

**Information and Communication
Technologies in Developing Regions:
Promoting Economic Opportunities**

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Introduction

Information and Communication Technology (ICT) is dramatically affecting many regions of the world. Economically, ICTs have created a new industry, increased the efficiency of all types of businesses, and opened up a new flow of information about economic opportunities. Socially, new online communities have formed, allowing people to interact without geographic constraints. Communication speed has increased with the advent of chat and email services. Information about government activity is more accessible, and it is easier for citizens to learn about government programs that impact them. Perhaps most striking is the fact that the Internet has just reached the point of a broad user base in the last 10 years, and its impact will only increase as innovators discover new ways to capitalize on the technology.

While ICTs are transforming some regions of the world, developing regions are removed from many of the benefits of the ICT revolution. Developing regions could also greatly benefit from ICTs, providing opportunities for growth while meeting basic human needs. This placement of technology is not only desired by the governments of developing nations, but is an explicitly stated goal of the United Nations, charitable organizations, and other international bodies. In addition, many people (including this author) feel that it is the responsibility of the privileged to help the poor and needy in the world. Deliberate action to install ICT infrastructure and research new technologies will accelerate the growth of ICTs that can meet people's needs. The goal of this research is to first investigate the needs that can be met by ICTs, survey existing initiatives seeking to use ICTs in developing regions and to develop a system to meet needs that are being missed by other initiatives. A set of principles for such a project will be developed to guide the design process. The research will conclude with a set of specifications for how the system will interact with all users, and make recommendations of the technologies that should be used to implement it.

The ultimate goal of this paper is to construct a design for using ICT practically, and in a specific region of the world. The end product depends on the many factors that

need to be considered: climate, culture, existing technologies and skill sets, etc. So in order to conclude with a system that could realistically be implemented, we need to specialize for a particular scenario. It is possible that generalizations could later be made from the design, but that cannot be the goal of the project. We choose to focus on African villages, particularly those in Cameroon that are under 100,000 people in population, but large enough to have a market. The author has traveled to this region, and observations made during the time there are helpful in envisioning applications that would be practically effective. Cell phones are common in this region. However, there is little use of computer technology. The larger population centers have Internet Cafes, but the villages only have scattered institutions (e.g., private schools) with small numbers of non-networked computers. This project will focus the use of computer technology in such a region.

Review of Current Work

Developing regions lack the opportunities, freedom, and standard of living that the rest of the world enjoys. There is a range of needs that could be addressed to help reduce this disparity, and alleviate the conditions of the disadvantaged. Efforts toward human development are intended to advance several goals for all people: healthy, long lives; knowledge and education; happiness and leisure; freedom and opportunities for improvement; and social justice. To this end, the MS Swaminathan Research Foundation [1], the United Nations Human Development Report [2], Reddy [3], Rao [4], Wunsch-Vincent [5], and the Organisation for Economic Co-operation and Development (OECD) [6] have identified a series of more tangible needs that should be addressed to help achieve these goals. The OECD's examination of how ICTs can meet development goals is particularly helpful. Included below are examples for each general type of need, with some specific examples that lend themselves toward a solution that can be met by ICTs (see Table 1).

Education

- Distance learning/classes
- Prerecorded lectures
- Digital libraries
- Send assignments for correction/feedback
- Enhanced classroom education
- Train teachers
- Teach students technical skills

Information

- News, weather
- Voter awareness (supports democratization), anti-corruption
- Religious
- Government programs
- Historical information
- Agricultural “best practices”
- Travel information

Communication

- Email
- Dating/marriage service
- Social networking
- Contact information (e.g., white pages, yellow pages, government offices)
- Forums
- Feedback to government

Economics

- Publish employment opportunities
- Exchange market information (prices, supplies)
 - Useful for policy makers and market participants)
- Connect importers and exporters
 - Take advantage of outsourcing from wealthy nations
- Online banking

<ul style="list-style-type: none"> • Advertising • Price listings for government services (helps detect overpricing and corruption) • Marketing assistance (auctions and online shops) • Coordinate infrastructure development • Online shopping • Increase efficiency of companies
Health
<ul style="list-style-type: none"> • Determine medication needs and arrange trade/delivery • Communicate for remote diagnosis • Retrieve accurate information about diseases and treatments • Exchange data to monitor disease and famine • Provide online drug libraries and connect pharmaceutical companies to needs
Leisure
<ul style="list-style-type: none"> • Entertainment media • Local entertainment; information about culture and cultural events • Video games

Table 1: Needs of developing regions.

While we are very excited about the potential ICTs have to meet these needs, we must also maintain a realistic perspective. Our excitement about technology should not overshadow the practical considerations, such that we invest money in technologies that are ineffective. As ICTs are applied to address needs, they must be accompanied by a holistic approach to development. Improving banking and financial systems, transportation infrastructure, and political stability are all equally or more important to the development of a region. There is a consensus among development organizations that ICTs have a role that can contribute powerfully to progress [4], but they depend on, and should be complemented by, non-technical development efforts.

Academic institutions are beginning to direct their research towards applications for the developing world. UC-Berkeley has a project looking into Distributed Searchable

Caches that are designed to speed Internet access, or provide access to parts of the Internet even when disconnected from the Internet as a whole [7]. A research group at Princeton has generalized this idea, working on a system that transparently provides network service by transferring data via media sent through the postal system [8]. In investigating these very practical ideas, the researchers address interesting computer science problems. At Carnegie Mellon University, Reddy is working on prototyping his “PCtvt,” a multifunctional device designed to be mass-produced and affordable for a broad range of people [9]. Such a device is a technical challenge, but key to his ambitious goal of ubiquitous ICT for people in developing nations [3]. Reddy also recognizes the social challenges in designing this device, considering the need for a simple interface and accessibility through the local language. Local content that is relevant to users is wisely emphasized. Reddy seeks to place technology in the hands of everyone, a goal requiring massive mobilization, funding, and training, but potentially being very fruitful.

Many development organizations are also working on applications for ICTs. Shekar and Borgaonkar are developing a “Script Mail” system that is designed to ease communication. It provides the speed of email, with the convenience of allowing users to write their message in script. The project does a good job of prioritizing ease of use, so that the end product will be accessible to the targeted users. The Initiative for Central Africa has used technology for communication as well, but by building networks that facilitate collaboration between development agencies, the government, and the end users. This sort of feedback is important in determining the efficacy of ICTs in promoting development and directing how money and energy should be expended. In addition, such networks provide feedback to the government about conditions in their country, helping them to set appropriate policies (e.g., setting economic policies according to market conditions).

Many projects have focused on the use of shared Internet terminals, providing access to the masses. Some envision Internet Cafes that provide income to their owner while charging for access; others aim to deploy networked computers free for anyone to use [10]. While this is a good goal, and worthy of some energy, it will take a long time to

realize. In addition to acquisition costs, and installation of supporting network infrastructure, there needs to be continued maintenance and training for people to use the computers. This takes time, and an ideal strategy takes advantage of ICTs immediately. A more limited and focused deployment could be achieved quickly, and begin providing benefits that meet needs while laying the groundwork for more extensive projects.

Throughout the design and implementation of any ICT, the interaction between culture and technology must be carefully considered [4]. ICT will impact the culture where it is introduced, and the local culture will constrain and impact the way that the technology functions (or fails to function). Hence it is very important that any ICT effort seeks to fit in with the local culture. Applying technology in the same way that has worked in Western nations may simply fail in developing regions. For instance, in cultures where visiting someone at any time is commonplace, we will likely not have the same priority on privacy that exists in the United States.

As evidenced in the long list of needs identified for developing regions, there is a huge space for work that can improve the life of billions of people. For the purposes of this design project, we choose to focus on economic development. The Institute of Information Studies (among others) identifies the theme: creating a market-friendly environment through ICT [11]. ICTs have already been markedly effective at this in Western nations, with everything from a boom of Internet shopping over the World Wide Web to email as a means for connecting the poor to economic opportunities [12]. So this project will seek to encourage the functioning of markets in a developing region – specifically, mid-size villages in Cameroon. (Okpaku provides a helpful survey of the status of ICTs in Africa [13].) Promoting a market-friendly environment goes beyond just the local economy; we also seek to promote participation in the global economy to take advantage of larger markets. In addition to promoting the functioning of the economy through local content, the information gathered and exchanged will be useful in analyzing the markets. Development organizations and the national government can use this data to help set economic policy and determine ways to expend their limited resources. Having noted the importance of considering culture, we seek to design a system that will fit with

and capitalize on existing cultural constructs. Rather than pursuing an extremely ambitious goal that requires large investments of capital and would not be deployed for some time, we envision a few computers in each village connected by a network (although it may not be constantly online). The individual computers and entire system will be designed to encourage market activity through the exchange of information. It is intended to be a very practical design, that could rapidly be deployed and begin reaping benefits in a short period of time.

Principles of Design

The preceding discussion yields several principles that we hold as vital in the design process (see Table 2). Bearing in mind these principles, we will start with the needs we have chosen to address, move to goals for this design, and then develop requirements for the system. The interface for all users will be specified, addressing appropriate questions of ease-of-use and cultural norms. We will then make some suggestions about effective implementations, although this will not be the focus of the paper as the engineering body is relatively good at implementing a given design. That said, special attention will be made to areas of the design that may be difficult to implement with existing technology and may require development of new technologies. The focus of this project is on the design issues in developing an effective system, which the engineering community often neglects to give due consideration. The nature of this project requires the synthesis of knowledge in many fields, including public policy, anthropology, economics, and computer science.

Culturally sensitive	Fits with the local culture
Sustainable	Profitable for local owners; self-maintaining
Low cost	Easy to get a system started quickly
Simple	Doesn't require extensive training
Flexible network	Effective with intermittent network connectivity
Scalable	Expandable to incorporate more hosts and features

Table 2: Principles of design.

Cultural sensitivity goes beyond merely designing a system that will be effective in a different culture. Our goal is to improve the quality of life in developing nations. In pursuing this goal, we should be careful not to degrade the optimism or confidence that people have in their ability to achieve a goal. We should avoid attitudes that degrade people as backward and inept, and instead frame the development efforts as *their* project [14]. They should feel that without their efforts and sense of responsibility that the project will fail; and they should feel that they are getting concrete benefits from its existence.

As a final method of developing design principles, it is helpful to consider a success story. Cell phone usage has boomed in developing countries such that 56% of all cell phone users are now in these regions [15]. Clearly mobile phone companies have created an effective approach to introducing the technology. There are several lessons to be learned from this approach. So, what has made cell phones such a success?

Cell phones provide freedom from the infrastructure. Instead of requiring more land lines to be installed, they allow technology to leap past an older generation of technology. There is no reason that developing regions should have to introduce new technologies in the same manner and fashion as Western countries have. The mobile nature of the phones freed them from the unreliable power grid. Mobile phone companies were also wise in their expansion practices. Rather than holding onto the Western billing patterns, they adopted to the conditions in the developing world. Most people do not have bank accounts. Therefore, billing based on disposable calling cards is used. Once a phone is purchased, the customer only pays for the calling cards that they can afford. Furthermore, it only costs to place outgoing calls. Unlimited calls can be received for free. So merely possessing a phone is useful, if friends or family wish to call. Mobile plans in the West charge for all time on the cell phone, a practice that may make poor people wary of possessing a phone. In Cameroon, mobile phone companies offered to install cell phone towers in any village that can get 100 people to commit to purchase phones. This ensures that there is sufficient interest in the technology before making a significant investment. Finally, communication with friends and family is an important

aspect of the culture of Cameroon (and as the statistics suggest, much of the world too). This creates the underlying desire for phone technology, and mobile phones provide a practical outlet for this desire.

From these observations, we make several specific suggestions to apply to our computer network for market information. In light of the calling card pricing model, posting and browsing market information on the network should be completely free. A charge is generated only if a transaction is conducted. Villages in which the system is introduced should have several businesses who are interested in using the network to exchange information. In this way, we guarantee a certain level of usage which should boost the system over the threshold which makes it worthwhile for general use. Perhaps certain companies or shops would commit to market their goods on the system, and certain import and export firms might post information about goods desired for sale abroad and imported goods that they can offer. The market information system should not rely on constant network connections, or even reliable power. Periodic network connections should suffice as updates, and printouts should be used to provide functionality even without power (also allowing multiple people to browse information away from the computer). Finally, the system can fit with local models of commerce by using shopkeepers as a hub of trade. In browsing the information on the market, the data could be presented as a virtual marketplace. This would permit browsing for various goods while grouping products in a way that would be natural to clients using the system.

Project Goals

The project design will focus on three specific economic needs in an effort to increase the efficiency of markets. In particular, we aim to exchange information about the prices of good and services, import and export opportunities, and employment offerings. The system will also contain mechanisms for communicating, providing static information (i.e., not updated regularly), and advertising. This will be done by emphasizing the shopkeepers in town as a hub of information and commerce, offering them incentives (e.g., advertising rights and increased customer flow) for distributing and

exchanging economic information. It is hoped that computers can help shopkeepers manage customers' trade interests, and connect people with trades in other locations.

Shopkeepers should keep track of their customers, and update each person's reputation according to his or her faithfulness to sale agreements. The reputation of the party is then included with future offers that are distributed on the network. A reputation mechanism is an important component of the overall system. Since the judicial system in developing regions is often weak, there is little legal protection to people from fraud and cheating the system. As Bakos describes, online reputation mechanisms can provide the same sort of protection for commercial transactions as legal systems do by creating incentives for good behavior [16]. He argues that reputation systems provide an alternative that is as efficient as litigation. When the legal system is weak, the advantages of reputation mechanism become even greater. For this reason, a reputation mechanism is integrated into the design so as to minimize cheating without relying on governmental enforcement.

The shopkeeper is the perfect party to establish the identity assigned to each transaction; no one else would be as familiar with the local population, and especially customers. If the shopkeeper does not already know the customer, then he or she could use a government-issued card to verify the customer's identity. Cameroon, and most developing, countries require that each person has such a government ID. There should be a period of training to orient all the shopkeepers to the system. By first training the shopkeepers and then setting up economic incentives for their continued contributions, the system will be self-sustaining once it is set up.

In terms of practical goals, we would like to install the equipment in a dozen villages in Cameroon. Funding sources would be provided for the initial installation and training. Government support is crucial, so that the government promotes operation both at a national level and in local offices. In fact, government bureaus may use the system to gather information and improve their work. Finally, a useful application of computers should encourage people to invest in training and expansion of ICTs.

Specification of Interfaces

To describe the operation of the system, we specify the manner with which it interacts with the pertinent parties. There are two primary interfaces: the “customer” and the “shopkeeper.” Customers are both buyers and sellers who use the system, and the shopkeeper is the local manager who administers the computer network. Technicians may be necessary, but they play a more minor and straightforward role, so we do not specify their interaction with the design explicitly. We abstract away from the network connection, assuming only a daily, high-bandwidth connection. The features of the primary interfaces are show in Table 3. This interface specification is not exhaustive, but rather clarifies the primary interactions that take place.

Customer
<ul style="list-style-type: none"> • Printouts are available from the shopkeeper’s computer <ul style="list-style-type: none"> ○ Include employment, import/export, and pricing information ○ For each, lists: picture, description, contact name & reputation, price, and location ○ Includes advertisements managed by the shopkeeper • To post an offer to the network (shopkeeper assists with entry into computer): <ul style="list-style-type: none"> ○ Take picture with digital camera, or select from a list of common images ○ Specify description, contact name, and price ○ Specify a minimal reputation necessary to agree to a trade ○ Pre-deliver product to the shopkeeper for special reputation marking • To complete a settled trade <ul style="list-style-type: none"> ○ Receive notification of settled trade from the shopkeeper ○ Deliver good to shopkeeper (within short period of time), if good was not pre-delivered ○ Pickup money from sale after the purchase (within a certain period of time) • To buy from an offer on the network <ul style="list-style-type: none"> ○ Identify a desired good

<ul style="list-style-type: none"> ○ Notify shopkeeper of purchase agreement (good goes off the market) ○ Travel to remote location within certain number of days ● To pick up a purchase <ul style="list-style-type: none"> ○ Identify self to shopkeeper ○ Purchase good for a pre-settled trade (portion of money goes to shopkeeper) ● Note prices in other villages, travel there independently to buy or sell goods at superior prices
Shopkeeper
<ul style="list-style-type: none"> ● Upon customer settling on a trade <ul style="list-style-type: none"> ○ Log entry into system and take good off of the market ○ Verify and record buyer identity ○ Notify the seller of a settled trade ● Upon a customer picking up a trade <ul style="list-style-type: none"> ○ Log purchase into system, and collect money (keep a portion as profit) ● Upon a seller posting an offer <ul style="list-style-type: none"> ○ Enter necessary information into computer ○ Assist with picture, ensure completeness of data ○ Verify and record seller identity ● Upon a seller delivering a good <ul style="list-style-type: none"> ○ Store for pick-up from a settled purchaser ● Upon a seller picking up funds <ul style="list-style-type: none"> ○ Deliver sale price (minus shopkeeper's portion) to the seller ● Upon buyer failing to pick up an agreed upon purchase <ul style="list-style-type: none"> ○ Mark down the buyer's reputation ● Upon seller failing to deliver a good (or delivering an inferior product) <ul style="list-style-type: none"> ○ Mark down the seller's reputation ● Periodically (at least daily) connect to the network to update information ● Periodically (at least daily) produce new printouts with market information

Table 3: Features of the primary interfaces.

The goal of this project is to produce a design, not to be concerned about the implementation. Sufficient programming work can create a reasonable solution for just about any given set of requirements. It is more difficult to determine an effective design for this specialized application than to find a way to make the technical realization work.

Future work

There is much future work to be done, and this design project will continue for another semester. As the design finalizes, efforts will be shifted to implementation and seeking funds to launch a pilot system in a developing country. Many aspects of the system will need adjustments after getting real feedback on how people interact with the system. Future work should include input from economists, computer scientists, development groups, and people familiar with the target culture and environment. The efficacy of the reputation system in particular will need testing. It has been documented by Bakos [16] as working in Western cultures, but a different view of the importance of reputation may significantly impact its effect in a different culture.

Several ideas are particularly worth investigating as applicable to the market information networking system. As noted in the report, cell phone usage is becoming common in developing nations. Cell phones may play an important role in supporting the system, particularly in settling trades via phone to ensure that no changes have been made since the last update with the network (assuming intermittent network connectivity).

Shopkeepers are given a powerful and significant role in this design. Yet this system will simply position them to expand into even more services. In particular, they may provide Internet services to local people (independent of the market information network), serve as financial brokers and extend into the banking industry, or start shipping services that handle the transportation of goods. These benefits should be communicated to shopkeepers interested in helping implement the system, and serve as incentives for them to join the project. Care must be taken to find honest shopkeepers,

while also setting up some monitoring and feedback systems to detect shopkeeper corruption.

Conclusion

While this market information network was designed specifically for Cameroon, many aspects of the design apply to developing regions across the world. Before applying such a project to any region, extensive visits and consultations with the local people should be conducted. Only after incorporating this feedback can a design by foreigners be effective. After an initial pilot installation, the system could be expanded to include more villages. As it expands, it will just become more productive and worthwhile for the consumers, further promoting its use.

References

- [1] M S Swaminathan Research Foundation. "Information Village Research Project (IVRP) Union Territory of Pondicherry."
<http://www.mssrf.org/informationvillage/infovil.html>.
30 September 2004.
- [2] "What is Human Development." Human Development Reports.
<http://hdr.undp.org/hd>. 8 October 2004.
- [3] Reddy, Raj, et. al. "Sustainable ICT for Emerging Economies: Mythology and Reality of the Digital Divide Problem." NSF-UN-World Bank conference on Technologies for Sustainable Development. <http://www.rr.cs.cmu.edu/ITSD.doc>. 16 February 2004.
- [4] Rao, Madanmohan. "Visions of the Information Society: A developing world perspective." <http://www.itu.int/osg/spu/visions/papers/developingpaper.pdf>. 16 June 2003.
- [5] Wunsch-Vincent, Sacha. WTO, E-commerce, and Information Technologies: From the Uruguay Round through the Doha Development Agenda. Report for the UN ICT Task Force. Markle Foundation.
http://www.markle.org/downloadable_assets/wto_e_commerce_10.20.04.pdf. 20 October 2004.
- [6] OECD. "How ICTs can help achieve the Millennium Development Goals." Integrating ICT in Development Programmes: Meeting Documents.
<http://www.oecd.org/dataoecd/54/4/2500199.xls>. 2 June 2003.
- [7] Brewer, Eric. "Global Visions for Local Technology." Forefront. University of California, Berkeley. <http://www.coe.berkeley.edu/forefront/images/fall2004.pdf>. Fall 2004.
- [8] Wang, Randolph, et. al. "Turning the Postal System into a Generic Digital Communication Mechanism." Proc. of ACM SIGCOMM 2004.
<http://rywang.cs.princeton.edu:8000/distance/sigcomm04.pdf>. August 2004.
- [9] Reddy, Raj. "PCtv: a Multifunction Information Appliance for Illiterate People." ICT4B retreat. <http://www.rr.cs.cmu.edu/pctvt.ppt>. 26 August 2004.
- [10] Badshah, Akhtar, Sarbuland Khan, and Maria Garrido. Connected for Development: Information Kiosks and Sustainability. United Nations ICT Task Force.
<http://www.unicttaskforce.org/perl/documents.pl?do=download;id=563>. 14 May 2004.
- [11] Institute for Information Studies. The Emerging Internet. Nashville, TN: Nortel. 1998.

[12] Kahin, Brian and James Keller. Public Access to the Internet. Cambridge, MA: MIT Press. 1995.

[13] Okpaku, Joseph O. Information and Communications Technologies for African Development: An Assessment of Progress and the Challenges Ahead. United Nations ICT Task Force. New Rochelle, New York: Third Press Publishers.
<http://www.unicttaskforce.org/perl/documents.pl?do=download;id=408>. 3 June 2003.

[14] Wicklein, Robert C. "Design Criteria for Sustainable Development in Appropriate Technology: Technology as if People Matter." University of Georgia.
<http://www.iteawww.org/PATT14/Wicklein.pdf>. 29 November 2004.

[15] CNN Technology. "Report: Mobile phone users double since 2000." Reuters.
<http://www.cnn.com/2004/TECH/ptech/12/09/telecoms.phones.reut/+cell+phone+usage+worldwide+itu&hl=en>. 9 December 2004.

[16] Bakos, Yannis and Dellarocas, Chrysanthos N. "Cooperation Without Enforcement? A Comparative Analysis of Litigation and Online Reputation as Quality Assurance Mechanisms." MIT Sloan Working Paper No. 4295-03. <http://ssrn.com/abstract=393041>. March 2003.