ICT4D and Sustainability

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Abstract
Sustainability is a systems concept, and ICT4D plays a vital role in a sustainable earth, as well as in sustainable communities. The concept of resilience is introduced since rapid change can push a system into another, possibly undesirable state. Resilience is the capacity of a system to absorb disturbance. ICTs play a key role in the decoupling of economic development from the use of natural resources, by reducing the energy use of economic processes. ICT4D has moved to the use of ICTs as a platform for transformative development. This development must start with human development, since technology is only a multiplier of human intent and capacity and cannot substitute for it. Human scale development strategies are discussed where self-reliant relationships are built via a network of aligned interests. These, in turn, are built from the bottom up and are supported via networks that span the local, regional and national levels.

Sustainability as a Systems Concept
Sustainability can be considered from different perspectives, e.g. economic, institutional, social and environmental, as well as in terms of short, medium or long term views. The ultimate, long term question posed by sustainable development is: how many earths are required to sustain the rate of resource consumption inherent in most of the current development trajectories of the world's economies. ICTs can play an important role in decoupling economic development from the use of natural resources, so that resource use does not increase with economic development (Giljum et al. 2005). At the other end of the scale many development initiatives struggle to be sustainable. ICT-enabled development interventions are no different and pose an enduring question as to how these initiatives can become sustainable in the long term, in order to contribute to the sustainability of developmental strategies at country or global level. The concern with rapid and possibly irreversible change to the global climate has increased the importance of resilience, i.e. the ability of systems to stay in the current regime of functioning despite shocks such as the rapid rise in the global average temperature. Sustainable and resilient development is therefore discussed.

The Institutional context: The rise of sustainable development and the role of ICT
Development theories have mainly arisen from economic theories in the eighteenth and nineteenth centuries, and evolved to “catch-up” theories of development after the great wave of industrialization in Western Europe. This was followed by the post-World War II boom in development theories and the current “alternative theories” derived from critiques of all forms of development theory based on human development, gendered, environmental and postmodern viewpoints (Payne and Phillips 2010, 8). Environmental critique grew rapidly, so that by “the end of the 1980s environmental issues had also been incorporated squarely into the discourse of development practice, clothed in the concept of ‘sustainable development’" (ibid, 135). The often cited definition of sustainable development is from the 1987 Brundlandt report: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987, 43). Sustainable development thus has an ethical aspect as well. Sustainable development as a multi-dimensional concept has been evolving continuously, with the economic dimension being augmented with social and ecological dimensions (sometimes shortened to people, planet and profit). The work of the United Nations Commission on Sustainable Development (CSD) to develop a set of sustainability indicators ultimately led to the recognition of the additional institutional dimension (UNDPCSD 1996). Institutions arise from interpersonal processes, such as communication and co-operation, which result in the emergence of systems of rules that govern societal interactions. Institutional sustainability objectives include participatory political systems, non-discriminatory education and social security systems as well as gender equity (Spangenberg 2002).

These four dimensions are not mutually independent. The ecological reality is that economic systems and institutions are embedded in social systems which are embedded in ecological systems. This perspective has been reflected in the debate around the creation of a set of sustainable development goals (SDGs) for integration

with the Millennium Development Goals (MDGs) after their 2015 deadline. A central issue is that definitions of sustainable development have to deal with the protection of the Earth as life-support system, and with reduction of poverty (security of people and of planet).

The role of ICT in aiding developing countries has evolved as ICTs have developed. Heeks (2008) has described this evolution in three phases: ICT4D 0.0, 1.0 and 2.0. In the first phase, until about 1990, computers were used to improve government administration and to stimulate economic growth. From the mid-1990s onwards, ICT4D 1.0 started as ICTs was seen as a tool for development by the development community in response to the exponential growth of the Internet and the adoption of the Millennium Development Goals (MDGs). In order to rapidly deliver solutions to poor rural communities, many telecentres were deployed in a top-down fashion to deliver information, communication and various services. The many failed telecentre initiatives resulted in a focus on sustainability of the initiatives (i.e. in their economic self-sustainability), scalability and evaluation, as well as the adoption of new approaches in ICT4D 2.0. This is a shift from ICTs as only a tool for development, a means to an end, to the use of ICTs as a platform for development. ICT4D should realise its potential to *transform* development processes and structures, and the focus is on the use of ICT as a *productive tool* that can be adapted by people to fit their objectives as well as to produce digital content and services to create income. The move is away from a passive diffusion view of technology where market forces will be sufficient, to an active innovation view where intervention is required via *innovations* in order to achieve development goals. These innovations can be created in different ways: *pro-poor* (for the poor), *para-poor* (working with the poor) and *per-poor* (innovation by the poor in their communities). According to Heeks (ibid) ICTs, such as ubiquitous mobile communications and social networking platforms, enable per-poor innovation that empowers people.

The theme of the transformative potential of ICT use was extended by Avgerou (2010), who researched the literature on Information Systems in Developing Countries and could discern *progressive* and *disruptive* perspectives on ICT-enabled developments. The progressive perspective sees ICT as enabling transformations in the multiple domains of human activities, but within the existing social order, while the disruptive perspective focusses on the politics and controversies surrounding development, and considers conflicts of interest and struggles of power as a necessary part of the innovations of ICT4D.

Some of the key aspects of a system that can be targeted by ICT4D in a transformative development strategy are: ICT as institutional enabler, as enabler for governance, accountability, and civil society (e.g. via increasing transparency), as enabler in service production and economic activities, and as enabler for access to global markets and resources (Thompson and Walsham 2010).

The discussion to date reinforces the view that the definition of the role of ICT4D depends largely on the perspective on development that is adopted. If economic growth is the perspective then the focus will be on market-led ICT4D and if participation and empowerment (human development) is the perspective, the focus will be on socially-led ICT4D that focuses on equality of access (Unwin 2009). These are recognised to be extreme positions, with most ICT4D initiatives fitting in between these positions. Some development initiatives remain a government's responsibility and sustainability is then a matter of political will and implementation ability, in other words, institutional sustainability. Sustainability does remain a problem for all of the initiatives outside these two special cases.

These strategies need to be critiqued from the systems-based sustainable development perspective as outlined previously. The environmental aspect and resilience thinking is discussed first, followed by economic and social perspectives.

Environmental Sustainability – a focus on Resilience

The understanding of ecological systems has been based on the idea of a dynamic equilibrium state to which a system will revert back to if disturbed (Walker and Salt 2006). This state may change slowly over time, but people can use resources and services from the system to a certain degree and the system will recover to the same equilibrium state. This understanding has led to an approach in which a few components of the system are used in optimization of just one aspect of the system, e.g. a forest being managed to increase the output of commercial interest such as wood production. This kind of optimization has not proved to be sustainable and resilience thinking has been developed as an alternative view that uses systems thinking to focus on the longer term view of the combined socio-ecological system in contrast to short term, single focus, optimization approaches. The three key concepts of resilience thinking are (ibid, 31-32):

- People exist in and depend on social-ecological systems and changes in either one of these domains have impact on the other.
- Social-ecological systems are complex adaptive systems (CAS) which do not change in a predictable, linear, incremental fashion. These systems can exist in alternative stable states or regimes in which the function, structure and feedbacks are different. Shocks and disturbances can drive these systems across the threshold of the current regime to a different regime (e.g. a lake can change rapidly from a clear water state to a persistent murky water state).

- Resilience is the key to the sustainability of these systems. Resilience is the capacity of a system to absorb disturbance; to undergo change and still retain essentially the same function, structure and feedbacks. A resilient social-ecological system in a desirable state (e.g. a productive farming region or natural forest) would have a greater capacity to remain in this state even if subjected to shocks.

Striving for efficiency (in a narrow sense) often leads to the elimination of redundancies which in turn lead to reducing the system's resilience. Sustainability requires enhancing the resilience of the system as a whole and not just the optimization of isolated components (ibid).

Resilience and Change

From a development perspective that is aimed at enabling a change from an undesirable towards a desirable state, resilience in itself may be a problem since the system may be very resilient to change. This is commonly referred to as "lock-in" or "poverty traps" or "resistance to change", e.g. economies that "remain stuck in the poverty trap of subsistence farming, while others experience economic development" (Sachs 2008, 209). A key question is how ICT4D can enable change across system thresholds towards resilient desirable states and increase the resilience of desirable states. How can resilient development be achieved?

A possible pointer to resilient development can be found in the Millennium Development Goals. The recognition that these goals are interconnected and the adoption of Amartya Sen's arguments for a multidimensional approach to poverty has led to the development of a multidimensional poverty index (MPI) with three dimensions, namely, health, education and standard of living, that are measured via ten indicators (Alkire and Santos 2010). An example of an education indicator is years of schooling, with a household considered deprived if no household member has completed five years of schooling. The MPI reflects the overlapping deprivations that members of a household experience and have been used to identify poverty types that show regular patterns of deprivation. This finding has led to the suggestion that different pathways can used by countries to reduce multidimensional poverty. The analogy between these pathways, poverty traps and the different possible regimes of a social-ecological system seems promising. From the MPI work it seems that agreement is developing that there are probably a few generic variables describing poverty (or more specifically, poor households). A developmental intervention could benefit from a study of the poverty types and patterns of deprivation in order to determine the key socio-economic aspects that influence change. These aspects would serve to define the resilient desired state of the system and would need to be addressed in conjunction to enable change towards this state.

Managing Resilience

From a systemic perspective the question of how to manage the resilience of a system is very important. The general resilience of a system is influenced by three key factors (Walker and Salt 2006, 121):

- The diversity of the system which expresses the variety of species, people and institutions that exist in the social-ecological system and includes both functional and response diversity.
- The modularity of the system relates to the way in which the components (e.g. a farm) of the system (an agricultural region) are linked. A degree of modularity in the system allows individual modules to keep functioning even when some loosely linked modules fail. The system as a whole can self-organise and therefore display a greater capacity to absorb shocks.
- Tightness of feedbacks refers to how quickly and strongly change propagates in the network. Tight feedbacks are largely determined by institutional and social networks. Centralised government and globalisation can weaken feedbacks and hence delay response.

Diversity – Functional diversity refers to the existence of different entities that perform the same function in the system. These entities should (ideally) also respond differently to changes in the environment, thus increasing the response diversity of the system. ICT4D projects, for example, need to explore and establish many different business models for delivering the same services (functions) to the community. This is contrary to the common driving force experienced by many implementers of ICT4D projects to find a unique, most cost-efficient or “sustainable” model, and then to replicate only this particular model to achieve economies of scale and impact, a classic example being government owned telecentres (Heeks 2008). A strategy to replace economies of scale with economies of scope (many different products and services) in resource constrained environments has been used to contribute to the sustainability of rural ICT-based micro-enterprises (Van Rensburg, Smit and Veldsman 2007, De Carvalho, Klarsfeld and Lepicard 2012).

Modularity - Reducing dependencies on donors is a common aim for ICT4D initiatives. For example, an ICT4D project that delivers telecommunications infrastructure without supporting relevant local ICT skills development reduce resilience by creating dependencies on systems that cannot be maintained locally. ICT4D projects should aim to establish entities that are well networked in the local context, with many loosely linked connections, that do not fundamentally depend on just a few entities for their survival. Within an organization

modularity should also be designed in. The question needs to be asked: who are we dependent on and how will we survive if they fail?

Feedbacks - ICT4D projects are in the unique position that the use of ICT can enhance communications. Key feedback loops between institutions can be supported with appropriate technology. The focus should shift away from internal project communication and the reporting function to project sponsors and donors to the establishment of communication channels with key players in the local and national contexts. Social network software supports a diversity of voices and enables peer-to-peer communication and support amongst the ICT4D practitioners and the community participants. The monitoring and evaluation strategy of ICT4D projects can create feedback loops via personal interactions to monitor key changes in aspects (e.g. behaviourial change) in order to enable rapid learning as to "what works or does not" and focus interventions on what are the really sustainable changes that will change the system to a new state.

The way in which multiple stakeholders are involved in managing a system is very important and the three key factors mentioned above (diversity, modularity, feedbacks) need to be combined. Ecologists have found that the adaptive capacity of a social-ecological system is enhanced when complex issues are dealt with by a network of loosely connected stakeholders located at different levels of society. Such a dynamic structure allows for flexible coordination and cross-scale responses to solving problems because there is experimentation and learning going on across the network. Such experimentation, combined with the networking of knowledge, creates a diversity of experience and ideas for solving new problems. It stimulates innovation and contributes to creating feedback loops at different scales. Therefore governance structures are recommended that are "messy" and includes redundancy, with, for example, "a mixture of common and private property with overlapping access rights" (Walker and Salt 2006, 8). The drive for efficiency via top-down governance structures decreases the response diversity, flexibility and the ability to respond to cross-scale influences. The voices of local people with their intimate knowledge of the local context need to be heard. Many ICT4D projects balance the need to deliver on the approved funded plan with the ideal of community ownership of the initiative. It is very easy to slip into a centralised governance model during the project phase which can jeopardise the long term resilience of the social-ecological system that remains when the project ends.

At the very least, resilience thinking leads to the asking of questions such as: What are the (unobtainable and counterproductive) optimal system states that ICT4D project teams have in mind? In what way does striving for an optimum reduce the resilience of the entities established and supported by the project?

Economic Sustainability

A macro view

The ever increasing use of ICT has affected the economies of developed and developing countries. Use of ICTs has a dual effect: as an economic sector ICT impacts overall economic growth and ICT as an enabler for enhancing human productivity influences human development via information and knowledge access that expand choices (UNDP 2005). In terms of ICTs as infrastructure, research done by the World Bank (2009) on the impact of broadband services in 120 developing and developed countries showed that a 10% increase in broadband penetration contributed a 1.38% increase in per capita GDP (Gross Domestic Product) growth for developing countries and 1.21% for developed countries.

A key strategy for sustainable economic development is the decoupling of economic growth from the use of natural resources in order to balance environmental imperatives and economic growth (Giljum et al., 2005). Relative decoupling refers to economic growth with concomitant lower growth in environmental pressures, while absolute decoupling refers to actual decrease in environmental pressures with environment growth. One of the strategies for absolute decoupling is dematerialization which aims to achieve an absolute reduction of resource use by, increasing the "metabolic efficiency" (using fewer resources to produce outputs) (ibid). Use of ICTs increases the metabolic efficiency of production and consumption processes by, for example, enabling process control, information distribution and disintermediation of "middle men" (e.g. via e-commerce).

The metabolic efficiency of ICTs can also be improved. The hardware running ICT applications (e.g. server farms) are significant consumers of resources such as electrical power and hence the need to increase energy-efficiency and use of renewable energy sources, as articulated in the movement to Green IT (Murugesan, 2008). In general Green IT refers to a focus by the IT sector and IT users to reduce the impact of IT use on the environment by " improving energy efficiency, lowering greenhouse gas emissions, using less harmful materials, and encouraging reuse and recycling" (ibid, 24 -25).

Development Initiatives

Shifting focus to the economic sustainability of development initiatives, in market-led ICT4D initiatives the issue of sustainability may be deceptively simple: if people really do need the product or service and it is affordable, they will pay for it (Unwin, 2009). The prime example in the developed and developing world is the rapid adoption of mobile phones for voice communication (even though Internet access in the developing world has been hampered by relatively high data costs). In a study of more than 280 ICT4D projects that focussed on

mobile services and business models for the Base of the Pyramid, it was found that successful projects focused on the "ability and willingness of their customers to pay, rather than on identified social needs and supposed demand" (De Carvalho et al. 2012, 200). The overarching conclusion is that while entrepreneurship is important in starting successful services, the construction of an ecosystem with "cross-actor and cross-sector collaboration" that offers a range of services is vital in order to scale (ibid, 200).

Another way of viewing this from a systems perspective is that "exogenous" models for development assume that an external cause such as an ICT4D intervention can achieve development outcomes (Mansell 2011). This view mostly assumes one universal model for development as economic growth. In contrast, socially-led strategies can be described as "endogenous" and focus on *internal causes* where ICT4D intervention strategies are developed with the intended beneficiaries (ibid). In an exogenous ICT4D discourse, sustainability is primarily a problem for the donor or funder who does not want their (limited duration) investment to fail. In some way initiatives must become sustainable via being economically self-sustaining as soon as the external funding is withdrawn. As discussed later, many factors play a role in project sustainability.

Social Sustainability

A key influence on social sustainability is the intentions behind the use of ICT4D. As Avgerou (2010) has found, there are *progressive* or *disruptive* perspectives on ICT-enabled development: ICT4D enables transformations in human activity, but within the existing social order, or conflicts of interest and struggles of power is seen as a necessary part of the innovations of ICT4D.

There have been many articles on the digital divide and the need to strive for an information society where all has equal access to internet and its benefits, but there has also been concern that existing inequalities may be increased (Unwin 2009). There is also the danger of marginalisation of local cultures since developmental use of ICT can bring with it an embedded Western value system

Many ICT4D initiatives are still *technocentric* and focus only on providing ICT and access to it, ignore "socially-led" strategy (are not *sociocentric*), are mostly top down, expect development to happen if access to technology is provided, and in practice disregard the actual needs of people (Chigona, Pollock and Roode 2009, 3). This leads to a "socio-techno divide" that needs to be closed: in human and technology development. The lack of sustainability is then embedded in the top-down technocentric approach due to an assumption that technology is an autonomous force that causes desirable developmental changes in the lives of people. Technology introduction will play its role if it is connected to human development via strategies such as grass root participation and community leadership (Armenta, Serrano and Mayer et al. 2012.)

Heeks (2008) advocates an active innovation view where ideally development goals are achieved via *per-poor* innovation. The roots of sustainability are then found in the collaboration between external development actors and local communities and the dialogue between people with different world-views, developmental aims and strategies.

How do we then link local development with the institutional capacity development at various levels from local to national? The obvious answer has often been the trickle-down effect of a growing economy, but other options exist.

Human scale development

The concept of human scale development, as developed by Max-Neef and collaborators is based on the pillars of satisfaction of human needs, growth in self-reliance, and relations of balanced interdependence of, amongst other aspects, people and nature (Chigona et al. 2009). The foundation on which these pillars rest is the creation of an environment in which individuals are the protagonists of their future. Active participation by an individual requires dealing with the massive scale of top-down development initiatives in order to avoid decision flow from the top to the bottom, so that human scale development can take place in which individuals can participate.

Self-reliance, ideally to be achieved at all levels, is understood as horizontal interdependence without being isolationist. Relationships of self-reliance are postulated to have greater synergy when these relationships flow from bottom to the top: local self-reliance influencing regional self-reliance, which grows national self-reliance. The quest for complementary self-reliant processes at the national and local levels (vertical complementarity) is to avoid the dominance of the macro level. The concept of human scale development was used by Chigona et al. (2009, 5) to formulate a definition of sustainable development:

> Sustainable development is achieved through self-reliant human scale development which flows from the individual level to the local, regional and national levels, and which is horizontally interdependent and vertically complementary.

In accordance with this definition of sustainable development, a development strategy can be developed that starts with activities at the local level and works towards the achievement of complimentary activities at the higher levels. The building blocks are the alignment of interests through the acceptance of mutual interdependence. Research in South Africa showed that communities are interested in development of

their people and need top down support for training and infrastructure (e.g. telecommunications infrastructure), while government is interested in achieving overall human development objectives through increased economic growth, for example by providing access to ICT as the means to bridge the digital divide (ibid). Access is an example of the translation of interests in order to build alignment of interests: the uptake and use of access is dependent on the interplay of factors at the personal and community levels that needs to be understood by both community level and government level actors in order to achieve their development interests.

True to the idea of human scale development, this translation process has to start with the individual at local level. The understanding of the interests of other levels should also be greater among key actors at local level, and the process of translation of interests to achieve alignment should be driven from the bottom up, hopefully resulting in the building of networks across all levels. The end result would be the bridging of all sorts of divides, including the digital divide. To contribute to sustainable development and to achieve sustainability, an ICT4D initiative should therefore encourage growth of mutual understanding to support the building of a network of aligned interests from the bottom up that covers all hierarchical levels (local, regional, national). Enrolment of existing intermediaries such as civil sector development organisations can play a vital role. In general this strategy for sustainable development would require intensive use of ICTs to support the various forms of communication required to build these human networks.

These various worldviews and philosophies provide a framework for understanding the different types of causes and the solution space for sustainability issues in ICT4D initiatives.

Sustainable ICT4D Initiatives

It is true that sustainability is only one of the many factors that influence success in ICT4D, for example, ICT4D practitioner insights have been summarised as eight interrelated principles for ICT4D success: a focus on needs, designing appropriate technology solutions, sustainability, vision and commitment, infrastructure, effective partnerships, monitoring and evaluation and addressing issues of accessibility (Unwin 2009). Research on rural ICT sustainability has added societal issues of social, cultural and political nature (Armenta, Serrano and Mayer et al. 2012.) These principles are echoed in common practitioner-based themes for success such as design (for local realities), governance and sustainability (socio-economic and political).

A more radical view is that the essence of the failure of ICT4D initiatives does not lie with any technology related issues, since technology is only a multiplier of human intent and capacity and cannot substitute for it (Toyama 2011). The consequences of this theory are wide-ranging: since technology cannot substitute for the lack in institutional capacity and positive human intent, and technology tends to amplify inequalities, technology projects are most successful when they amplify existing successful development initiatives or positive intent, rather than trying to fix or replace institutions (governmental or non-governmental) that are broken or absent (ibid). This puts the human dimension of ICT4D in the foreground and clarifies the dependence of the impact of technology on the socio-political systems and positive or negative human intent. Technology use may exacerbate inequalities and divides of various kinds and the real development need is to address the power relationships which perpetuate these inequalities.

In terms of resilience thinking, poor communities stay in a resiliently poor state since well-intentioned capable people and institutions are scarce and technology will make a limited and unsustainable difference. In summary, for ICT4D interventions to be sustainable, the role of technology is limited while the human dimension is paramount. In each of these summaries or perspectives on sustainability issues, the focus is wider than the individual project and includes the greater context within which the project is conceptualised and executed, and within which it ultimately has to become sustainable. Sustainability is the outcome of a combination of endogenous and exogenous factors. When project sustainability is being considered, the unit of analysis is always greater than the project itself and the actual scope and extent of the system that is relevant to sustainability needs to be considered, for example community level uptake of internet access combined with the economics and politics of national broadband access provision.

The human scale development or socially-led approaches can indeed start with one person. As soon as there is some human capacity that can be amplified by technology, and if there is positive intent, a positive feedback loop of change can be initiated. The champion or visionary leader role is required at many levels and vision and commitment is included as one of the eight interrelated principles for ICT4D success (Unwin, 2009). It has also been found that the single best predictor for the success of telecentres in India was the presence of a local, capable and motivated champion (an entrepreneur or a member of a NGO) that invests time and effort to keep a telecentre going (Toyama 2011).The focus should not be on the identification of a champion in order to assist with quick achievement of the ICT4D project's goals, but the champion (or champions) can self-identify, emerge from community structures or be grown gradually with the assistance of the external resources. One of the key roles of the champion, in a human scale development approach would be to play a role in building a network of aligned interests in communities and assist to grow networks between communities. Relationship networks between champions at different levels in the hierarchy of systems to the national level can serve to align interests to build additional networks to support the bottom-up flow of self-reliance and the top-down flow

of support. Champions require support since it is a very demanding role. This support should, ideally, be both local and externally based and need to be sustained since the development of such champions takes time. Since the typical ICT4D project does not get funded for a long enough period to invest enough time and effort to grow and nurture champions, alternative sources of funding and expertise is mostly required to sustain the "incubation" and on-going support of these champions (Van Rensburg, Smit and Veldsman 2007).

Future Research

Human scale development approaches can be supported by innovative use of the social media to self-organise and create wide spread awareness at all levels in society. Research is required regarding the shift of the source of innovation in ICT4D to the user and the emergence of co-innovation models. Globalisation and rapid climate change will continue to drive research into what makes socio-economic-ecological systems resilient. New definitions of development and of sustainable development will no doubt emerge and will challenge ICT4D researchers to respond with appropriate strategies that encompass socio-economic, environmental, political and technological dimensions.

SEE ALSO: ICT4D; ICT4D and Economic Development; ICT4D and Poverty Reduction; Digital Divide(s); ICT and environment; Telecentres; ICT4D and Ethics; ICT4D and Mobiles; Critical overview of theory; ICT4D and Participation, Democracy and Empowerment;

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