The Lwazi Community Communication Service: Design and Piloting of a Voice-based Information Service

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ABSTRACT
We present the design, development and pilot process of the Lwazi Community Communication Service (LCCS), a multilingual automated telephone-based information service. The service acts as a communication and dissemination tool that enables managers at local community centres to broadcast information (e.g. health, employment, social grants) to community workers and the communities they serve. The LCCS allows the recipients to obtain up-to-date, relevant information in a timely and efficient manner, overcoming the obstacles of transportation, time and costs incurred in trying to physically obtain information from the community centres. We discuss our experiences and fieldwork in piloting the LCCS at six locations nationally in the eleven official South African languages. We analyze the usage pattern from the pilot call logs and thereafter discuss the implications of these findings for future projects that design similar automated services for serving rural communities in developing world regions.

Categories and Subject Descriptors
H.5.2 User Interfaces: Voice I/O User Interfaces; H.5.2 User Interfaces: Evaluation; H.1.2 User/Machine Systems: Human Factors

General Terms
Design, Human Factors, Languages

Keywords
Voice user interfaces. ICTD, literacy, speech technologies, rural, developing regions, mobile, spoken dialogue systems

1. INTRODUCTION
Access to information is a key element for stimulating socio-economic growth in individuals and communities by acting as a means to improve people's livelihoods. Access to information about entitled services alone has been found to improve the delivery of health and social services to resource-poor populations (Pandey *et al.*, 2007). Over the past two decades, information and communication technologies (ICTs) such as computers, Internet and mobile phones, have become prevalent as the means for us to obtain and interact with information. Despite these, numerous communities in developing world regions such as South Africa (SA) face many barriers to access, including infrastructure, distance, language and literacy. Many government entities and non-profit institutions need to deliver services and provide timely, accurate and relevant information to their communities of interest, which can be a challenging task due to these barriers.

Automated telephone-based services or spoken dialogue systems (SDSs) can play an important role in addressing these barriers and bridging the information gap as mobile phones are by far the most widespread form of ICTs in developing world regions. Mobile phone penetration and usage in Africa have experienced massive growth, with Africa having more phone connections than USA and Canada combined (Heeks, 2009). South Africa in particular has also been part of this leapfrog development, where 83% of South Africans have access to a mobile phone (Gapminder, 2005). Automated telephone-based services also help overcome barriers of language and literacy. With eleven official languages, information dissemination through the traditional print media can be costly and difficult to achieve in all the languages. English is by far the most commonly used language in the commercial sector and although 47% of South Africans do not understand English, it is the language in which most government messages are disseminated (Heugh, 2007). Even within a given linguistic region, low rates of literacy hinder the government's ability to inform citizens. In 2000, of all the South Africans that constituted the "African" group of people (73.8%), only half could read and write (Gordon, 2005). Telephone-based services have the further advantage that they do not require any computer infrastructure from the user end and can be used from anywhere, alleviating transport-related costs and delays.

We believe that such telephone-based services, enabled with human language technologies (HLTs), have immense potential to enhance service delivery and information access for many South Africans who may currently face challenges in accessing government services and information. As such, this type of service represents a new class of extensions to the concept of the World Wide Web; for additional background on this perspective, see, for example, (Web Foundation, 2011; Kumar *et al*, 2007). Prior related work in this field has shown much promise in domains such as agriculture (Plauche *et al,* 2006; Nasfors, 2007; Patel *et al*, 2010), health (Sherwani *et al*, 2007, 2009; Sharma Grover *et al*, 2009), government services (Barnard *et al*, 2003) and even voice-based community forums (Agarwal *et al*, 2009). Sherwani *et al* (2007, 2009) and Sharma Grover *et al.* (2009) developed health information lines for low literacy users in Pakistan and Botswana respectively. Some of the issues explored were around input modality performance and preferences (touch-tone/DTMF vs. speech recognition), menu structures for navigation and usability evaluations. Patel *et al* (2010) also present an interactive voice response (IVR) type application for farmers that provides agricultural information and allows farmers to leave questions for the farmer community, akin to a voice-based forum. Aggarwal *et al* (2009) piloted a voice-kiosk system in Indian villages where users can obtain information on a variety of topics such as farming and health, and also post advertisements (similar to a classifieds

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section). Here a kiosk operator (based within the community) is allowed to change or modify the content on this voice-based forum.

Our work in this paper relates most closely to the work of Patel *et al* (2010) and Aggarwal *et al* (2009), however with the exception of the community interaction features and more focus on the piloting and deployment aspects of such voice-based services and lessons learnt thereof. Section 2 provides an overview on the Lwazi project, and section 3 describes the features and implementation of the Lwazi Community Communication Service (LCCS). The results of our pilot deployment in six locations in South Africa are presented in section 4, while in section 5 we reflect and discuss our experiences and implications of these findings and we conclude in section 6 with directions for future work.

2. BACKGROUND

The Lwazi project was commissioned by the South African Department of Arts and Culture (DAC) in 2006 to enable the development of a multilingual, telephone-based proof-of-concept service, in the nation's eleven official languages, to assist the government in service delivery and overcome language and literacy barriers (Meraka Institute, 2009).

The first phase of our work started with the process to select an appropriate service (i.e. the 'application selection process'). We commenced by trying to identify a service domain (e.g. health, education or labour) and a specific application (e.g. an automated health line or bus schedules) based on an extensive survey of the information needs of the target audience. The assessment focused on how automated telephony services could support government's current service delivery to individuals throughout the country and make a measurable, positive impact in their daily lives. We investigated the various factors such as:

- The type of information communities primarily need;
- Potential sources of this information;
- The relevant cultural and social preferences – any issues based on gender, age, geographic location, language and the cultural background of the community;
- Suitability of technology (e.g. Is the medium of speech appropriate for an information service, and if so, what is the best way to present information to such a community through the medium of speech?);
- User experience (e.g. What is the literacy level of the target group?; Is the target group able to use a telephony-based system?; What other technologies have they been exposed to in the past?); and
- Potential uptake (i.e. any issues pertinent to the usefulness, usability and sustainability of a speech-driven information service).

Our investigative meetings covered seven research groups involved in ICT for development projects, three non-profit organisations (NPOs), six government departments and three national call centres (see Plauche *et. al*, 2010 for details). We also conducted site visits in seven rural villages, which each had a Thusong Service Centre (TSC). TSCs are one-stop centres that provide integrated services and information to communities (especially in rural areas) close to where potential users live. Some of the services offered are government social and administration services, office services, education and skills development and local economic development services. In March 2009, there were 137 centres across South Africa, all managed by local municipalities (DPSA, 2010).

In each of the rural villages, a community survey was undertaken by a community development worker (CDW). CDWs are community members trained as public servants to engage with citizens, determine their service needs and ensure that government services are available to them (DPSA, 2010). Interviews were also conducted with TSC employees and community members. Overall, we found that both of the rural government programmes (TSCs and CDWs) were effective, and that TSC staff and CDWs see the impact of their work daily, despite limited resources. CDWs used their mobile phones as a powerful tool for community organizing, raising awareness about services to which communities are entitled, following up with citizens and getting relevant and updated information from TSCs. TSC staff and CDWs contributed many ideas for automated telephony services that would support their efforts to keep rural South Africans informed.

Overall, the application selection process resulted in many ideas for automated telephony services ranging from automated health information lines, hotlines for electricity load-shedding and sporting events, information lines for child-headed households and social services, as well as audio telephone toolkits for entrepreneurs and communities and information sharing service for CDWs. We used the morphological analysis (MA) framework as a tool that allowed us to take into account the above-mentioned factors to select the final Lwazi application, viz. the LCCS, as we describe in the following sections.

Morphological analysis is a problem structuring method (PSM) which is an alternative to mathematical modelling and was developed to address complex problem spaces such as socio-technical systems, where the problem space is structured according to *logical* relationships. All PSMs are well-equipped to model data with strong socio-technical characteristics. However, we found the logical approach of MA to be particularly well-suited to the problem of selecting a telephony application for government service delivery in South Africa because the relationships between the relevant social and technical factors are interlinked and overlapping, which makes causal or hierarchical structures difficult to define. For a detailed overview on the morphological analysis framework and the application selection process see (Plauche *et al*, 2010).

3. THE LWAZI COMMUNITY COMMUNICATION SERVICE (LCCS)

3.1 User Context

In order to further familiarise ourselves with the user context and environment of the application, we visited several TSCs across South Africa between April and August 2008. During each visit the team made contact with the TSC manager, who hosted team members for 2-3 days, and conducted interviews, focus group discussions, community surveys and household surveys with service providers (including TSC staff), CDWs and community members. We found that TSCs often need to communicate announcements to the CDWs, who in turn disseminate the information to the relevant communities. The TSC managers and local municipal (government) communication officers most often have regular Internet connectivity and use emails in their day-to-day work to communicate with government departments and NPOs. In the majority of the communities we investigated, communication with the CDWs is mostly through face-to-face meetings and via the

telephone (though in some instances (e.g. Vredendal) we found that even some of the CDWs had Internet access, albeit intermittent. CDWs on average had grade 8-12 or higher level of education (vocational certificate courses), ranged between 20-45 years in age, with no significant differences in the gender proportions. They were familiar with mobile phone usage and some even used computers and the Internet. Almost none of the community members have access to the Internet, while most of the households have access to at least a mobile phone.

Initially the service was designed with CDWs as the target users, but during the pilots, we were often requested to register local and ward councillors, as well as chiefs, on the LCCS, as they are also key community gate-keepers whose responsibilities include information dissemination and community service delivery. Councillors are political appointees and chieftaincy is inherited through family lineage. Henceforth, we refer to the collective user group of CDWs, local councillors, ward councillors and chiefs as community workers.

3.2 LCCS Design and Features

The LCCS allows TSC managers to place messages on the system through the use of a web page, and allows community workers and community members to access these messages through the use of a telephone. In addition, community workers can leave a message for the TSC manager via a telephone, which the TSC manager can then listen to using the web interface. Thus, at a high-level, the LCCS can be viewed as consisting of two distinct parts (illustrated in Figure 1):

1. A website that provides a TSC manager (or municipal communication officer, or any registered government authority) with a) the ability to upload new announcements to the service for community workers and/or community members, and b) the ability to listen to voice messages left by community workers.

2. Two telephone services that allow a) community workers to phone in and get access to the announcements uploaded by TSC managers and leave voice messages for the TSC managers (Lwazi CDW service), and b) community members to phone in directly and listen to announcements left by the TSC managers (Lwazi community service).

In the following sections we present a detailed account of the operation of the LCCS website and the Lwazi CDW and community telephone services.

3.2.1 LCCS website

The LCCS website is a web portal designed to allow TSC managers to create and manage various types of announcements and listen to voice messages left by community workers. For each targeted community area, the LCCS administrator (located at the CSIR) creates a user account for the local TSC manager (and/or municipal/government communication representatives who want to be registered) on the LCCS website. The TSC manager can then log into his or her account and create four different types of announcements, namely meeting invitations, outreach invitations, imbizo invitations[1], and notices as illustrated in Figure 2. These four categories were created based on our needs investigation phase at the TSCs, where we examined the type and content of information that flows from the TSCs, community workers and the community members. Managers may choose to send any announcement to all the community workers registered in their area, or select groups of individuals (e.g. either councillors or CDWs) or specific individuals (not shown in the Figure 2). The manager can also choose to send the announcement to the rest of the community.

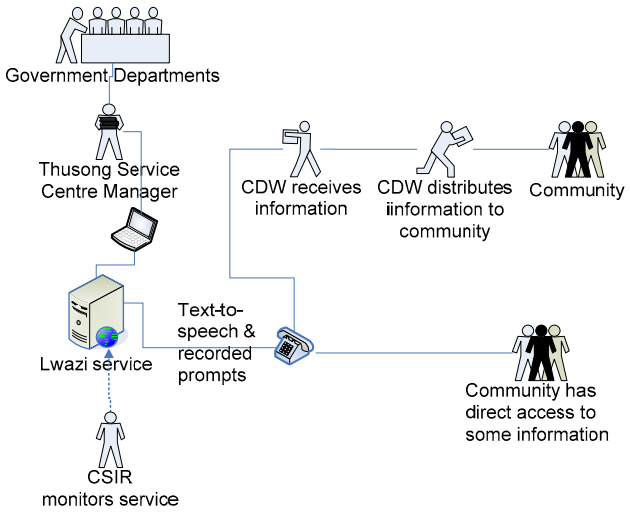

Figure 1. Workflow overview of the LCCS.

The manager is required to provide the information for the relevant fields (date, time, etc.) of the announcement and select the languages he/she would like the message to appear in. For each additional language selected, additional textboxes are provided to type the message text for those languages. The manager then 'creates' the announcement, which effectively posts it on the Lwazi CDW and/or community telephone service (depending on the chosen recipients). The announcement is played back using a combination of recorded voice prompts for the dates and time fields and TTS for the message text. The audio structure of the announcements as heard by the community workers is detailed in the following section.

The TSC manager may also use the 'Manage Announcements' feature to delete announcements, while the Lwazi service back-end has a built-in functionality for removing old announcements based on their expiry date (e.g. a meeting invitation is removed after the meeting date). The 'View Messages' feature provides managers with a voicemail-like facility to listen to messages (new and old) on the LCCS website left by community workers through the Lwazi CDW service. The LCCS administration is managed by the CSIR through an 'administrator' login, using the same website but with access to additional administration pages. These include pages for creating a new pilot site, capturing community worker details for registration, creating TSC manager accounts, as well as creating recipient user groups for pilot sites. The administrator login also provides the functionality to review and edit the announcements created by TSC managers (this functionality is required for formatting announcement text in order to improve TTS rendering quality, as described later).

[1] An Imbizo is a mass community meeting that acts as a forum for discussion of community matters and is usually chaired by community leaders, whilst 'meeting invitations' refers to meetings between the TSC manager and the community workers, or meetings held by government departments with community workers and/or community members at large.

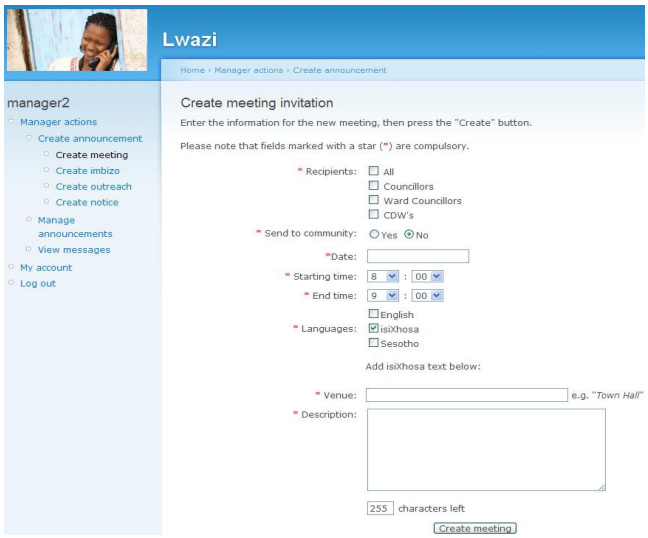

Figure 2. LCCS website – creating a meeting announcement.

3.2.2 *Lwazi CDW service*

The Lwazi CDW service is an interactive voice response (IVR) telephone service that allows community workers to listen to announcements posted by their TSC manager (or other relevant registered government authorities) and leave voice messages for the TSC manager. Each community worker in a targeted area is registered on the CDW telephone service and obtains a personal identification number (PIN code) that allows them to access their announcements. The CDW's personal details, mobile phone number and preferred language are required for this registration. Within each targeted area the service is provided in the most commonly spoken languages of that area, which were determined in consultation with the TSC managers, community workers and the community at large during the investigation phase described earlier. At the end of each day (5 pm) all the recipients receive an SMS notification if they have new message(s) on the LCCS, which they must call. The service is free in the sense that a community worker only gives a missed call to the service (calls the service number and hangs up after a ring), and the service then calls them back.

In the case that the community workers call from their registered mobile phone numbers, the service uses caller identity to map them to their user accounts, and the dialogue is initiated in the user's preferred language on the system (sample interaction shown in Figure 3). If the community worker, however, gives a missed call from an unregistered number (e.g. a public phone), (s)he is presented with a language choice menu prompt and asked for a PIN code to listen to the messages. The user also gets the option in the main menu to record a voice message for the TSC manager. This feature was envisaged to save the community worker the cost of a phone call to leave a voice message for the TSC manager using their mobile phone (i.e. to directly dial the TSC manager's number vs. using the LCCS). The TSC manager, in turn, receives all her/his community workers' related messages through the LCCS website where he/she can easily store and retrieve them as required. The structure of the audio message is of particular interest, where a concatenation of audio recorded prompts and TTS technology is used to convey the announcement to the user (more technical details on our approach to TTS technology development are available in (Van Niekerk, 2009)). Some of the announcement variables, such as date and time, are played back using pre-recorded prompts, whilst less predictable variables such as the venue and message text are played backed using a TTS voice (indicated in **blue**).

Lwazi (user is called back on registered number): *Welcome to the Lwazi Service. You have 2 new messages. To hear your New Message, press 1. To hear your Old Messages, press 2. To Leave a Message for the Thusong centre manager, press 3. Note that you can return to the 'Start' of the service at any time, by pressing 0.*

User: *(presses 1)*

Lwazi: *New Messages. Note that you can skip to the next message, by pressing 1. First message:*

Lwazi: *Description of Meeting: <(TTS:) Weekly progress report meeting>*
Date: <29th> of <March>
Venue: <(TTS:) Thusong Service centre>
Starting Time: <3> <30> <PM>
End time: <5> <PM>
Message: <(TTS:) All CDWs are requested to attend this weekly meeting where community participation strategies will be discussed>.

Figure 3. Lwazi CDW service – sample dialogue.

3.2.3 *Lwazi community service*

The Lwazi community service extends from the Lwazi CDW service; if a TSC manager wishes to make announcements to the community in general, community members are marked as recipients on the LCCS website. Therefore, the same announcement which goes out to the community workers is then accessible to the community members as well. Community members similarly give the service a missed call, which calls them back making the service free for their usage. However, the community line differs from the CDW line as no registration is required by the communities (i.e. no PIN codes thus any user can call in or SMS notifications of a new message on the service). Figure 4 shows a sample interaction.

Lwazi: *Lwazi Service. Om in Afrikaans voort te gaan, druk een. Ukuqhubekeka ngesiXhosa cinezela uTwo. To continue in English, press 3.*
User: *(presses 3)*
Lwazi: *Hi, my name is Tebogo. I'm here to share important information about our community with you. Note, that you can return to the start of the service at any time, by pressing 0.*
Lwazi: *For this week's messages, press 1. For the rest of this month's messages, press 2. For next month's messages, press 3. To end the call, press 9.*

Figure 4. Lwazi community service – sample dialogue.

3.2.4 *Implementation*

The initial dialogue and prompt design for the LCCS was in English, and thereafter translated into the local languages, which was a significant task. We found that great care had to be taken in the translation phase to ensure that the intended meaning of the original prompt (English) was preserved in the translated prompt (local language) and conveyed in the simplest and shortest way possible. We ensured that all the translated local language prompts were verified by in-house local language speakers, after which prompts used in the system were recorded by mother-tongue

speakers. The preliminary in-house testing of the local language IVRs also posed a challenge in the case of languages where we did not have in-house personnel who spoke the particular language. Here, we made use of external mother-tongue speakers who were briefed on the LCCS and provided with use cases to test the system and verify the correctness of local language prompts. These experiences highlighted some of the challenges of designing voice user interface services in local languages.

The LCCS system architecture is illustrated in Figure 5. The LCCS website was built using the Drupal web content management system, which enabled the re-use of existing open-source components. The CDW service was built using the open-source Lwazi telephony platform (http://sourceforge.net/projects/lwazi), which facilitates speedy development and provision of multilingual IVR applications.

The telephony platform builds upon the well-established Asterisk software private branch exchange (PBX) by providing an IVR application programming interface (API) and runtime engine in the Python programming language, MobilIVR. This enables application developers to easily create telephony-based information services. The LCCS is provided over a standard ISDN line, which in turn interfaces with the Asterisk software PBX via an ISDN-SIP gateway with the SIP protocol. All incoming calls are serviced by the Lwazi telephony platform's call-back mechanism, which interfaces directly with Asterisk. The call-back mechanism queues all missed calls and services them sequentially, one at a time. When the service calls the user back, it hands the call over to be handled by the CDW IVR dialogue application, which also interfaces directly with Asterisk.

All messages created by managers on the web site interface, as well as voice messages left by CDWs using the telephone service, are stored in the CDW database which was implemented using the open-source MySQL relational database management system. A TTS daemon monitors the database for new announcements created by the manager via the LCCS website.

New announcements are rendered into audio using the Speect TTS engine (http://sourceforge.net/projects/speect), and a link to the rendered audio file is stored in the database. The Speect TTS engine is capable of rendering text into speech for all eleven official South African languages. An SMS notification daemon also monitors the database for newly created announcements rendered into audio and uses the open source Kannel SMS gateway software.

4. PILOT DEPLOYMENT AND FINDINGS

Over the period June 2009-June 2010, we piloted the LCCS in six locations in South Africa, covering all the eleven official languages in these pilots, as summarised in Table 1. We provided the LCCS in the most commonly spoken languages in each pilot area (the dominant language(s) are in bold). The pilot areas included rural localities, typically where less development-related infrastructure such as tarred roads, clinics and schools are available and with more conservative communities where, for instance, our pilot team would first have to seek the permission of the local headman before approaching community members. Some of the pilots were also conducted in semi-rural areas (more infrastructure and commercial activity) and urban areas (usually located on the peripheries of towns and cities where housing varies from formal to informal). Note that these pilots were intended as short-term deployments running on average 4-12 weeks to determine the uptake and usage trends in each area.

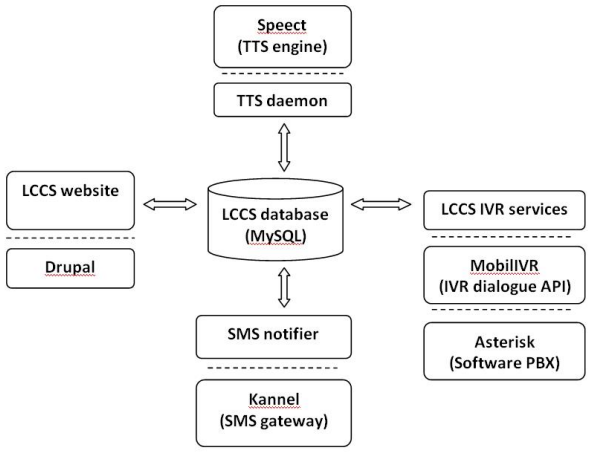

Figure 5. LCCS system architecture.

The typical pilot process at each site entailed a 3-5 day interaction with the TSC manger, community workers and the community at large. Our aim in these pilots was to introduce the LCCS and ascertain if users were able to navigate and understand the prompts and in general gather as much information around issues pertaining to service usage and opportunities for improving the system. As such, our approach was through semi-structured interviews and informal focus group discussions, as opposed to formal usability evaluations, which have proven to be challenging in such environments (Sharma Grover *et al*, 2009). In general, we first met with the local TSC manager and any other government representatives that would be registered as information providers on the LCCS website and introduced and demonstrated the LCCS.

The managers/representatives were then requested to try the website themselves (using their own laptops and assigned user account) by creating relevant announcements for their community workers and community members. This was followed by meetings with community workers, where the Lwazi CDW service was demonstrated. Typically this was done in a group setting followed by informal focus group discussions to address any queries. Thereafter, depending on the availability and location of the CDWs, we held one-on-one sessions or small focus group discussions with the CDWs to provide them with their Lwazi CDW service PIN codes and request them to try the service. Lastly, we conducted community walk-about sessions where we introduced and demonstrated the Lwazi community service and requested community members to try the service.

Here, in particular, we made use of small informational pamphlets (Figure 6) that graphically illustrated the use of the service with a colourful storyline and minimal text and found these to be very useful in explaining the service to community members. Throughout these interactions with TSC managers, community workers and community members, observations were made and short questions asked about the content quality, typical usage, expectations, likes/dislikes and overall experience to gather further qualitative data.

Table 1. Summary of Lwazi service pilots across South Africa

Pilot area	Area type	Literacy	Income	Languages	Registered community workers	Registered TSC managers	Preferred language (registered)
Vredendal (June 2009)	Rural	Low	Non-skilled: Farming	**isiXhosa, Afrikaans,** English	9	1	Afrikaans (10)
Sterkspruit (July 2009)	Semi-rural	Ranges: Low-to medium	Non-skilled and skilled: Government	**isiXhosa, Sesotho,** English	43	3	IsiXhosa (43) Sesotho (2) English (1)
Tshidilamolomo (August 2009)	Rural	Low	Non-skilled: Mines in nearest town	**Setswana,** English, Afrikaans	40	2	Setswana (41) isiXhosa (1)
Atteridgeville (September 2009)	Urban	Ranges: Low-to-high	Non-skilled and skilled: Various sectors in nearest city	isiZulu, Setswana, isiXhosa, English, Sepedi	117	2	English (119)
Bushbuckridge (May 2010)	Semi-rural	Ranges: Low-to medium	Non-skilled: Game parks and government	**Siswati, Xitsonga,** Sepedi, English	15	4	Xitsonga (19)
Madimbo (June 2010)	Rural	Low	Non-skilled: Farming	**TshiVenda**, IsiNdebele, Xitsonga, Siswati	30	2	Tshivenda (32)

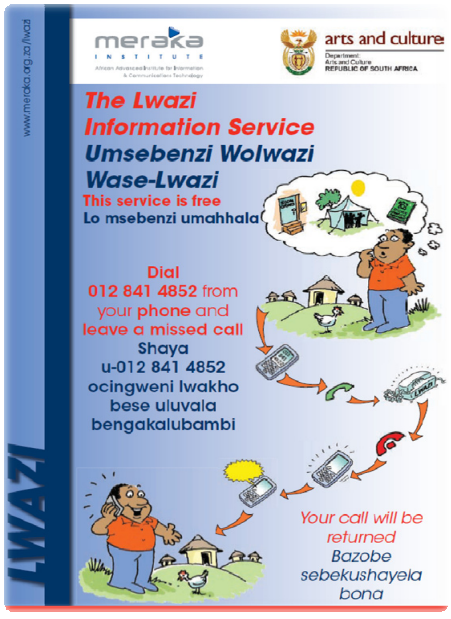

Figure 6. Lwazi information pamphlet

4.1 Traffic overview

Across the six pilot sites a total of 530 calls were received, of which the vast majority (69%) were from the Sterkspruit pilot. Here, one TSC manager and two local government communication officers were registered to input announcements on the LCCS website. Table 2 provides a summary of the pilot calls across the sites. We found that the most chosen option was the retrieval of new messages by community workers, followed by the retrieval of old messages (e.g. referring back to old announcements), with the 'leave a message for the TSC manager' option the least used.

Note that when comparing sites in Table 2 and 3, the last two pilots (Bushbuckridge and Madimbo) were launched in mid-May and June 2010 respectively, and did not run as long as the other pilots (4 weeks or less) due to project constraints.

Table 2. Pilots' call summary (includes deployment dates)

Pilot area	No. of calls	New msg	Old msg	Leave msg	No option
Vredendal	12	11	1	0	0
Sterkspruit	363	223	66	5	69
Tshidilamolomo	34	20	7	1	6
Atteridgeville	18	6	5	0	7
Bushbuckridge	63	39	10	3	11
Madimbo	40	24	11	2	3
TOTAL	**530**	**323**	**100**	**11**	**96**

Table 3 presents the summary of the call traffic with the calls made on the pilot deployment dates filtered out (i.e. the in-field days during which we were introducing the Lwazi CDW service to community workers). For Sterkspruit, particularly, we observed that 81% of the registered community workers called at least once and 26% called more than 10 times, with the top five callers calling

between 16 and 34 times. The top 10 callers accounted for 54% of the total calls at Sterkspruit.

Table 3. Pilots' call summary (user initiated)

Pilot area	No. of calls	New msg	Old msg	Leave msg	No option
Vredendal	12	11	1	0	0
Sterkspruit	322	201	59	3	59
Tshidilamolomo	24	14	5	0	5
Atteridgeville	16	5	5	0	6
Bushbuckridge	20	15	3	1	1
Madimbo	9	2	7	0	0
TOTAL	**403**	**248**	**80**	**4**	**71**

In terms of input of announcements (Table 4), we found that Sterkspruit had the highest number of announcements in the system (37), while the majority of the announcements were sent out in one language, except in Sterkspruit, where 54% of the announcements were in two or more languages (English and Sesotho). Again in Sterkspruit, 60% of the announcements were meeting requests to call the community workers and/or members together for a meeting and the remaining 40% were announcements about events and occurrences in the area.

We found that the two local government communication officers and TSC manager in Sterkspruit were by far the most enthusiastic users. However, the motivation behind their use was different, based on their context for using the service. For the two communications officers, service usage was motivated by the fact that it made their job of disseminating information to the community workers easier and faster. Traditionally, the communication officer would have to call all the community workers individually to make an announcement. Thus, the communication officers were very keen to use the service and also contacted us to provide feedback on service problems and suggestions for improvements. In the case of the TSC manager, his motivation seemed to stem from pride that his Centre was one of the first in the country to offer such a service to the community and therefore exemplary of government service delivery in the area.

Table 4. Summary of announcements on the LCCS website

Pilot area	Announcements	Avg. recipients/ announcement	Languages/ announcement
Vredendal	2	7	1 lang (2)
Sterkspruit	37	32	1 lang (20) 2 langs (15) 3 langs (2)
Tshidilamolomo	5	26	1 lang (5)
Atteridgeville	5	9	1 lang (5)
Bushbuckridge	7	8	1 lang (7)
Madimbo	1	33	1 lang (1)
TOTAL	**57**	**26**	

In terms of the Lwazi community service, a total of 774 calls were received (excluding the calls during the demonstration periods), of which 203 were early disconnect calls where the call was aborted in the first 1-2 seconds. From the remaining 571 valid calls we found that 278 of the calls were aborted at the language choice menu, which resulted in 293 clean calls (i.e. 37,9%). (This low fraction of regular calls is explained by the relative novelty of the system - that is, users would often simply call the system to demonstrate its operation to other community members.) The average call duration was 1 minute and 40 seconds, with the majority of the calls being between 15s and 1 min 45s in duration, as seen in Figure 7. Due to technical issues (problems with Asterisk PBX set-up on the site identification) related to logging information for this line, we are unable to report the breakdown per site for the community line. However, based on our observations we are confident that the usage follows a similar pattern to that of the Lwazi CDW service.

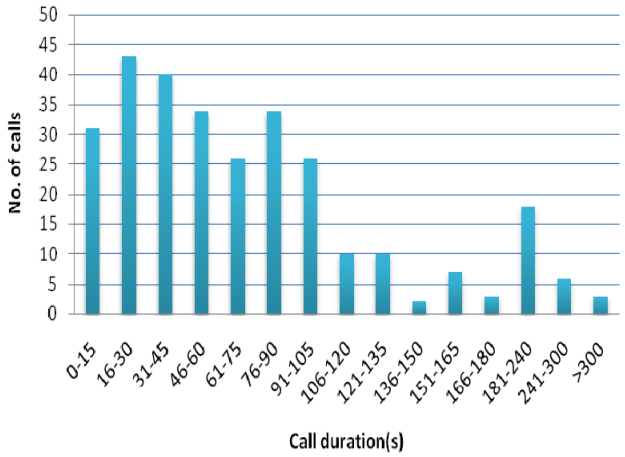

Figure 7. Call duration breakdown –Lwazi community service.

4.2 User Interface

4.2.1 LCCS website

In general, across the pilot sites, we found that all the registered TSC managers and local government representatives were able to understand the website and create announcements after the initial demonstration. During the first pilot, there were problems with the text input of the announcements, where special punctuation characters such as apostrophe (') and acronyms in the text message could not be rendered correctly by the TTS engine. This was, to a large extent, corrected with improvements in the TTS system in the subsequent pilots. However, to ensure that the TTS audio announcement was sufficiently intelligible, we introduced a 'human-in-the-loop', where every time an announcement is posted, a notification was sent to our TTS support team which checked the quality of the rendered audio file for the announcement and, if required, normalised the input text (e.g. special characters and acronyms) to render better quality TTS audio that would be posted to the telephone services. In the earlier pilots we also noted that some users mixed languages when entering text for creating announcements, which lead to errors during the TTS synthesis process. Thus, the TTS support team also checked for such occurrences. To mitigate this issue in the latter set of pilots, we advised users during the LCCS website demo sessions to refrain from mixing languages.

We also found that councillors are usually assigned on a ward number (area) basis in a community and thus we were requested to group them according to these areas. For this, we created user recipient groups for the TSC manager that would enable him/her to easily send announcements to selected individuals as illustrated in Figure 8, for example Ward 03 and 07 have been added. Some CDWs (e.g. Vredendal) had regular Internet access and wanted to be able to create announcements themselves and were curious as to how the announcements were created. CDWs often also gave suggestions for additional persons that could be registered on the LCCS website as information providers, e.g. local heads of government departments, in which case we tried to establish contact with and register the suggested persons.

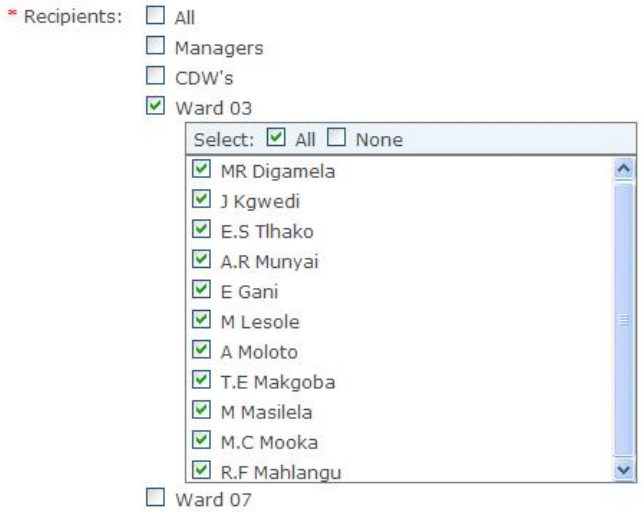

Figure 8. User recipient groups on the LCCS website.

4.2.2 Lwazi CDW service

During the piloting process it was observed that the community workers were comfortable with the service and quite often enjoyed testing it. In the vast majority of cases they found it easy to follow the instructions. Community workers were also concerned about leaving their personal numbers as contact numbers when they create announcements (an announcement has the option to leave a contact number for further enquires). They were afraid that this may lead to abuse such as receiving prank calls from the community at large. In communities with lower literacy levels, we found that some community members struggled to follow the telephone service instructions, which was more prevalent among the older generation. A notable observation from the community was that community members sometimes struggled to understand how the service could be free if they needed airtime (prepaid balance) in order to give it a missed call. Community members could often be wary of using their own phones to test the service, afraid that their airtime would be used. We tried to address this by showing them (with our phones) that no charge was incurred upon calling the service. In some cases, we also noted that people did not have enough airtime to even give a missed call to the service.

In the first pilot, many of the respondents (community and CDWs) said the volume of the TTS voice was too low and that they sometimes struggled to hear their messages. The volume issue was addressed for the subsequent pilots. In the earlier pilots the feedback on the TTS voices (isiXhosa, Sesotho) was that they sounded somewhat 'funny' and robotic and as if a non-mother tongue speaker was trying to speak a language. Sentence intelligibility tests on six of the eleven languages ranged between 93-99% (Meraka Institute, 2009). With improvements to our TTS technology, we have found in our newer pilots, such as at Madimbo, that the TTS voice (Tshivenda) was much clearer and understandable and thus better accepted by the users. We also observed that in most of the pilots, we were asked for a provision for community members to contact the TSC and for a way to ensure that the community's queries are addressed by the TSC.

5. DISCUSSION

In terms of pilot usage, Sterkspruit has by far been the most active area. In analysing the low usage of the other pilots, we considered the details of these areas.

- Vredendal – Here we found that the majority of the CDWs had government sponsored Internet access and laptops. Their primary means of communication with the TSC manager was through face-to-face meetings or email. The TSC seemed to be operating quite well, and the existing channels set up for communication between CDWs and the TSC manager were actively used and worked well for their needs. Two of the CDWs mentioned that their offices were located (unusual for CDWs to have fully-fledged offices) close to that of the TSC manager, and they may therefore not be using the service so much. Another suggested that the service be linked to their emails. From this, we surmised that the service only supplemented these existing channels and thus was not so widely used.

- Tshidilamolomo – This was one of the most rural sites, where the TSC itself was not equipped with Internet access. The TSC manager of Tshidilamolomo was based at Mafikeng, a town located 120 km from this site. She was employed in another managerial position at the Mafikeng CDW office, as well as remotely handling the Tshidilamolomo Centre. During our interactions with her, we observed that she preferred to communicate with the Tshidilamolomo CDWs via telephone and did not mind the cost factor as the calls were government-sponsored. The literacy rates among community members here was also low and the CDWs commented that the community members may even struggle to give a missed call to the service. At the Tshidilamolomo TSC site itself, we found that a government representative wanted to use the service but did not have Internet access. A few of the CDWs here also expressed concern that they would like to use the service but mobile phone network coverage could be a problem in the area and they usually had very little airtime on their phones.

- Atteridgeville – This was the most urban site where a pilot was deployed. During the piloting stages we picked up that there seemed to be political issues around the Centre management. For instance when choosing languages for the service, the TSC manager mentioned that he would probably only be using English as using one African languages and not another would lead to politically-motivated questions being asked about why some languages were being 'favoured'. We noticed that all the registered community workers used English as their preferred language.

- Bushbuckridge and Madimbo – These were relatively new pilot sites (mid May to June 2010) where we piloted to expand our coverage of the smaller minority languages such as Xitsonga, Tshivenda, isiNdebele and Siswati towards the end of the project. The usage was not significant up to July 2010. However, we did make some interesting observations here: Madimbo is also a very rural area where only Tshivenda is spoken by most community members. Unlike the other pilots the language barrier was quite a challenge for our team in communicating with the Madimbo community and CDWs. We noted that during the focus group there was even one suggestion that the English dates and times be changed to Tshivenda in the announcements (a stark contrast to the rest of the pilots). As we tried to test the service with community members, we found that unlike other pilots many people did not own a mobile phone. The Bushbuckridge pilot seemed more promising; the Centre is relatively new and the CDWs were very excited and keen to use the service. The assistant TSC manager also invited the team to present the LCCS at the official launch of the Centre held at the end of June 2010.

Ultimately, in reflecting on the highest usage at Sterkspruit, we found that one of the most critical aspects was the keenness of the TSC manager and the communication officers involved. The latter, in particular, were young, open to trying new technologies and quite familiar with the Internet. They were enthusiastic to try out the service if it would assist in making their jobs easier and also contacted us to provide valuable feedback and suggestions for improvement. For instance, the communication officer related to us that she was using the service to disseminate messages and had feedback from the Sterkspruit community workers that at times they had difficulty in understanding the announcement voice (TTS) and would also prefer to receive instant SMS notifications about messages (as opposed to at the end of the day). To this end, we are working on improving the TTS technology for the particular languages involved and exploring the use of SMS announcements in the interim to supplement the telephone service.

These pilots highlighted a major challenge for such SDS services and perhaps ICTD projects in general that *the availability of information sources which provide content for the service is a crucial aspect*. That is, even if the means are available to communicate information to users in an efficient and affordable manner, services using these media will only be used if they contain relevant and timely information. Capturing such information in a developing-world situation is a significant challenge in itself. In our case, this translates to the critical role of the TSC managers as the 'feed' to the LCCS. The existence of electronic information sources that provide content feeds for the SDS would be ideal (as in the developed world) when building such a service, however the nature of the information space in the developing world is such that these sources are unavailable, thus building them from scratch often takes bulk of the effort required in designing such SDS services.

In general, we observed that the *uptake of such a service is affected by a complex interplay of various factors*, which range from the readiness of the technology (e.g. our TTS), the motivation and technology sophistication of the user (e.g. the communication officers), the communication preferences of the user (e.g. preference to use email, face-to-face meetings or telephones), the alternative means to the service and its related cost (e.g. government-sponsored phone calls or close proximity to the TSC), success in marketing of the service (e.g. effectiveness of brochures and marketing material), along with the demographics of the user. For example, in Sterkspruit the road infrastructure is poor and the community workers live far from the TSC. This, coupled with the willingness of the TSC manager and communication officers to try the technology, may have led to higher usage (but, on the other hand, also hampered by the TTS intelligibility problems), compared to Tshidilamolomo, where the community workers were also far from the TSC but the TSC manager involved preferred telephonic communication. It is also interesting to note that the motivation of use in Sterkspruit differed for the TSC manager (status) and the communication officers (efficiency); it would be worthwhile to further *explore how the type of user (demographics) relates to these motivation factors in encouraging the uptake of the LCCS and ICT interventions in general.*

Relating to the sustainability of the service for future projects, it is important to take cognisance of the fact that *pilot deployments may be viewed exactly as that by the community* and therefore may not obtain their full buy-in, i.e. if the community knows that a service will only be available for a short period of time, they may be less inclined to use it than if it were introduced as a permanent solution. In general, when using ICT for development, researchers need to carefully balance this aspect with that of not creating false expectations when introducing ICT interventions into communities. Another sustainability aspect is the issue of call costs, as in our previous experiences (Sharma Grover *et. al*, 2009) and also highlighted by Patel *et. al* (2010) we again find that *users are extremely sensitive to call costs and the possibility of having to pay for such a service.* Of course, various business models around marketing companies that target emerging markets or government subsidies are potential options to be considered. However this challenge may prove to be a significant one in the long-term deployment of such services.

Finally, in terms of the language preference, across the various pilots we have found that, *in most cases a dominant language (or two) prevails in an area, and in areas where there are multiple languages most users tend to be multilingual and conversant in the dominant language(s)*. Thus, it may be more practical to first focus on the improvements of the technology for particular languages before expanding language coverage across all national languages. The availability of automated translation systems for translation of the announcements into multiple local languages could also play an important role in increasing usage, as it alleviates the input burden on the TSC manager.

6. CONCLUSION AND FUTURE WORK

In this paper we have presented the findings of the design, development and pilot process of the LCCS, South Africa's first multilingual, community-oriented telephone information service. *We have found that automated telephony services can be used as an effective means to communicate and disseminate localised information and enhance government service delivery in rural communities*. Many pertinent and interesting questions remain to be answered. Finding suitable domains and creating meaningful telephony services that users find useful and easy to use is a challenge to be addressed. Technically, the possibility of multilingual TTS, which accommodates some form of code switching between languages for synthesis, and the incorporation of machine translation or even human-aided machine translation, remain as challenges and can assist in enabling open multilingual

information spaces in countries such as South Africa. We aim to address some of these questions in a follow-up project where we will be developing additional telephony services with a focus on addressing live deployment and user impact issues and improving our speech technologies to ensure greater uptake in future applications.

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