

A Preliminary Investigation into the Implementation of ICTs in Marginalized Communities

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Abstract—We live in a society where there is a growing gap between the privileged and the underprivileged. A recent contributing factor to this separation is the communities' ability to access, contribute and participate in the global knowledge economy. This paper outlines both our current and future research to implement ICTs in a marginalized community, paying detailed attention to the networking and telecommunication infrastructure that is required to bridge this gap. We also describe the other contributing factors to the successful acceptance of ICT by the community: training, software, tailor made services and culturally sensitive applications.

Index Terms— Sustainable Development, Information and Communication Technology, Telecommunications Infrastructure, Information Society Technologies.

I. INTRODUCTION

The “digital divide” is a term coined in the 1990s referring to the growing gap between those who have access to Information and Communication Technology (ICT) facilities and those who through social, economic, or geographic reasons have limited or no access to such services. Since this time, there has been mounting concern by researchers, government, as well as businesses to bridge this divide. The “digital divide” is considered particularly important as researchers are concerned that it will exasperate pre-existing inequalities [9, 18].

In this era, information has become the latest currency, where a community's ability to access up to date information defines their ability to participate in the global economy. Accascina [3] goes so far as to define poverty as including the deprivation of information to effectively participate in the wider society, at the local, national or global level. As well as being able to access information, members of marginalized communities require access to communication facilities to enable the information to be continually updated and make communication between geographically dispersed individuals possible. ICTs are an effective tool to support marginalized communities as they allow the continual flow and transfer of information. ICTs allow these communities to create, preserve, codify and communicate their information within a global context.

This paper describes the initial steps that have been undertaken towards the implementation of an information society in Dwesa. The work falls into an overarching project being run jointly between University of Fort Hare and Rhodes University to investigate the application of ICTs in marginalized communities. The primary objective of this project is to develop and field-test the prototype of a simple, cost-effective and robust, integrated e-commerce / telecommunication platform, to deploy in marginalized and semi-marginalized communities in South Africa, where the majority of the South African population live. These communities, by sheer size and because of current political dynamics, represent a strategic emergent market. This research is also applicable to other countries, where approximately 675 million people live in similar marginalized communities [4, 5].

The second objective of this project is to build technically skilled human resources in the field of e-commerce, particularly, but by no means only, in the context of supporting e-commerce activities in marginalized and semi-marginalized communities. This activity is designed to stimulate and catalyze entrepreneurship in these communities.

This paper consists of six sections. The first section motivates the need for ICTs in marginalized communities. The second section provides a review of existing work designed to tackle the “digital divide” that exists between communities. The third section provides a brief description of the Dwesa/Cwebe region where this investigation is taking place. The fourth section details the ICT infrastructural technologies and techniques implemented in Dwesa. This is followed in the fifth section by a discussion of planned extensions to this infrastructure that will take place in subsequent years. The final section provides some concluding remarks.

II. RELATED WORK

A popular technique used in addressing the digital divide is referred to as minimally invasive computing, that installs computers in marginalized communities with no training and allows community members to learn how to interact with the computers themselves. Using this technique the computers are installed and left to the users to train and educate each other. Hole in the Wall [13] is one of the most recognized projects designed to increase mass computer

literacy. The goal of this India-based project is to produce basic computer literacy within the low socio-economic users of the system. In completing this project, researchers install basic computers fixed with a mouse and keyboard into a “hole in the wall” to protect them from vandalism [6]. The computers used within the project run standard software (for example: Microsoft Windows), so users can apply the computer skills they learn through this project to the other computing scenarios.

Digital Doorway [10] is another project that is based on minimally invasive computing. The first ‘Digital Doorway unit’ was installed in the remote Cwili Village in the old Transkei in South Africa in November 2002. Since then, over 24 more installations have been made throughout South Africa. As with Hole in the Wall, Digital Doorway findings exceeded all expectations, with children teaching themselves how to use a computer without any formal instruction.

BingBee [17] is an information kiosk that is designed to be deployed in low socio-economic areas in South Africa to help improve education levels in underprivileged children. It has a novel aspect, that it is fully contained behind a shop front window. For this, BingBee uses a novel contactless technology that provides direct finger tracking from within a shop front. Unlike the Hole in the Wall and the Digital Doorway projects, BingBee does not support traditional mouse and keyboard input. Instead, BingBee is more concerned with educating through entertainment, and as a side effect, increasing user’s familiarity with computing devices rather than focusing solely on improving users computing skills.

Another project that focuses more on improving education levels and computer skills around the world is the International Education and Resource Network (iEARN). iEARN [7] is an online strategy for educating young people (ages 5-19) around the world. Currently more than 400,000 students in over 95 countries are connecting to the network, undertaking collaborative projects that enhance learning and address global issues [12]. It addresses three main concerns: building bridges between cultures, improving education, and making a difference in the world. All content is delivered through the internet, providing equal access to information across the globe. As part of the network, learners are able to improve their computing skills as well as gain an adequate education.

III. DWESA / CWEBE REGION

Dwesa / Cwebe is a coastal region located in the previous homeland of the Transkei in the Eastern Cape, South Africa. It has an estimated population of 15000 people living in 2000 households. The inhabitants of Dwesa/Cwebe are traditionally subsistence farmers who depend on their crops for their livelihood [14]. Figure 1 shows a typical Dwesa / Cwebe homestead. The region features a coastal nature conservation park which is owned by the community around a reserve and a hotel. The region has a high potential for eco and cultural tourism due to the rich cultural heritage and the marine conservation project undertaken at the nature reserve. We consider the Dwesa / Cwebe region to be ideal to take advantage of the global upsurge in eco-tourism

activities.

The Dwesa / Cwebe region comprises of two distinct communities. The Dwesa people on the southern side of the Mbashe River, and the Cwebe people on the northern side. This delineation is not only geographical, but extends to the philosophical outlook on the underlying world views of the two communities [14]. This introduces an interesting cultural dynamic, with the Dwesa community being more educated and open to change, and the Cwebe community representing a more traditional and static culture.



Figure 1 Dwesa / Cwebe region

From a political viewpoint, Dwesa / Cwebe is only the second successful land restitution claim case in South Africa, and the first in the Eastern Cape. We believe that it is therefore an ideal location to use as a testbed for the implementation of ICTs in marginalized communities.

Like most marginalized communities, Dwesa / Cwebe suffer from major infrastructure problems including limited electricity availability and connectivity, minimal telecommunication infrastructure, poor quality of the transport infrastructure, and most importantly, sub-standard education facilities. The schools that do exist are also under-funded, under-equipped, and under-staffed. Figure 2 is an example of such a school in the Dwesa region, which even lacks basics such as a roof.



Figure 2: Ntubeni School in Dwesa region

ICT holds the promise of providing a solution to most of these problems through e-commerce portals, e-learning solutions, e-government services and e-health applications. A simple, locally maintained e-commerce platform can be

implemented to market the region globally, and facilitate the resultant business transactions to take advantage of the international increase in eco-tourism activities. Likewise, e-learning solutions (for example: learning management systems, content authoring tools, iEARN) can be implemented to remedy the sub-standard level of education. As previously mentioned, a community's ability to access up to date information defines not only their ability to participate in the global economy, but also to participate at a national level. e-government services enable and empower individuals to engage in these responsibilities. Because of the geographic locations of these marginalized communities, it is typical that the health facilities are of a lower standard than what can be found in urban areas. e-health applications can provide health workers in marginalized communities with access to tools and information to improve their health service delivery.

The next section describes the current implementation of ICT facilities to enable the provision of the above-mentioned e-services in Dwesa.

IV. CURRENT SITUATION

The current deployment of ICT infrastructure in Dwesa has been concentrated around schools which provide a centralized location, accessible to many villages. This allows us to piggy back on existing societal structures which facilitate community acceptance, buy-in, and eventual ownership of the infrastructure. Another important benefit of locating computer laboratories in schools is that they are already fitted with electricity.

This project can be seen to have two primary concerns: firstly the provision of computing infrastructure and secondly the development of ICT skills. Although these concerns will be discussed separately, we understand the importance of providing both to the community concurrently. Training without the availability of basic computing infrastructure (for example computers, software, peripheral devices) lacks practicality as learners have no previous experience with computers. Similarly, computing infrastructure without training leads to under-utilization of these facilities. The remainder of this section discusses the infrastructure and training aspects of the project.

A. Computing Infrastructure

The current rollout of the computing infrastructure in Dwesa comprises of four desktop computers (see Table 1 for specifications). Although a 40GB hard disk would suffice for Small Office/Home Office (SOHO) usage, it becomes inadequate for whole community usage. Due to this hard disk size limitation, key users of the computing facilities (in particular teachers at the Mpume School where the computer lab is housed) have been issued with a flash disk for storage purposes. There has been an impressive uptake of this idea by the community, with the flash disk becoming a common accessory amongst the teachers.

To maintain low costs, all software installed on the computers is Free/Open Source Software (FOSS). This not only helps us as researchers, but also means that if community members acquire computers, they can install an exact image of the software available on the desktop

computers at minimal costs. Table 1 provides an overview of all software that is installed on the desktop computers. Computers use the Edubuntu Linux distribution that is designed in particular to be user friendly to young users. As well as including all software found on typical Ubuntu installation, the Edubuntu distribution also includes educational software such as GCompris and the KDE education suite [8].

As described in Section III, marginalized communities are typically characterized by underdeveloped infrastructure. This includes both public and school libraries. To ensure students and community members have access to information resources, we have installed an offline version of Wikipedia and Project Gutenberg onto desktop computers. Wikipedia is a free, online encyclopedia that is written collaboratively by its readers [2]. Offline versions can be downloaded and installed on desktop computers showing the current state of the encyclopedia at the time of download. Project Gutenberg is a collection of 18000 electronics books that are no longer under copyright [1]. Users can browse through a catalogue and search for books of interest. Once found, the book can be read or printed from the computer at no charge.

Client Machines	Specifications
Hardware	2.67 Intel Prescott Celeron 512 MB DDR 40GB SATA HDD Sony 52X CDROM
Software (FOSS)	Edubuntu educational software – games, learning suite Wikipedia – offline version SchoolTool Project Gutenberg

Table 1: Dwesa desktop hardware and software specification

We are currently in the process of developing an e-mall to be deployed in Dwesa. This will allow local entrepreneurs to own and administer an integrated e-shop within the e-mall. A novel component of this architecture is an online user driven, music recording facility. This service enables the community to codify audio indigenous knowledge with the possibility of selling it online. Preliminary tests on this service within the Dwesa community have returned favorable results. Community members were interested in the concept and the prospect of having their music and cultural artifacts preserved. Their enthusiasm was illustrated by the willingness of a local music group to rehearse for a whole week in preparation for one day of recording.

B. Training

The second concern of this project is to develop ICT skills within a community. As previously mentioned, computing infrastructure without training will lead to the under-utilization of the facilities. Our current technique for training the Dwesa community is to first train teachers at a local school. During this process we identify "champions" who learn quickly and seem excited about the use of

computers within their area. This step is crucial to the success of subsequent training sessions, as the champions will later act as the trainers for other community members. Extra help and lessons are provided to these champions to ensure they are proficient enough in the skills they have learnt to be able to pass this information onto other community members. We have chosen to involve community members instead of outsiders in educating the majority of the community to firstly enable the community to continue when we are not available, but also and perhaps more importantly, to increase community ownership of the project. We think that if the community does not feel that they are in control of the project, it will not be as successful.

Our current computer rollout has focused on one of the five villages in the Dwesa region, Mpume. We are in the process of extending this to other villages, starting with Nqabara. The first step in this process is to identify champions in the Nqabara region and to equip them at the Mpume lab. This training is primarily undertaken by the existing champions at Mpume. This process has begun the iterative cycle of community training within the greater Dwesa region. The initial training was performed in English, but we are currently exploring the effectiveness of training in Xhosa, the mother tongue of most Dwesa residents. This has been facilitated by the language support that is inherent in the FOSS that we have implemented on the desktop computers. It is hoped that the community will engage in the localization of other software at a later stage.

V. PLANNED EXTENSIONS

In view of the need to support a plethora of community and societal activities (e-learning, e-commerce, e-government, and e-health) in marginalized communities, a multi-protocol, multi-service IP based infrastructure is planned for deployment in Dwesa. The infrastructure is designed to leverage the contextual relevance of various technologies to situations that exhibit characteristics typical of marginalized communities. A few of these characteristics include:

1. Low level of teledensity.
2. Low literacy levels.
3. Limited financial resources

The proposed ICT infrastructure and policy defines solutions as far as the network, services and applications are concerned. These three concerns will now be discussed separately.

A. IP based Network infrastructure

We are proposing a converged IP network consisting on both wired and wireless technologies [Figure 3]. In this setup, VSAT forms part of the backhaul connectivity to the Internet. As previously mentioned, the marginalized communities suffer from a lack of infrastructure including high bandwidth access technologies. The cost of laying the high bandwidth cabling over large distances is prohibitive for the communities and unattractive for telecommunication companies due to the lack of commercial demand. The use of VSAT for the backhaul connectivity was chosen after a preliminary investigation into the applicability of different

technologies (for example: GPRS, EDGE, 3G, VSAT).

IEEE 802.16 (WiMAX) forms the last-mile access to the villages. This technology is chosen due to its larger range, Non Line of Sight (NLOS), high bandwidth, and comparative cost to other wired alternatives.

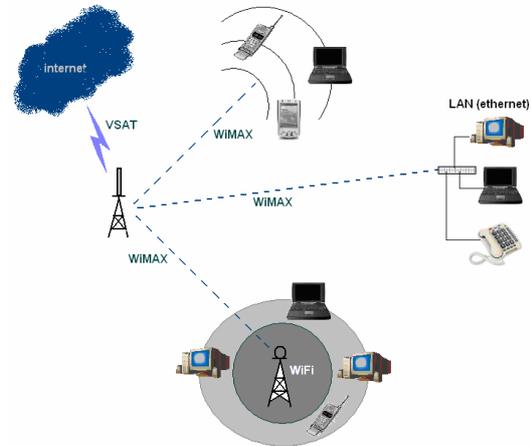


Figure 3: Proposed network infrastructure

The community accesses the network via one of the following three possible alternatives:

- WiFi hotspots: A WiMAX Consumer Premises Equipment (CPE) unit links to the base station signal and distributes it via a WiFi Access Point (AP) to the roaming client devices that have WiFi capabilities. This access technique would be used in a clinic or other common areas where no computing facilities are provided but community members tend to gather. They would then be able to connect to the network via their personal mobile devices, such as cell phones, PDAs, or laptops.
- Wired Lab: These are going to be implemented as community multi-purpose centers in a lab setup, which link to the WiMAX base station for connectivity. The community members would be able to go to the centre and use the available computing facilities.
- Mobile clients: This differentiates from the first technique in that the client devices connect directly to the WiMAX base station. This is a possible usage scenario pending the availability of WiMAX enabled end-user mobile devices.

B. Services

The services that we plan to implement and offer on the network are: Voice over IP (VoIP), BingBee and local content provisioning through the Open Source Software (OSS) Web 2.0 tools [11]. These services will now be described.

In areas where there is no telecommunication infrastructure in place, we propose the use of VoIP to facilitate inter-community communication. VoIP will also be used as an alternative to the GSM network. The VoIP infrastructure will build on top of iLanga, an open source Asterisk-based, Private Branch eXchange (PBX) system developed at Rhodes University [15, 16]. This can be

extended to allow calls to be forwarded to the Public Switched Telephone Network (PSTN) via VoIP call termination services and leased cost routing services provided by third party companies. The implementation of the VoIP infrastructure will also enable subsequent services to be tailor made for the community (for example: conference calls between community members). In a preliminary rollout, phones will be provided at schools, clinics and the headmen within the villages. The second phase will be guided by the usage patterns of the community as established from the preliminary rollout.



Figure 4: BingBee information kiosk

BingBee is an information kiosk designed to improve literacy and numeracy skills in children through edutainment activities. As shown in Figure 4, it is a fully self-contained kiosk that is designed to be installed behind a shop front window or community lab window. BingBee is controlled through a touch sensitive pad mounted on the outside of the window. Inside the building, a webcam monitors for distortions in the touch-pad fabric and from this calculates the new input position. This means that all items of value are stored inside a protected shop which makes BingBee ideal for deployment in areas that are susceptible to vandalism. Some of the current edutainment activities installed on BingBee include: a language quiz to translate between Xhosa, Afrikaans and English; a quiz to help read an analogue clock; logic skills problems; and basic mathematics problems.

OSS Web 2.0 tools will be used to enable local community members to contribute indigenous knowledge to available content management systems. An example of how this would benefit the community would be the creation of a local Dwesa-Wiki to store relevant information specifically for the community (for example: meeting times, phone numbers of key leaders, farming tips relevant to subsistence farmers in the region).

C. Applications

Some of the applications that will be developed / implemented specifically for the Dwesa region include: mobile Java MIDP applications, 3G applications and localization tools.

Research is currently being undertaken to investigate the

use of mobile Java MIDP and 3G applications to facilitate e-commerce activities. These activities include allowing entrepreneurs to remotely update stock information on an e-shop via a cell phone.

Since English is not the mother tongue language in Dwesa, we are currently investigating the role of localization in interface design for marginalized communities. This would entail not only language translation facilities, but also the adaptation of existing interface components such as icon sets, colour schemes, themes and skins.

VI. CONCLUSION

This paper has described steps that we have undertaken to deploy ICT in a marginalized community. It highlights the two equally important concerns in this process: training and infrastructure. The paper has also presented our proposed IP based network infrastructure which will support the connection of geographically dispersed community members. As well as connecting the community together, it opens up doors to participation in the global information economy. On a national level, this networking infrastructure has the potential to facilitate the implementation of services such as e-commerce, e-learning, e-government and e-health.

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