Ensuring Sustainable Internet Access for Development in Africa: Insights from mHealth Innovations

Adesina ILUYEMI
Centre for Healthcare Modelling and Informatics, University of Portsmouth, Portsmouth, PO1 3HE, United Kingdom
Tel: +44 023 92846784, Email: Adesina.iluyemi@port.ac.uk

Abstract: In arguing that ICT4D, from its present state of 1.0 to an emerging and future 2.0 one, Richard Heeks, called for attention to be shifted to three areas, namely: low-cost devices, telecommunications, and energy. These areas are touched upon here and argued as important for providing sustainable internet access in Africa based on empirical insights from mHealth innovations from Africa and other developing countries. These mHealth cases have shown that wireless/mobile ICTs, mobile/nomadic devices, and fibre-optics-wireless convergence are technologies to be employed for broadband internet access now and in the nearest future in Africa.

1. Introduction

According to Heeks [13], sustaining ICT innovations and digital divide reduction efforts in Africa has been hampered by the misalignment between technological concepts or designs and the reality facing local users. A major failure of ICT4D, according to Heeks [1], is the lack of evaluation of existing initiatives at the micro-level of practice for informing at the macro-level of policy and development. Heeks further stated that triansiting from what he labelled the present state of ICT4D 1.0 to the emerging and future 2.0 one requires a different way of thinking. ICT4D 1.0 according to Heeks is about adopting ICT tools, especially the Internet for meeting the Millennium Development Goals (MDGs). Aggressive push of ICT4D 1.0 paradigm mostly by international bodies, informed by narrow empirical experience from DCs led to a mad rush of project and policy implementations. This paradigm was informed mostly by the implementers' western view of Internet access as argued by Heeks and has terminated with failures and without achieving any tangible sustainability whatsoever. Notwithstanding this observed failure, lessons learnt from the 1.0 paradigm is now informing how the not too clear 2.0 one should go in making ICTs to deliver on its much published promises of bridging digital divide. Transiting into ICT4D 2.0 paradigm as argued by Heeks will be how to deliver sustainable Internet access to end-users in DCs. According to him, a paradigmatic shift to user-centric access model from the unsustainable western inspired access model of the 1.0 era should be done away with. Further, he also argued that western inspired model of a fixed computer connected to a landline was costly and could not provide sustainable Internet access to users in DCs. Shaping the emerging and future 2.0 paradigm to deliver will therefore require innovative user-devices, telecommunications and energy solutions. Low-cost internet access devices (IADs) such as laptops and personal digital assistants (PDAs), terrestrial wireless networks and electricity generation are three relevant areas of innovation according to Heeks [1].

Empirical observations from case study evaluation of mHealth initiatives will be adopted as a lens into Internet access practice at the micro-level. It is hoped that analysis of this
micro-level practice will make clearer how technological innovations will unravel within the emerging ICT4D 2.0 paradigm. Hopefully, ICT4D policy at the macro-levels of international and national bodies can also be influenced. Extension on the role energy innovation will play within the ICT4D 2.0 will be provided based on practices from the mHealth cases. This issue only received a fleeting mention by Heeks.

2. mHealth Innovations are Contesting Mobile Phones and SMS

mHealth [2] involves using mobile/wireless technologies such as Bluetooth, GSM/GPRS/3G, WiFi, WiMAX and so on to transmit and exchange various eHealth data, contents and services. Usually these are accessed by health workers through devices such as mobile phones, Smartphones, Personal Digital Assistants (PDAs), Laptops and Tablet PCs, and even PCs. mHealth practices from Africa and other developing regions have demonstrated that these technologies are sustainable within the low-resource condition in these environments. Innovative deployment of these technologies has helped in improving health services to populations and delivered better health patient outcomes. Of specific concern here is how these technologies have enabled access to the web and data through the Internet and beyond ordinary SMS technology. Innovative energy sources are also being employed for powering these devices in some of these mHealth initiatives.

Empirical observations from these mHealth practices are in agreement with Heeks' three innovations proposed to define the trajectory of the ICT4D 2.0 paradigm. It is therefore my proposition here that sustainable Internet access for end-users in Africa within the paradigm of ICT4D 2.0 will involve learning from how these three innovations are being adopted. However, practice from these mHealth cases is also contesting Heeks’s argument that older technologies such as mobile phones and SMS should be the platform for Internet access in DCs in the nearest future (ibid., p. 80). Rather, wireless telecommunications enabling Internet access via powerful portable or mobile devices as in these mHealth cases indicate that ICT4D 2.0 will be different from that of Heeks’ opinion. Also, these should be seen as platforms for bridging the digital divide in Africa. Arguments in favour of this view will be pursued later on in this article. Aside from this contention, this article will also provide an extension to Heeks’ argument for sustainable power generation. These mHealth cases provide proven examples of how to adopt renewable and local energy sources for powering these devices and networks.

Heeks furthermore claims (ibid., p 79) that the boundary separating the paradigmatic transition from the ICT4D 1.0 to that of 2.0 is blurred, with no definition of what 2.0 is all about. I also challenge this view. Recent global 2008 e-readiness reports [3, 4] focus on reviewing and benchmarking digital divide reduction trends also collaborate these mHealth technological innovations.

3. Telecommunication Innovations

Most 2008 global e-readiness reports highlight the influence of the rising adoption and diffusion of wireless internet as drivers for bridging the digital divide [3, 4]. Its influence was noted to be more profound in DCs, partly because of absent legacy fixed telecommunication infrastructures. Moreover, the reality is that digital divide reduction – which is measured by e-readiness benchmarking – is now about broadband connectivity and data exchange. This emerging trend towards broadband connectivity contrasts with Heeks’ view of using SMS within the ICT4D 2.0 paradigm, but is in support of some mHealth cases in adopting wireless Internet.

A 2008 report from the Organization for Economic Cooperation and Development (OECD) on the future of internet economy [5] is also in congruence with this observation. Here, the convergence of broadband wireless/mobile and fibre-optics technologies, the next generation networks is regarded as the bedrock of future internet telecommunication infrastructure. Technology convergence, as of this OECD view, is also in agreement with
Heeks’ prediction on how ICT4D 2.0 will evolve. However, according to the OECD report, this innovation is already in use in many of the western countries surveyed in the report. This observation contrasts with Heeks’ opinion that western inspired technology imported to DCs was responsible for the failure of ICT4D 1.0. Practices from some mHealth cases support that the telecommunication convergence trend is already a thing of the present and not of the future.

Providing internet access through wireless telecommunication in Africa is argued here as not negotiable, as the recent explosion in GSM telecommunication suggests [24]. GSM network as employed in the mHealth case from Uganda [16] is the most widely used wireless technology in Africa. They are mostly used for voice communication, but data exchange and internet access is now being enabled through GPRS and EDGE in some of these countries. The broadband capability of these two wireless technologies has made this possible. Broadband telecommunication technologies such as WiFi and WiMAX have been used for wireless Internet access in mHealth cases from rural Zambia [25], Malawi [23] and rural South Africa [8] respectively. Economic benefits to users, such as about 100% reduction in data transmission costs brought by increased bandwidth in the Ugandan mHealth case is one of the reason why these technologies should be employed within the ICT4D 2.0 paradigm [6]. Moving from ordinary GSM, capable only of delivery SMS to these broadband capable GPRS and EDGE made this cost-savings possible to the users in this same mHealth case from Uganda. 3G wireless telecommunications has also been piloted successfully in another mHealth case from South Africa [26]. Further, broadband technologies also provide other benefits that SMS cannot provide. For instance, in a mHealth case from Bangladesh [7], broad bandwidth afforded by EDGE enabled remotely located doctors to conduct real-time videoconferencing teleconsultation with distant colleagues in medical emergencies. This example for need for data transmission even in DCs, is also in contention with Heeks’ argument of sticking with SMS in the new phase of ICT4D 2.0. At least, if this is not perceived as feasible for users in Africa, this will be required for businesses and enterprises in this knowledge economy. For example, e-Business and e-Commerce applications for small and medium enterprises in Africa will surely benefit from this. Because, knowledge economy is not about SMS but about access to the Internet. Likewise, digital divide reduction is about providing access to sustainable Internet access in DCs [1].

Another contention with Heeks view on the ICT4D 2.0 is that fixed and satellite telecommunication still has a major role to play in complementing these rapidly adopted terrestrial wireless ones. This contention is that, if going by the practice from cases from Malawi [23] and Tanzania [27], fixed lines will also have some roles to play in narrowing digital divide gap in Africa.

It is evident that fixed lines are making a comeback as means for providing internet access, especially for providing upstream or “first mile” window to international internet backbone or traffic in these mHealth cases. Again, this contends with Heeks’ outright dismissal of fixed line roles in the ICT4D 2.0 paradigm. Broadband wireless technologies such as WiFi and WiMAX are married with fixed ones for providing “last mile” wireless internet access to the end-users. Wireless-Optical fibre convergence is being employed in these mHealth cases as Fibre-WiFi convergence in Tanzania [27]. Fibre-WiMAX convergence is being employed for wireless internet access for rural health workers in South Africa [28]. WiFi-copper convergence is also in use in mHealth in Peru [22]. Aside from this observed double marriage of wireless and fixed telecommunications, triple convergence is also evident. For instance in an mHealth case from Zambia [25], microwave, the traditional terrestrial wireless alternative to fibre-optics first mile window in Africa, is combined with fibre and WiFi to deliver wireless internet to health workers.

In contrast with Heeks’ view that these innovative wireless technologies will not be available for providing internet access to rural dwellers in DCs, these mHealth practices are proving the suitability of these technologies for rural use. WiFi in particular has proven has a
cost-effective medium for providing wireless Internet to rural health workers as most of these mHealth cases concerned health workers in rural communities.

However, in agreement with Heeks’ view, a marked distinction is evident between technologies for western and developing ones. For instance, WiFi are generally used for both long distance (outdoor) and short distance (indoor) connectivity in most of these mHealth cases. But a distinction is that, WiFi are usually used for indoor communications in western countries, which is in contrast to its predominant use for long-distance outdoor communication in DCs, as in these mHealth cases.

Satellite wireless technology, the usual window to international bandwidth and upstream internet access in many African countries is also converging with terrestrial wireless networks as in this rural South Africa mHealth case [8]. However, the exorbitant and prohibitive costs of satellite subscription have prompted a rethink, because it threatened the project’s sustainability. Currently, attempt is at considering 3G/HSPDA as complementary or substitutive.

With a slight disagreement with but also in partial agreement to Heeks, terrestrial wireless technologies should either be seen as substitutive or complementary use to SMS and voice for DCs’ end-users in this ICT4D 2.0 paradigm. This use will as such be influenced by the factor of geography and occupational status. Wireless Internet should be substitutive to SMS and voice for rural dwellers where infrastructure for supporting it is neither available nor economically viable. But for knowledge workers, such as health workers or educators, either in urban or rural areas who require access professional or educational contents, wireless Internet should be complementary.

Ensuring sustainable ICT4D 2.0 paradigm will require other innovative models beyond those identified by Heeks in his article.

Fair and concessionary wireless spectrum regulation and management will also have a say in how Internet access and efforts at bridging the digital divide are made pro-users in Africa. Special governmental consideration and legislation ensured that dedicated broadband wireless networks were built purposively for health services mHealth cases from Zambia [25] and South Africa [28]. Here, unlicensed wireless spectrum allocated by the regulator to these mHealth cases ensured that building a wide area network (WAN) was made possible. Therefore, this model can be considered for providing wireless Internet to rural users in Africa, where business case might not be seen as palatable by commercial operators. Therefore, access to future internet in Africa should be made possible through broadband wireless networks that are not encumbered by strict regulation, so as to ensure users uptake of mobile services.

Finally, recommendation made in an evaluation of an mHealth case from South Africa [28] suggests that convergence between and combination (2Cs) of telecommunication technologies might be the "killer apps" in this ICT4D 2.0 paradigm. Here, combining and converging of wireless, fixed and satellite technologies ensured that health data, even bandwidth intensive videoconferencing are made accessible to rural health workers. Again, this innovative model should be considered for bridging the digital divide in Africa. Access to health data by health workers in many of these mHealth cases are via devices that are internet-enabled and more powerful than mobile phones, that is, more powerful than the type of device backed by Heeks as relevant within the ICT4D 2.0 paradigm, as will be discussed in the following section.

4. Mobile Internet Access Devices

It is not an argument here that mobile phones will not be of relevance in the ICT4D 2.0 paradigm, but that practice from these mHealth cases challenges Heeks’ stance that mobile Internet access devices (MIADs) will not be relevant in ICT4D 2.0 in the foreseeable future. MIADs are taken to include Internet-enabled mobile phones, PDAs, laptops and their hybrids.
Two 2008 global e-readiness reports [3, 4] observe the rising adoption, diffusion and gradual shift towards MIADs from traditional desktop or PC ones. MIADs are taunted future Internet access devices being pushed by the explosive parallel adoption of broadband wireless telecommunications. Although, prediction was based on adoption in western countries, emerging practice from these mHealth cases is also in support of this trend and portends that this might be sooner than expected in DCs.

Innovation in MIADs has also brought about device hybrids that combine the communication functionality of a mobile phone with the user-friendly interface of a laptop. These hybrids, miniaturized versions of laptops, are also described as ultra mobile portable laptop (UMPC), low-cost version of which was pioneered by One Laptop Per Child (OLPC) fame. Even Heeks agree that hardware innovation in this mode will have a role to play in the ICT4D 2.0 paradigm in DCs. Special mention was made by him of likely roles "Blackberry-like devices" and OLPC mutants will play in accessing Internet services in DCs. Use of MIADs and laptops by health workers in these mHealth cases is not far-fetched either mHealth cases from India Smartphone [9] and Uganda PDAs [16], South Africa [21] and Bangladesh Laptops [7] are examples. Rural health workers with minimum education and computer literacy were able to access web-based mHealth applications from their wirelessly Internet enabled PDAs. Thus, agreeing with Heeks that adult illiteracy will not be a barrier to eService adoption in the ICT4D 2.0 paradigm. Familiarity with and prior exposure to mobile phones was a reason alluded to this observed ease of adoption in the mHealth case from rural South Africa (ibid.). The health workers first contact with any form of a computing device was with mobile phones. This observation also agrees with Heeks suggestion of sticking with mobile phones as Internet access devices, at least for a foreseeable future. However, observation from the mHealth cases will suggest that functional limitations of mobile phones will hinder their usefulness for a class of users in DCs.

By not generalising users, but focus on different segments of users, a contention with Heeks’ discourse, better understanding of “device-user” fit will be appropriate in the ICT4D 2.0 paradigm. User segmentation to recognise knowledge workers such as teachers or educators, health workers, students and business persons regardless of their geographic location is a point in case. Their need to access data beyond the capacity of SMS, which can only take 160 words, makes mobile phone a substitutive device for them. Smaller screen interface size and processing speed are also reasons for contending with Heeks’ suggestions.

Supporting this argument, is an observation from an mHealth case, where lower cadre, minimally literate health workers equipped with basic mobile phones, made these complaints [20]. In another mHealth case from Uganda [6], demands for high performance devices were made by health workers, because their functional limitations. Their first generation PDAs, in use since 2003, were unable to meet their information processing and presentation needs at the point [10]. For example, these health workers required statistical analysis of data inputed into their devices for evidence-based decision-making at the point of care.

Moreover, small screen size was also reported as a barrier to optimal human-computer interface (HCI) engagement by health workers in another mHealth case from India [11].

A mobile phone can be used by knowledge workers for voice and SMS communications, but it cannot substitute for more appropriate devices like MIADs. Even, as such, voice over internet protocol (VoIP) over WiFi for voice communication could also make GSM voice one irrelevant in the ICT4D 2.0 paradigm as demonstrated in another mHealth case [8]. Here health workers were able to communicate with their colleagues in a cost-effective manner by circumventing the commercial GSM network.

The combination of these different limitations has influenced the proposition here, that access to the Internet for knowledge workers in Africa and other DCs should be through MIADs, especially low-cost UMPCs as being championed by OLPC. Heeks’ expression of OLPC-like UMPCs/Laptops as prototype MIADs in the far future of ICT4D 2.0, also stands in contention with practice from these mHealth cases and with global trends. Laptops are used...
in most of these mHealth cases, more visibly in with rural HWs in South Africa [21] and Peru [22]. So for knowledge workers in Africa, OLPC-like laptops should be the MIADs substitution to mobile phones in the ICT4D 2.0 paradigm now. Now, because knowledge workers require these devices for accessing information to innovate to solve local problems and also to participate in the global knowledge economy in which they are lagging behind now. For instance, health workers in DCs need access to vast global knowledge base for tackling MDGs-related disease burdens. Also, data and information gathering such as epidemiological ones for decision-making are beyond the capacity that mobile phones can provide. Therefore, low-cost OLPC-like UMPCs for knowledge workers should be very high on the agenda of the ICT4D 2.0 paradigm and not just mobile phones.

Case for OLPC-like MIADs is further reinforced by practical lessons from two mHealth cases [21, 22]. One of which brings into agreement with Heeks’ conclusion on the reason for failure in the ICT4D 1.0 paradigm: technology inspired by western worldview was this reason. Empirical observation from this mHealth case from South Africa [12] buttress this conclusion. Here, laptops developed for western markets were reportedly prone to frequent breakdowns, without any local technical expertise to tackle these. The harsh climatic conditions such as dusts in the air and high temperatures are probably the cause of these frequent hitches. The laptops were made for western markets, where the environmental conditions are more favourable. However, innovative concept brought about by OLPC birth should be adopted to overcome these hindrances. Product innovations in intuitive user interface, wirelessly enabled-Internet capability, low-power consumption, intuitive software, hardware ruggedization et cetera, should dictate MIADs design for users in DCs. Ease of maintenance concept currently being pushed by OLPC could help in transferring technical expertise to DC users.

Device preferences from knowledge workers’ perspective should also dictate the move in the ICT4D 2.0 paradigm in DCs. For example, in this same mHealth case [21], rural health workers initially equipped with a PC-based patient management application could not use it effectively because frequent power shortage hindered effective adoption. To overcome this, the application was then ported to a laptop. Eventually, this ported and adapted to a MIAD because of an organizational barrier. Adoption by the health workers soared and feedback from them revealed that portability feature of the device endeared them to it. Device isomerism from PC to laptop and finally to what Heeks described as Blackberry-for-development like device, further reinforces this argument for OLPC-like UMPCs for DCs’ knowledge workers.

This is not to preclude any role for PCs within the ICT4D 2.0 paradigm, as they are still useful as in mHealth cases in Peru [22], where they became complementary options to failed laptops. Again this view stands in contention to Heeks’ opinion on internet access devices. PC will still be relevant, but for it to be so, hardware innovation as suggested by Heeks will be required as in an mHealth case from Malawi [23] where touch-screen interface was locally built into a PC so that busy health workers can enter and recall information in a jiffy. This customized innovation also contributed these local health workers’ sustainable adoption of the devices. In the aforementioned mHealth case from Uganda, portable wireless servers manufactured by a local SME was adopted as replacements for legacy, imported, more expensive, poorly performing and difficult to maintain earlier ones. This innovative effort has also resulted in creating an industrial and economic base for the manufacturing of cost-effective and functional devices, which have been employed for replicating the project elsewhere in Africa.

Increasing global trend in UMPCs adoption, inspired by OLPC commercial mutants should “commodify” them like mobile phones. This trend together with the entry of open-source driven innovation like the VIA OpenBook1 one joining the fray, should ensure that are eventually affordable to DCs’ consumers. Commercial mutations from established laptop

---

1 http://www.viaopenbook.com/
original equipment manufacturers (OEMs) such as Dell, Asus, HP et cetera are already making these low-cost UMPCs more affordable, powerful and user-friendly for those in western countries. It is an irony that devices inspired by pro-poor design is now benefiting those it was not initially intended for. Failure of IS researchers to come up with innovate ideas, as suggested by Heeks, might be a reason for this lack of benefits to DCs’ users. Perhaps a way to overcome this, as also suggested by Heeks ([1], p. 81), is to stimulate and encourage social enterprises partnerships between these global OEMs and local SMEs in DCs.

Finally, open-source inspired hardware and software innovations, failed to get a mention in Heeks’ vision for ICT4D 2.0. Observation from most of these mHealth cases explored here suggest otherwise. Locally developed open source software was observed to have stimulated innovation in locally relevant contents. Contents that meet the needs of DCs’ users were suggested by Heeks (ibid., p. 80) as important for ensuring success within the ICT4D 2.0 paradigm. Open source software low cost of development, easy access to source-codes for customization and ease of adaptation to local needs brought successes to these mHealth cases. As such, ensuring sustainable internet access in Africa could also depend on how software are available to local innovators in order to create appropriate contents and services for users. So also, any sustainable device uptake could also depend on this. Sustainable energy for powering these devices and telecommunication network to be deployed is also important for consideration, and this issue will be addressed in the next section.

5. Energy Innovations

Extending Heeks’s thoughts on the importance of electric powering of the ICT devices as well as the communication infrastructure, I will here make a short note on determining how devices and telecommunication networks are powered in DCs.

Powering ICT hardware in an African environment or generally in DC environments where regular and reliable electricity is an exception could be a daunting task. Product and process innovations in making hardware energy efficient and less power hungry are global industrial trends [15]. This, together with the need for low-cost energy solutions, is in agreement with Heeks’ view. Innovating hardware to be able to function with detachable batteries, either rechargeable or otherwise, are low-cost solutions for health workers in the mHealth case from Uganda [16]. For powering their PDAs this was and still is a technological masterstroke. Here, these batteries were found to be a lower cost alternative compared to PDAs with inbuilt power cells, because regular power supply is required for powering the latter. Further, locally sourced solar panels are also being used for recharging these batteries and other telecommunication hardware.

Moreover, WiFi routers and antennas are also being powered in an mHealth case from Peru [17]. Even bigger telecommunication hardware is already being powered by solar energy. An Indian, company-led low-cost innovation has come up with solar-powered GSM base stations for rural and village projects [18]. Implementations are already underway in Africa and India.

Other renewable energy sources like micro-wind turbines are also being deployed for power generation in an mHealth case in Tanzania [19]. Going by these examples, energy innovations for powering ICT4D 2.0 paradigm will require moving from pilots or patchy usage as in these cases for achieving scalability and impacts. Global and industrial trend in “green product” revolution should also be captured in making this sustainable. Global carbon market and trade in particular could be exploited in this regard.

Knowing that the energy-related innovations of these mHealth cases are borne out of necessity rather than a deliberate means of carbon footprints reduction, creating carbon markets around this kind of initiatives, through linkages with global carbon trade, could provide the required financial resources for ensuring scalability.
Naturally, any extension of eHealth solutions to other e-areas has to consider that for the eHealth cases there are often also other reasons to produce electricity than to drive the MIADs. For instance, health centres may use solar-powered fridges for vaccine preservation.

6. The Way Forward for the ICT4D 2.0 paradigm

Means of sustaining internet access for users in Africa have been discussed in this article based on the analysis of mHealth cases from DCs. Attempts to bridge north-south digital divide is still dominating policy makers’ attention in Africa, but these mHealth cases have provided some insights into how internet access can be sustainable. These mHealth cases have shown that wireless/mobile ICTs, mobile/nomadic devices, and fibre-optics-wireless convergence are technologies to be employed for broadband internet access now and in the nearest future in Africa.

As we are transitioning from the ICT4D 1.0 phase to that of 2.0, as envisaged by Heeks [1], demonstrating impacts of ICT4D initiatives and ensuring their sustainability will depend on how evaluation of micro-level practices are used for informing macro-level policy making.

Acknowledgement

The Centre for HumanIT at Karlstad University supported the author’s participation in the conference. The author also wishes to acknowledge the many helpful suggestions by the General Chair, John Sören Pettersson, when preparing this paper for publication. Carl Adams’ name should also be mentioned for providing useful suggestions in writing the paper while Jim Briggs is more or less a co-author!

References


