sustainability doctrine and its social consequences. *World Development*, *37*(7), 1182–1196.
Tilson, D., Lyytinen, K., & Sørensen, C. (2010). Research commentary-digital infrastructures: the missing IS research agenda. *Information Systems Research*, *21*(4), 748–759.
Tomlinson, M., Rotheram-Borus, M. J., Swartz, L., & Tsai, A. C. (2013). Scaling up mHealth: where is the evidence? *PLoS Medicine*, *10*(2), e1001382.
Tongia, R., & Subrahmanian, E. (2006). Information and Communications Technology for Development (ICT4D)-A design challenge? In *2006 International Conference on Information and Communication Technologies and Development* (pp. 243–255). IEEE.
Unicef, Organization, W. H., & others. (1978). Primary health care: report of the International Conference on Primary Health Care, Alma-Ata, USSR, 6-12 September 1978.
Unwin, P. T. H. (2009). *ICT4D: Information and communication technology for development*. Cambridge University Press.
WCED. (1987). *Our common future* (Vol. 383). Oxford University Press Oxford.
Yoo, Y., Henfridsson, O., & Lyytinen, K. (2010). Research commentary-The new organizing logic of digital innovation: An agenda for information systems research. *Information Systems Research*, *21*(4), 724–735.
Zittrain, J. L. (2006). The generative internet. *Harvard Law Review*, 1974–2040.
Zittrain, J. L. (2009). *The future of the internet: and how to stop it*. Yale University Press.
Zuckerman, E. (2010). Decentralizing the mobile phone: A second ICT4D revolution? *Information Technologies & International Development*, *6*(SE), pp–99.