

## **The Role of Appropriate ICT in Bridging the Digital Divide: Theoretical Considerations and Illustrating Cases**

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### **ABSTRACT**

The importance of bridging the digital divide is no longer discussed; the focus has shifted to the design and implementation of programs that aim to close the information and knowledge gap between the developing and developed nations. Unfortunately, the majority of these programs mimic what has been successfully implemented in the developed world. It becomes increasingly clear that these successes do not necessarily translate to the context of developing nations. This chapter develops the hypothesis that information and communication technology (ICT) projects in developing countries will become more successful when they adapt to local conditions. The concept of Appropriate Technology (AT) is explored. This concept has already been embraced by fields like architecture, building technology, and agriculture, but has not yet rooted in the area of ICT.

This chapter proposes a preliminary theory of Appropriate ICT along the lines of existing theories in AT and system development. The theory identifies Appropriate Technology principles at three levels: hardware, software, and ICT change management. By examining real-life cases in Africa in the context of ICT for Development (ICT4D), the guiding principles of Appropriate ICT (A-ICT) are illustrated. This chapter will conclude with an agenda for further research in the three identified levels. The research agenda will target academia, governments, non-governmental organizations (NGOs), and industry.

***Keywords:** ICT for Development, hardware design, software design, Africa, Appropriate Technology.*

### **INTRODUCTION**

It sounds pretty normal: When you plan a mountain hike, you ensure to wear firm boots and a pullover against the cold at higher altitudes; in case you go to the tropics you choose a light, well ventilating tropical outfit and a hat or cap against the merciless sun. You have been taught that you need to adapt to the local circumstances. In disciplines such as architecture, civil engineering, and industrial design, the discipline of identifying suitable and Appropriate Technology (AT) is an important

component. However, in the field of information and communication technology (ICT), which is a young discipline, this concept is still in its infancy.<sup>1</sup>

Computer hardware and software, and also methods and techniques for design and implementation of information technology, are almost without exception invented and developed in the West (Europe and North America). Environmental requirements and conditions become an integral part of the design and limit the transferability of the technology to other, different environments. Designers are often not aware of the contextual elements that become part of the design (Collins, 1992; Evans & Collins, 2007). Embedded assumptions become clear in cases of breakdown of operation (Winograd & Flores, 1986) and will initiate problem-solving discussion or discourse (Habermas, 1985). In the field of ICT for Development (ICT4D), a discussion on the limitations of commercial off-the-shelf ICT tools, software, and methodologies in the context of less-developed countries has been initiated (Dymond & Oestmann, 2004; Gairola et al., 2004; Gurstein, 2003; Reijswoud & Topi, 2004).

The field of ICT4D has grown dramatically in size and importance over the past decade (Levey & Young 2002; McNamara, 2003). ICT4D is based on the premise that ICT is able to bridge the digital divide between the West and the less-developed countries and, therewith, able to contribute to equal distribution of wealth. ICT is considered to be vital for the improvement of governance and production resources (Sciadas, 2003). The importance of ICT for poverty alleviation was recognized at the highest international levels when the United Nations Development Programme (UNDP) dedicated their Annual Human Development Report to the role of information and communication technologies (UNDP, 2001). At present, most large development organizations have substantial ICT programs and a large number of smaller development initiatives have started projects in the field of ICT.

Many who are not familiar with ICT4D wonder if ICT is relevant to the poor. They argue that poor people in the South not only have less access to ICT, but they also do not have access to sources of stable income, education and healthcare and at a first glance these issues may seem more relevant than access to ICT. However: ICT is increasingly important in the creation of economic opportunities and for the delivery of services such as health and education. When focussing on healthcare: it is not a matter of

choosing between ICT or health services, but it is a matter of choosing the most effective way to improve healthcare delivery. ICT is just one of the tools that can realize improvement in overall services.

In spite of all the efforts, the digital divide has not been bridged, and well documented success stories of the application of ICT for poverty alleviation are hard to find (Curtain, 2004; Osama, 2006). There are many reasons why ICT projects in less-developed countries fail (Heeks, 2003), and these problems have been reported from the start (Moussa & Schware, 1992). Evaluation of ICT projects often reveals underutilization of resources, because the newly introduced ICT has not been well integrated within the local context (Kozma, 2005). The worst cases result from “dump-and-run” approaches (Reijswoud, de Jager, & Mulder, 2005; Vosloo, 2006) and lack of local ownership in the receiving communities (Vaughan, 2006). Also, technical (hardware and software) problems resulting from the “hostile” conditions (dust, heat, and humidity) in which the ICT was introduced put a strain on the actual impact (Gichoya, 2005). High rates of breakdown combined with low technical problem-solving skills have lead to underutilized and even abandoned projects. Moreover, recurring high maintenance costs for hardware, software, and Internet connectivity put a financial burden on projects, making them financially unsustainable. Finally, the change management process, i.e., the approach by which the new technology is introduced and integrated in the new environment, does not take into account local conditions values and cultural requirements.

To address these issues we develop a theory for the design and implementation of ICT projects in less-developed countries. We develop this theory along the lines of existing theories in AT in other fields of science. Like in other disciplines, the design and implementation of ICT solutions must be carried out in relation to culture, environment, organization, available resources, economic and political circumstances, and desired impact. We propagate an integration of the AT discipline, which aims at devising suitable technological solutions. Our theory identifies principles to do so at three levels: hardware, software, and ICT change management. First, we describe the theory. Then, the guiding principles of Appropriate ICT are illustrated by means of real-life cases in Africa in context of ICT4D. In the final section, we will conclude with an agenda for further research.

## **APPROPRIATE TECHNOLOGY**

In order to understand better how we can improve the design and implementation of ICT projects in less-developed countries, we need to explore the field of Appropriate Technology (AT). Since AT has not yet gained ground in the area of ICT, we will start our exploration in other fields of application.

As a general definition, we adopt the idea that AT is technology that is suitable for the environmental, cultural, and economic conditions in which it is intended to be used. At the other end of the spectrum, we find the one-size-fits-all concept, which builds on the premise that well designed technology can be used under all circumstances, also known as the universal model.

Darrow and Saxenian (1986) provide ten criteria that we take as starting point. These criteria have been formulated to act as a basic set of guidelines for a broad spectrum of several technologies. ICT is not considered explicitly by the authors; however, the criteria can serve us well as a reference for devising and evaluating ICT-supported programs in less-developed countries. The following are criteria for an appropriate technology as proposed by Darrow and Saxenian (1986):

1. It should be possible to implement/realize technological solutions with limited financial resources.
2. The use of available resources must be emphasized to reduce the costs and to guarantee the supply of resources (e.g., for maintenance).
3. Technologies may be relatively labor-intensive, but must have a higher output than the traditional technologies.
4. The technology must be understandable for people without specific or academic training.
5. Small rural communities should be able to produce and maintain the technology.
6. The technology must result in economic and/or social progress.
7. The technology must be fully understandable for the local population, the end-use resulting in possibilities for them to become involved in the possible innovation and extension of the use of the technology.
8. The technological solutions must be flexible and easily adapted to changing circumstances.
9. The technology must contribute to the increase of productivity.
10. The technology should not have a negative impact on the environment.

The guiding idea for these criteria is that technologies have a good chance to be effective if they are appropriate to the needs, expectations, and limitations of the surroundings in which they will be applied. In other words, the selected solution must be in harmony with local standards and values and build on existing skills and techniques. A new technology will not be embedded in a sustainable manner into an organization or community if dependence on the developers of the solution is high and the available resources (financial and human) for maintenance are expensive and scarcely available.

Finally, it is important that the added value of a new technology is not only visible to the policy makers and the implementers, but also to the potential end-users. The introduction of new technologies is often done through a push mechanism. With a larger agenda in mind, governments and national/international non-governmental organizations (NGOs) tend to impose the use of new technologies on communities. The introduction of ICT is doomed to fail when the added value is not clearly understood by the potential end-users.

The criteria as proposed by Darrow and Saxenian result in an appropriate design of the technology, but they fail to highlight the implementation process. Even Appropriate Technology can be abandoned by the potential end-users if the implementation process is not in line with the needs, expectations, and limitations of the community. It can also fail when the invoked changes are not guided in an appropriate manner. We will highlight this aspect in more detail in the next section where we concentrate on Appropriate ICT.

## **APPROPRIATE ICT**

The large-scale use of ICT in less-developed countries is new and strongly in development (McNamara, 2003). Until recently, the use of ICT in Africa had been limited to large international organizations and foreign NGOs. Foreign ICT experts had to be brought in for installation and maintenance (Bruggink, 2003) and for training beyond basic-level office applications (Heeks, 1998). Implementers had to fly to Europe or North America to receive training. Only 1 in 130 people in Africa own a personal computer (Jensen, 2002), and most people have never seen a computer. Over the last couple of years, this has begun to change rapidly (Levey & Young, 2002). The digital gap appeared on

the international agenda—and is often strongly linked, to amongst others, the eight Millennium Development Goals (MDG)<sup>2</sup>—and with foreign support, the first programs and projects have been set up.

In order to bridge the digital gap, information technology must be available and affordable for the “ordinary man.” Like in Europe, North America, and increasingly in Asia, everyone has access to computers and information almost everywhere and always. Not only in the large cities, not only the privileged class, but information technology must also be available for the population in the rural areas and for people with a lower level of education. This creates formidable challenges for the developers and implementers of ICT solutions.

Availability in this context is a multi-faced term: Availability not only depends on the existence of infrastructure and access, but to a large degree on the existence of human capacity. These capacities can be divided into three main groups: First its is all about affordability: ICT can only be appropriate where ICT systems and infrastructure can be procured at a reasonable price in a different economic setting than the west. Second comes usefulness: ICT only becomes valuable to people when useful local content is available. Therefore the capacity to create and maintain useful content for different sectors in appropriate language must be available. Third: end-user capacity: users must develop the capacity to understand and use the applications and the infrastructure.

Appropriate ICT should be perceived from two perspectives: the product and the process. The product perspective is concerned with the design of the ICT systems that will be used to offer information and communication services. This covers all aspects, including computers (and other connected electronic equipment), servers, networks, and connections. For example, in our approach, a computer setup that is to operate in a community in the African desert is not considered to be appropriate when it is not well protected against heat, sand, and dust. The product perspective is very much in line with the guidelines that were developed by Darrow and Saxenian (1986).

The process perspective is vital during the implementation process and has, up to now, received less attention. However, we are convinced that a mere technology-centric approach, even when rooted in

the principles of AT, will not deliver suitable ICT solutions that are embedded in the community and will be used by the potential end-users. We refer to the emerging, interdisciplinary fields of Social Informatics (Kling, 1999) and Community Informatics (Gurstein, 2000; 2003) to address the process perspective of our Appropriate ICT approach. Social Informatics concentrates research in three areas:

**Theories and models.** The development of models and theories that explain the social and organizational uses and impacts of ICT.

**Methodologies.** The development of methodologies that address the social impacts of the design, implementation, maintenance, and use of ICT.

**Philosophical and ethical issues.** The study of philosophical and ethical issues that arise in the use of ICT in social and organizational contexts.

Community Informatics constitutes a subset of Social Informatics with a focus on communities (McIver, 2003). Where Social Informatics has a stronger research focus, Community Informatics is more suitable for the development and implementation of ICT in less-developed countries (e.g., Vaughan, 2006). The community itself is involved in the adaptation of ICT to their purposes through advocacy, local information on available community resources and services, and community mapping for community planning and development (demographics, geography) (Gurstein, 2000).

The process perspective of Appropriate ICT needs to encompass a community-oriented and participatory focus to address the needs, expectations, and limitations in which the technology is to be used. So, if computers are introduced in the African context, the process of introduction should address the expected changes in the working practice, the impact of ICT on the knowledge levels, and how this can affect the relations in the community. To summarize, we define Appropriate ICT as follows:

*The integrated and participatory approach that results in tools and processes for establishing ICT that is suitable for the cultural, environmental, organizational, economic, and political conditions in which it is intended to be used.*

## **A FRAMEWORK FOR APPROPRIATE ICT**

In this section, we will go beyond the definition of Appropriate ICT and propose a framework that enables the design and implementation of ICT in less-developed countries. The framework is based on the traditional Systems Development Life Cycle that is used in Computer System development, but extends it with tools and approaches that will guide the ICT solution to appropriateness.

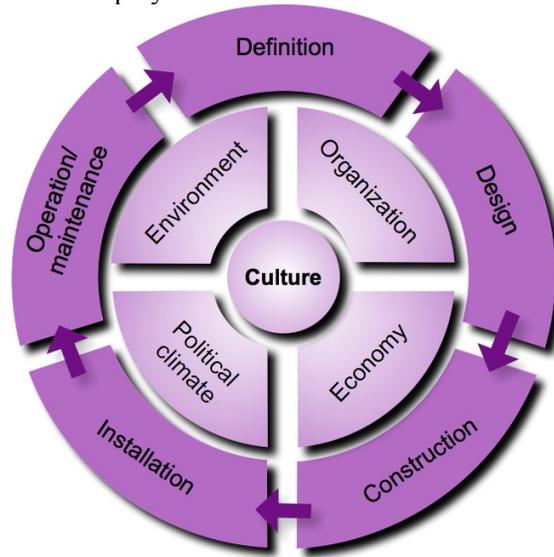
Systems Development Life Cycle (SDLC) comes in many types and flavors (Brandon, 2006), but we will adopt a basic five-phase model (Laudon and Laudon, 2005; Hoffer et al., 2006, Dennis and Wixom, 2000)

1. **Definition.** Determine the goals, scope, and requirements of the ICT solution
2. **Design.** Resolution of technical issues; selection of architecture and standards
3. **Construction.** Implementation of the design; testing and documentation of the system
4. **Installation.** Roll-out of the services offered by the systems to the end-users; training
5. **Operation/maintenance.** Problem solving, user support, and incremental improvement through monitoring and evaluation focusing on the use of the services by end-users

In the Appropriate ICT framework, the SDLC is supplemented with five specific focus areas that will guide the ICT tools and approaches to appropriateness:

1. *Culture:* Societies, or groups in a society vary in their sets of shared attitudes, values, goals, and practices. Culture deserves careful attention when ICTs are introduced in the development context (Westrup et al., 2003). We consider culture a central variable.
2. *Environment:* Physical conditions (heat, cold, dust, humidity etc) need to establish an important ICT solution design.
3. *Organization:* The structure of the organization (in the broadest sense of the word) determines the implementation strategy of systems both in the developed as developing world.
4. *Economy:* The current and future economic situation of a country, sector or organization should serve as a determinant in the ICT investment decisions.
5. *Political climate:* Some governments are more restrictive in their ICT guidelines than others. Openness is not always appreciated and some governments have 'partnerships' with hardware and software suppliers.

In figure 1 we have displayed the foundation of the Appropriate -ICT Framework: the SDLC on the outer ring and the five criteria that should be considered to design and implement appropriate ICT solutions on the inner ring. Culture is displayed in a central role.



**Figure 1: The Core of the Appropriate ICT framework: the SDLC combined with focus areas.**

Most of the methods to support the development of Appropriate ICT solutions are still under development or taken from traditional system development approaches. An integrated approach still needs to be developed further. In Figure 2, we have included some tools on the outer ring that have proven to be helpful in the development of Appropriate ICT. More tools and methods can be included as long as they are able to address cultural, environmental, organizational, economic, and political aspects of the ICT project.

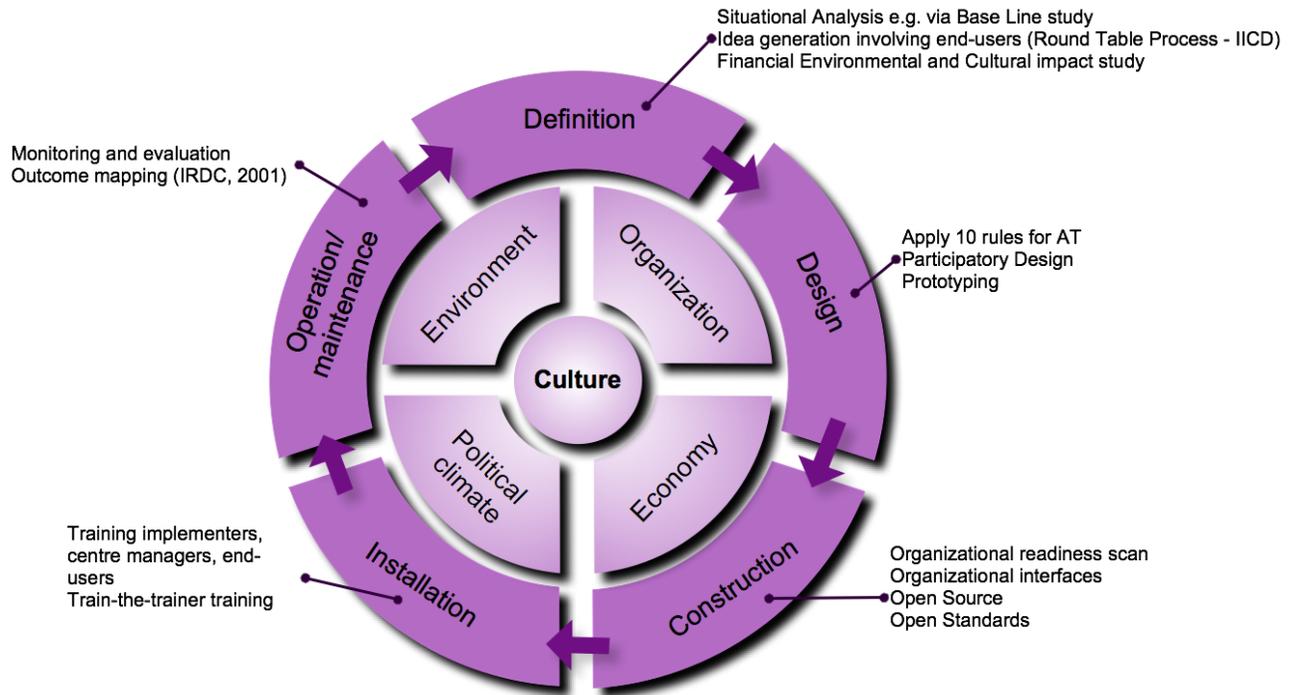


Figure 2: Some tools that are used in the Appropriate ICT Framework.

As mentioned earlier, Appropriate ICT should be perceived from two perspectives: the product and the process. Therefore, the Appropriate ICT framework needs to address three aspects: hardware, software, and change management. In the table below we provide examples of key questions that need to be answered to address the issues relevant in the Appropriate ICT framework. The questions in the table integrate the ten rules for AT and the focus areas of Appropriate ICT: culture, environment, organization, economy, and politics. The questions are structured along the phases of the SDLC: definition, design, construction, installation, operation/maintenance.

**Table 1: Key Guiding Questions for Appropriate ICT Development**

<b>PHASE</b>	<b>HARDWARE</b>	<b>SOFTWARE</b>	<b>CHANGE MGNT</b>
<b>Definition</b>	<p>Specific requirements in terms of climatological and environmental conditions?</p> <p>What are the enabling factors (Internet connectivity, electricity)?</p>	<p>What are the needs?</p> <p>What are the expectations?</p>	<p>What are the ICT knowledge levels?</p> <p>What are the financial constraints?</p> <p>What is the cultural context?</p> <p>What added value is created?</p> <p>How is the economic equilibrium affected?</p> <p>What new ways of working are introduced?</p> <p>What will be the impact in terms of organizational change?</p> <p>What is the involvement in the idea generation of key decision makers (political and religious leaders)?</p>
<b>Design</b>	<p>What is offered on the local market?</p> <p>What are the physical constraints?</p> <p>What are the financial constraints?</p>	<p>What interoperability is needed?</p> <p>What localization is needed?</p> <p>What flexibility is expected?</p>	<p>What are the information needs of the various target groups?</p> <p>How will these needs and expectations evolve?</p>
<b>Construction</b>	<p>What local skills are available?</p> <p>Is the equipment protected against physical conditions?</p>	<p>What local skills are available?</p> <p>Are features in line with skills?</p> <p>Are free and open source alternatives considered?</p> <p>Is the system well documented?</p>	<p>Are local skills and knowledge being developed?</p> <p>Are stakeholders actively involved?</p> <p>What new ways of working are introduced?</p> <p>What will be the impact in terms of organizational change?</p>
<b>Installation</b>	<p>Is the equipment protected against physical conditions?</p>	<p>Has the system been tested with all stakeholders?</p>	<p>Are all stakeholders involved in the training program?</p> <p>Is the added value made clear?</p>
<b>Operation / maintenance</b>	<p>Is local capacity sufficient?</p> <p>Are spare parts easily available?</p>	<p>Are software maintenance skills available?</p>	<p>Is a support organization in place?</p> <p>Is the support organization able to support all stakeholders (e.g., gender issues)?</p>

## **EXAMPLES OF THE APPROPRIATE ICT FRAMEWORK**

In this section we will illustrate the Appropriate ICT framework with some examples. We will describe the situation and explain how an Appropriate ICT perspective would change the design and implementation of the ICT solution. The examples are based on experiences by the authors in their respective activities in Africa.

### **Determine Appropriate ICT Requirements**

Determining requirements for ICT solutions has been a challenging issue in ICT4D projects. The most important reason being that the majority of the users and policy makers in less-developed countries have never been exposed to the actual use of computer to support their work processes. Their understanding of the capabilities of ICT is based on the media and hearsay in other projects. Expectations are high and often unrealistic. Project managers from development agencies, donors, or ICT consultants end up prescribing the solution based on their experiences in other projects. As a result, a larger number of the resulting ICT solutions do not address the needs of the target group and are, in other words, not appropriate.

Lack of proper communication and coordination instruments results in the initiation and execution of multiple, similar ICT4D projects in the same geographic area and/or the same thematic field. For example, in Kampala, Uganda, several organizations are supporting the set-up of telecenters or information centers to improve the access to information and communication in poor neighborhoods. At the same time, many of these initiatives fail to deliver services that are appreciated by the targetgroup, and most suffer from operational problems because of limited technical maintenance skills. Within an Appropriate ICT framework, these problems are identified and addressed.

### ***ICT for health in Tanzania: Determining Appropriate ICT requirements in the definition phase***

In recognition of the fact that ICT can offer important advantages to the health sector in less-developed countries and the fact that a large number of projects have been initiated over the past years,

the start of a new ICT for health program in Tanzania by IICD<sup>1</sup> was faced with a challenge. The chances of unwanted duplication of initiatives were high, and the need gaps for the sector were unclear. At the same time, it was noticed that the local ICT skills were minimal, especially in the sub-urban and rural areas. In order to address this challenge, it was decided to start the program with a health sector-wide initiation phase.

To determine the needs and expectations of the sector and to avoid duplication of projects, a participatory idea generation process<sup>3</sup> was initiated. This participatory idea generation process goes beyond that traditionally used in consultation processes and is more suitable to generate the requirements in the context of an Appropriate ICT framework. It uses the scenario development method to allow participants to identify priority areas for the development of their sector or organization. This avoids a technology focus. To bring all participants to the same starting level, a baseline study (situational analysis) is produced on the current status of the sector prior to the workshop. Thus, this process is a useful method of allowing participants to answer the questions from the initiation phase. The workshop is just one part of the overall process and gets a follow-up which allows the participants to develop and implement their own ICT projects.

During the workshop in Tanzania, the stakeholders were not only asked to express their needs and expectations of the program, they were also assisted in the generation of preliminary project and policy proposals that were shared with all stakeholders involved. Through a process of feedback and support, the stakeholders were able to generate ideas (such as using ICT's to create more opportunities for in-service training, access to information on outbreaks of diseases etc..) that were new, in line with the needs of the sector, and feasible in the context of the available skills.

Through the participatory idea generation approach, the sector has been able to generate a coherent ICT program for the health sector of Tanzania. The program now includes the following interrelated project areas:

1. ICT Policy for the health sector, supported by all stakeholders in the sector to facilitate a conducive environment

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<sup>1</sup> International Institute for Communication and Development: [www.iicd.org](http://www.iicd.org)

2. Capacity development for health workers through a continuous medical education program
3. Development of management capacity in both the public and private health sector
4. Development of ICT tools, based on Free and Open Source Software<sup>4</sup> and Open Standards for cost-effectiveness and to enable the development of national standards and avoiding reinventing the wheel all over again. For instance when projects on HMIS information were trying to identify a suitable solution it was discovered that the proprietary, commercial HMIS solutions used in the West were not appropriate since the required functionality was completely different. Since proprietary solutions can not be adapted to the needs in Tanzania it was decided to look for an open source HMIS platform. After careful selection Care2X was identified, which integrates data, functions and workflows in a health care environment. Currently the Care 2X software includes modules for amongst others patient registration, billing, laboratory results, pharmacy management, stock/inventory management, x-rays, doctors' office and ward management.
5. Information portal and low-costs internet connectivity services to enable especially health-units up-country to get the latest information on outbreaks, available treatments etc.

In fact the projects be classified according to their target groups: The ICT strategy is obviously targeting the **political level and the donor community**. The other projects are in fact all about capacity development: HMIS and Continuous Medical Education projects are about improving the access to and management of information and knowledge for better health care delivery by **health staff** while grassroots projects such as Health Child Uganda (see [www.iicd.org/projects/uganda-health-child/](http://www.iicd.org/projects/uganda-health-child/)) focus on improving the access to information for **patients and/or people in the community**.

This participatory idea generation approach naturally structured the definition phase, which takes into account the needs and expectations of the stakeholders. Political, cultural, and organizational issues were addressed in the process through elaborate peer and reality checking of the preliminary project proposals that were generated. Economic issues were covered less in the initiation phase, but financial feasibility studies were conducted before the design phase of the projects. Environmental issues were insufficiently covered in this phase and were addressed in the construction phase.

## **Designing Appropriate ICT**

Designing hardware, software, and network configurations that fit within the development context has been a major challenge over the past years. Unfortunately, in most cases, the solutions are founded in the European or American contexts and are not necessarily suitable for the development context. For example, hardware is not protected against the dust, sand, and heat of African countries; software needs an Internet connection to be activated or does not support local languages. Also, theories and tools for system development, such as the Unified Modeling Language (UML), have proven to be difficult to use in an African context. UML is a software specification tool. Essentially it is a graphical tool to support a specification of software. The symbols used are understandable for the target groups and support in this way the refinement of the requirements. Amongst western developers there seems to be a strong preference for using UML as a communication tool as opposed to as a basis for partial or full code generation. Many developers in the South complain that the graphical notations used by UML does not solve the communication problems at all. In various projects (by the IICD, University of Dar-es-Salaam, Tanzania and by Makerere University, Uganda) the authors experienced resistance while trying to talk prospective users through the use cases of a simple Information System. The graphical notations in the use cases are not associated with anything serious.

A carefully conducted project definition phase results in an outline of the needs, expectations, and possibilities for the ICT solution. In the design phase, creativity is needed to determine the specifications of the new ICT tool. The specifications need to address the context, not the other way around. We do not have to implement the complexity of Microsoft Word when the characteristics of a simple word processor like AbiWord are needed. Similarly, Wi-Fi equipment that is suitable for the European context, where large numbers of people operate in a large area, is not a suitable choice for Timbuktu, where a very limited number of people are using the connection in a large geographical area (Wireless Internet Institute, 2003).

*Designing a campus-wide ICT infrastructure in rural Uganda<sup>5</sup>*

Uganda Martyrs University is located 80 km from Kampala, the capital of Uganda. The university operates on a relatively small budget, but has been able to develop itself as the leading private university in the country. In spite of the financial limitations, the university administration decided that access to information technology and Internet is essential for the students and staff. Against this background, the university requested an ICT infrastructure that is low-cost (both in terms of initial and recurrent costs), and easy to maintain, but allows staff and students to access academic information and equips students with good ICT skills.

With the requirements in mind, the ICT department of the university developed, in collaboration with the external expertise, a plan for an ICT infrastructure based on the following:

- Open Source Software and Open Standards to keep costs for software low and avoid future license costs
- Re-use and upgrade of existing infrastructure through the implementation of a Linux terminal server project (Martindale, 2002)
- Elaborate capacity development to train knowledgeable ICT support staff and well-informed students and lecturing staff
- Bandwidth management to provide maximum access to research information while limiting non-academic information (pornography, music and film downloads, sports, chat rooms, etc.)

The ICT infrastructure was successfully implemented over the period from 2003 to 2005 and serves as a point of reference for other universities in the East African region that operate under similar conditions. The infrastructure has proven to be low-cost, and through the capacity development program, it is well-maintainable. The managed Internet connection provides important information for staff and students.

The project is a good example of the design phase of Appropriate ICT, since it has taken into account the specific local conditions of the university and the context in which the ICT was to be implemented. The economic requirements were addressed as well as the organizational aspects. The academic culture that was considered important was covered in the design of the network.

## **Implementing Appropriate ICT**

Introducing ICT in a rural setting has challenges from a product perspective (e.g., the robustness of hardware and software), but also from a process perspective. For example, introducing a system up-country without consultation and/or participation of local and religious leaders is doomed for failure. While citizens of urban centers are more or less used to modern ICTs, the rural population of SSA (Sub-Saharan Africa) is not; this population requires a step-by-step approach when introducing ICT solutions in a rural setting.

### ***Constructing and implementing a Health Management Information System in Uganda***

The Uganda Catholic Medical Bureau (UCMB) is the health office of the Roman Catholic Church in Uganda and is amongst others in supporting 27 rural hospitals. In 2004, the UCMB established a system aimed at improving the use of the national Health Management Information System (HMIS). The introduction of the HMIS is an example of an initiative in which ICTs are being used to improve management. Improved management is a necessity in a situation in which health sector funding in the global South are decreasing and, at the same time, health care delivery funding is changing from lump sum financing (in which hospitals just receive a fixed sum from central government) to a cost-based system (hospitals receive funding from government based on data such as number of patients, number of treatments). Therefore, more effective and efficient management procedures were the only solution to keep health services at an acceptable level.

The project addressed five prominent problems:

1. Unreliable information collection. Using the lengthy, labor-intensive HMIS forms was unreliable, incomplete, and inaccurate. The hardcopy forms had to be filled in manually, demanding hospital managers spend hours to correct for mistakes. Then, the data from the 27 hospitals had to be typed at the UCMB in order to create a digital record.
2. Slow feedback from the UCMB concerning the inaccurate information in hardcopy form provided by the hospitals. Backlogs of three to six months were not uncommon.
3. Insufficient human capacity (technical as well as managerial) in order to implement and use a proper HMIS.

4. A HMIS system at hospital level in fact supports decentralization. Therefore it is key to include users in the planning and implementation of the system particularly when deciding who is responsible and deciding who to train. And it is vital to show these users the results of their involvement. For instance creative feedback loops for data typists.
5. Change management: Changes will always threaten the status of persons. Therefore it is crucial to give medical staff the recognition for their important role in the organization so they realize that their importance will not change.

The proposed technical solution was simple and straightforward. Problem 1 was addressed first: The hardcopy forms were replaced by standardized spreadsheets (which were sent to the UCMB using regular postal mail). The organizational impact of this step was still small: The introduction of ICTs in an organization often starts by supporting manual processes with ICT applications. After this step, communication links between the up-country hospitals and the UCMB were set up to address Problem 2, while Problem 3 was addressed throughout the lifespan of the project by a massive training program addressing administrators and managers. The percentage of hospitals submitting complete and accurate HMIS forms eventually rose from 48% to 96% during project implementation. Moreover, the UCMB can now work much more efficiently, because it is no longer responsible for digital recording, thus allowing more time for analysis and feedback to hospital managers to enable informed decision-making. The feedback mechanism enables hospital managers to finalize their planning and budgeting processes in a timely manner. The impact of these steps from an organizational perspective was much bigger. For example, it allows managers—due to the timely, high-quality feedback from the UCMB—to base their decisions on an activity-based costing analysis.

At the start of the project, the rural hospitals had virtually no experience with ICT and the offerings of the different ICT suppliers were meager. The implementers constructed the project acknowledging the huge changes the project would invoke and chose a careful, step-by-step approach. The data collection and transformation went through the following phases over a period of three years:

1. **Data quality.** From hardcopy forms to standardized Excel spreadsheets which could be filled in using a computer

2. **Data timeliness.** From sending these Excel forms by normal mail to sending them as email attachments
  
3. **Managerial-level data use.** Implementation of a system which made it possible to link and analyze the HMIS output with a cost-based financial system, allowing hospital managers to implement an activity-based costing model in their hospitals
  
4. **Macro-level data use.** From sending Excel forms as email attachments to filling in online forms to allow UCMB and the 27 hospitals to generate quality information on trends, statistics. etc.

The project is a good example of the construction and installation phases of Appropriate ICT, since it has taken into account the enormous changes in the organizational structures and applied a step-by-step approach over a period of three years. The economic requirements were addressed (the hospitals took over the recurrent costs after a period of two years), as were the political aspects (involvement of religious leaders and the Ministry of Health).

## CONCLUSION

The need to bridge the digital divide is evident. No organization or individual will deny this fact, and donor support has been significant over the past years. At the same time, although progress is being made, it is being made too slowly, and in many cases, the progress has a very fragile basis (United Nations Conference on Trade and Development [UNCTAD], 2007). Other media like radio, television, and printed media also play a role in bridging the information gap, but ICT and the Internet offer the largest source of free information and allow easy distribution of local information.

The biggest challenge at the moment is to develop an ICT infrastructure, knowledge, and skills that provide opportunities for sustainable development. As we have discussed in this chapter this requires a change in perspective. The ICT for Development community has to shift away from traditional off-the-shelf solutions to a perspective where Appropriate ICT is being developed and used that fits into the context in which it is to be implemented. The ICT hardware, software, and change management needs to be aligned with the local cultural, environmental, organizational, economic, and political contexts in order to realize sustainable development.

The Appropriate ICT framework, as presented in this chapter, provides a guiding model to develop suitable ICT for less-developed countries. The model is based on existing theories in Appropriate Technology, Social and Community Informatics, and the System Development Life Cycle. As was illustrated in the examples, an Appropriate ICT perspective can make important shifts to the solutions that are being designed, developed, and implemented.

More expertise is needed in the design and implementation of ICT projects. We often encounter situations in which the complexity of ICT is underestimated. Project managers of ICT4D projects have little understanding of the possibilities of ICT and resort to the implementation of standard solutions that have proven their effectiveness in the developed world. Finally, the recipients in the ICT projects are left with hardware that is not designed for the harsh conditions, insufficient skills to maintain the software, or users who do not see the added value. The initial success and euphoria disappears as soon as the donor retreats. Donor agencies need to recognize that ICT projects require qualified expertise and cannot be left to general project managers.

With respect to the private sector, suppliers of software and hardware should be questioned critically on how their products fit in the local context. Plus, the private sector should acknowledge the business potential of developing specific hardware and software for the ICT market in less-developed countries. The success of companies like Cell Tell shows that there is a viable ICT market once the products are in line with the needs and the local circumstances.<sup>6</sup>

Also, governments need to continue their efforts to increase the penetration of ICT skills and infrastructure among their citizens, concentrating on the rural areas, while development partners should support more research

We recommend more research take place. So far, the academic world has shown very little interest in the development of theories and models that suit the developing world. Too often academics seem to believe that they are developing universal theories or models. Experiences with applications of these theories and models in the developing world show that they are far from universal and do not guarantee success. In other words, we challenge the academic world to develop a system development theory covering both the product and process dimensions. We challenge the academic world to further develop the model of the Appropriate ICT framework as initiated in this chapter.

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1 For a good attempt to adapt hardware design to the requirements of the environment is the design of the XO-computer (One Laptop Per Child project) at <http://laptop.org>. See also Kramer et al, 2009 on the challenges of the project.

2 For more details on the role of ICT in realizing the MDG, see [http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2004/09/15/000090341\\_20040915091312/Rendered/PDF/278770ICT010mdgs0Complete.pdf](http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2004/09/15/000090341_20040915091312/Rendered/PDF/278770ICT010mdgs0Complete.pdf)

3 The process was facilitated by the International Institute for Communication and Development (IICD). The organization uses the term “Round Table” to label a participatory idea generation process. For more details on ideas behind this process, see IICD (2004).

4 See Dravis (2003) and Reijswoud and Topi (2004) on the advantages of the use of Free and Open Source Software in the developing world.

5 For an in-depth discussion of this case study, see Reijswoud and Mulo (2007).

6 for more information see amongst others [http://www.globalclearinghouse.org/InfraDev/assets/%5C10/documents/Khalil%20-%20Evolution%20of%20Telecom%20in%20Emerging%20Markets%20\(2006\).pdf](http://www.globalclearinghouse.org/InfraDev/assets/%5C10/documents/Khalil%20-%20Evolution%20of%20Telecom%20in%20Emerging%20Markets%20(2006).pdf) and <http://arnic.info/workshop05/Waverman.ppt> and