

BUSINESS DRIVERS AND DESIGN CHOICES FOR MULTILINGUAL IVRs: A GOVERNMENT SERVICE DELIVERY CASE STUDY

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ABSTRACT

Multilingual emerging markets hold many opportunities for the application of spoken language technologies, such as interactive voice response (IVR) systems. Designing such systems requires an in-depth understanding of the business drivers and salient design decisions pertaining to these markets. In this paper we analyze the business drivers and design issues for a voice service (the School Meals Line) piloted in the public sector. We find that *cost saving, increased customer satisfaction* and *improved access to services and information* are the primary business drivers for this use case. The main design issues we identify for this use case, and discuss, are *language offering, persona design* and *input modality*.

Index Terms — Business drivers, VUI design, spoken language technologies, voice services, ICT for development, multilingual emerging markets

1. INTRODUCTION

In recent years, significant advances have been made in the field of spoken language technology development for under-resourced languages, such as automatic speech recognition (ASR) and text-to-speech (TTS) systems. However, the same cannot really be said about the field of applying such technologies in environments where under-resourced languages are used. Despite some progress, the big breakthrough application that will prove the practical utility and advantage (and perhaps commercial success, or at least potential) of spoken language technologies in the developing world, still evades the speech community. Nonetheless, the search continues through various endeavours investigating information and communication technologies (ICTs) for multilingual, emerging markets, e.g. IBM's Spoken Web project in India [1], or the Lwazi project in South Africa [2].

Our research focuses on obtaining a better understanding of designing effective voice user interfaces

(VUIs) in environments where little is known about the general profile, needs, preferences and behaviour of users accessing information via technologies such as interactive voice response systems (IVRs) [3]. These IVRs – also known as voice self-service solutions, speech recognition solutions or dual tone multi-frequency (DTMF) solutions – enable task completion (such as call routing, information provision, or transactions) through speech or keypad input [4, 5]. In many of the cases, when a project commences, developers might not yet have a clear idea of the potential users of an IVR, since many of these projects aim to find possible technological solutions for needs that are often not yet pronounced in the user communities [6].

In two other publications [7, 8] we developed and described a model comprising business drivers and design decisions prevalent in the development of multilingual IVRs in South Africa. We firstly aimed to get a better understanding of the operational context of potential applications by analyzing what the most important business drivers are for implementing multilingual IVRs. Cost saving, customer satisfaction and improved access to information or services rank top, while others (such as compliance with laws and regulations, or political motivations, or increased call centre agent utilization, to name but a few), might be of importance in specific countries or contexts.

Secondly, we provided an in-depth analysis of three highly pertinent challenges in multilingual VUI design for emerging markets, viz. how multiple languages should be offered in an IVR, what factors influence the choice of the persona, and how the choice between touch-tone and speech as input modalities should be handled. We investigated 34 selected South African IVRs and found that only nine had a multilingual offering, with only five having some form of speech input. For the South African context (and certainly other similar contexts) the local availability of commercial-grade technologies and expertise (to develop, fine-tune and maintain such technologies sustainably) are significant hurdles for implementing ASR. Also, persona and gender choice for prompts do not feature as high design priorities in

such contexts, due to a lack of business intelligence related to language attitudes, making it difficult for designers to make informed choices during the design phase. Our contention is that cost is a primary driver for multilingual IVR development in emerging markets, despite the many positive business drivers in support of multilingual IVRs.

As part of the above-mentioned Lwazi project [2] we are developing various multilingual, telephone-based proof-of-concept services to improve service delivery and information access in non-traditional, non-mainstream customer groups, such as people living in deep rural areas without internet access, people with low levels of literacy, people with impairments or disabilities, etc. The overall aim is to assess “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” [2].

One of the specific services that we are exploring – and which is the focus of this publication – is an IVR service developed for the Department of Basic Education (DBE), which is aimed at obtaining feedback from children regarding the South African government's National School Nutrition Programme (NSNP). The NSNP provides meals to circa 7 million learners in 20 000 schools on a daily basis; our target group is therefore aged 12-18 (although younger learners might also phone in), with the main target group 13-15 years of age. In another publication [9], some of the preliminary findings of focus groups used in the design of this School Meals Line (SML) have been discussed at length.

The SML consists of a dual frequency multi-function (DTMF) input IVR which is used to gather the data from the users. The data is stored in the SML database which is linked to a web interface developed in Drupal. The web interface was built using the Drupal web content management system. The IVR was built using the open source Lwazi telephony platform (<http://sourceforge.net/projects/lwazi>).

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. The IVR is provided over a standard ISDN line, which interfaces with the Asterisk software PBX via an ISDN-SIP gateway with the SIP protocol. 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 SML IVR dialogue application, which also interfaces directly with Asterisk.

The SML was designed and piloted in five schools across three provinces over a period of five months during 2011. The application includes a web-based monitoring

interface which provides for real-time tracking of the responses from users. The current interface also provides for (manual) transcription and translation of user messages, and filtering of the messages per school, province and date. The data can be downloaded for further analysis.

In this paper we want to use the SML as a case study to verify the business models and design issues we identified and framed in the above-mentioned two publications [7, 8]; ultimately we aim with this paper to get a better understanding of business decisions and design choices to be made when designing services/applications/user-interfaces for multilingual emerging markets.

In the next section we describe the various business drivers of the SML at length – and seek to understand what other business drivers we should add to our initial list [7, 8]. Section 3 deals with three of the pertinent design issues for multilingual design, viz. the language offering, persona choice, and input modality. Section 4 presents conclusions and our ideas for future research.

2. BUSINESS DRIVERS

In conjunction with the national NSNP unit, we conducted several joint requirements planning sessions to analyze the operational context of the SML. We used the model developed in [7, 8] to structure those discussions and grouped the 17 business drivers identified in the model into two categories:

Primary drivers: cost savings, increased customer satisfaction, and improved access to information and services.

Secondary drivers: improved branding, revenue generation, customer retention, customer delight, increased call centre agent morale, increased agent utilization, improved productivity, access to business intelligence for strategic advantage, opportunities for upselling of products, compliance with laws and regulations, political motivation, competitive advantage, response to pain-points, and multi-channel consistency.

In considering the business drivers for the SML, we first discuss the primary drivers, then the secondary drivers. Lastly, we consider whether any new business drivers emanate from the SML, which could help to improve our model [7, 8].

2.1. Primary drivers

Our analysis indicated that the following three primary business drivers from our model [7, 8] apply to the SML:

Cost saving: Cost saving is the reason cited most often for implementing an IVR system. Cost saving occurs mainly through the optimization and automation of selected work processes which increase efficiency, thereby reducing expenditure. In the case of the SML, costs are saved in two ways: (1) the feedback enables the

DBE to rapidly identify a problem and focus attention on resolving it; and (2) the supply chain and reporting lines are improved. We therefore introduced a second IVR system – the Coordinator Line (CL) – to enable the NSNP school coordinators at each school to provide daily reports on the meals fed at their respective schools. The CL is, however, not the main focus of this paper.

Increased customer satisfaction: Improving the efficiency and effectiveness with which services are delivered, will generally increase customer satisfaction. The main objective of the NSNP is to ensure that learners are fed a balanced meal that will increase their capability to learn, as good health and nutrition are prerequisites for effective learning. A secondary objective is to improve school attendance rates [10]. As indicated above, the SML enables the identification of problem areas and facilitates their efficient and effective solution – thereby also increasing customer (learner) satisfaction and enabling the NSNP to achieve its objectives. Being able to complain about and provide feedback on a service received, may also increase customer satisfaction.

Improved access to information and services: Automating access to relevant information or services may improve service delivery; optimizing service delivery is a national priority of the South African government. The SML contributes to improving service delivery in two ways: (1) it provides an effective and efficient channel for users to provide feedback on a service which they are receiving – feedback which they might not have been enabled to provide previously; and (2) it empowers the DBE with information on the NSNP implementation challenges, which it can then address more effectively and efficiently.

2.2. Secondary drivers

Of the 14 secondary business drivers identified in [7, 8], the following seven apply to our case study:

Response to pain-points: Responding to customer requests or demands based on knowledge of their pain-points, may further the business aims of an enterprise. The SML enables the DBE to obtain first-hand information on problems that learners may be experiencing with the NSNP, as well as insight into their nutritional needs and demands. Armed with this information, the DBE can address the NSNP implementation challenges and monitor whether there is improvement in pain-points once reported issues have been resolved.

Compliance with laws and regulations: The NSNP is funded through a conditional grant from the South African National Treasury and its implementation is regulated by the applicable Grant Framework [10]. The SML (and more particularly the CL) enables the DBE to monitor compliance with National Treasury's

implementation directives for the NSNP. In addition, the language offering in the SML (see 3.1 below) enables conformation to language prescripts as stipulated in various laws and policies, such as [11] (sections 6(3)(a), 6(4) and 9(3)), [12] (section 2(c) and (d)), and [13] (paragraphs 2.1.2, 2.2.2, 2.4.3 and 2.4.6.2). These prescripts prohibit unfair discrimination on the grounds of language. They also call for oral communication with the public in the preferred official language of the target audience, equitable (multilingual) access to government services and information, and good language management for efficient public service administration which meets the needs of the public.

Business intelligence: Call analytics can assist to determine call reasons and customer profiling. For example, insight into caller behaviour can be used to optimize IVR design and develop differentiated and bespoke offerings. Implementation of the NSNP differs slightly from province to province, both in terms of content and operation: there are language differences and some provinces provide two meals to learners, while others provide one meal daily. The IVR design for the SML reflects these content differences – it offers language choices and prompts tailored to the province from which the call is made, thus enabling bespoke information gathering. (This applies equally to the CL – specifically relating to the types of food served in each province.) By providing provincial NSNP staff with information pertaining to their province, the SML (1) creates opportunities for differentiation at school, district and provincial level; (2) enables information-gathering on a range of issues – from learners' food preferences to problem identification and programme administration; and (3) encourages duplication of best practices. At a national level, the SML facilitates policy change, leading to improvements in the implementation of the NSNP.

Improved productivity: Automating mundane and routine tasks and services and routing complex tasks to relevant, skilled employees is likely to increase the productivity of the employees in an enterprise and improve efficiency. Through the web-based monitoring tool, the NSNP unit has real-time access to the information being obtained through the SML. The activities of the NSNP staff can therefore be directed towards complex tasks, such as problem-solving, rather than the more mundane tasks of collating and analyzing paper-based reports. Improved utilization of staff and improved productivity also help to alleviate the DBE's capacity constraints which are a result of the magnitude of the service delivery needs of its clients.

Customer delight: Although efficiency rather than customer/user delight is the main motivator for choosing an IVR solution, the SML does have the potential to delight the user for two main reasons: (1) novelty – it is the first time that the users are encountering an IVR and

children enjoy experimenting with new things; and (2) the users can exercise a language preference when interacting with the SML and can respond in their language of choice. It is noteworthy that learners indicated that they would prefer to use the service in English in order to improve their English language skills – the anticipated benefit of which also appeared to delight them [9].

Improved branding: Designing and deploying an IVR in concert with an existing marketing strategy can reinforce the image of the enterprise. Providing nutritious meals to large numbers of learners, daily, with limited resources, is challenging and may not always be a positive experience for every learner. A positive image of the NSNP with an emphasis on the benefits of the programme is therefore required. The SML assists in promoting a positive image of the NSNP, through its trustworthy persona, Mama Nandi (see 3.2 below), and her portrayal in the marketing materials for the SML as being friendly and helpful. Figure 1 illustrates the pamphlet used for marketing the SML to learners and Mama Nandi’s friendly disposition.



Figure 1. Pamphlet used to inform users about the SML

Political motivation: Political motivations such as serving a political agenda, being seen as “politically correct”, and portraying a “trustworthy” image to Government, may underlie an enterprise’s decision to implement an IVR system. Implementing the SML to enable compliance with laws and regulations and improve its service delivery, certainly boosts the DBE’s image of being politically correct and committed to national government priorities.

The secondary drivers identified in [7, 8] which *do not apply* to our case study are revenue generation, customer retention, improved call centre agent morale, increased agent utilization, opportunities for upselling products, competitive advantage, and multi-channel consistency. Many of these drivers emanate from the commercial and call centre environments, and are not really applicable in the SML context.

Our conclusions here are that, in congruence with our model [7, 8], cost savings, increased customer satisfaction and improved access to information and services were the

primary drivers for implementing the SML. Although many of the drivers coincide, there is substantial evidence of a number of secondary drivers that apply to this use case. Commercial applications are likely to have different drivers to those of the SML, making this a topic for future research.

3. MULTILINGUAL VUI DESIGN

3.1. Language offering

In creating a multilingual IVR, various design decisions are required around the language offering. These decisions pertain firstly to how many and which languages to offer, an issue typically addressed in the requirements analysis phase. Secondly, the designer must decide where in the IVR the languages offered are presented and how the language offering is made (e.g. through upfront language menus or caller line identification, etc.). Finally, in the prompt design phase, the sequence of languages and the medium of the offering (e.g. all languages presented in English, or rather in each of the respective languages) must be determined. The decision on which languages to offer within a multilingual IVR is based on a complex interplay of various factors (for further details see [8]). Below we discuss these factors in the context of our design decisions for the SML:

Caller demographics: Various sub-factors beyond just the primary language of the callers need to be considered:

Language proficiency: The designer must take into account the levels of multilingualism of the target audience. For the SML, we found that children are mostly multilingual in 2-5 languages [9]. English was almost always one of the languages being spoken, with the remaining languages being the dominant local languages for the area. Thus, for our current pilot deployments across three South African provinces we provided five languages, viz. English, Sepedi, Setswana, isiZulu and Afrikaans. These are the dominant languages used in the schools we targeted.

Language attitudes: This is a crucial factor that delves into caller preferences for using English vs. a home language, especially in the context of using IVRs and information and communication technologies in general. We conducted a user study with our target audience of school children aged 12-18 years to investigate language and input modality in terms of performance and preferences [9]. We found that a majority (80%) of the children reported that they prefer to use English over a local language, citing reasons such as “my teacher says we must speak English”. However, interestingly, in terms of the caller statistics for our pilot deployments we found that 43% of callers chose English and 57% chose a language other than English (presumably their own language). Figure 2 illustrates the number of calls per language. Note, the five pilots

had been running for varying periods of time (1-4 months) but all had English and two other languages available.

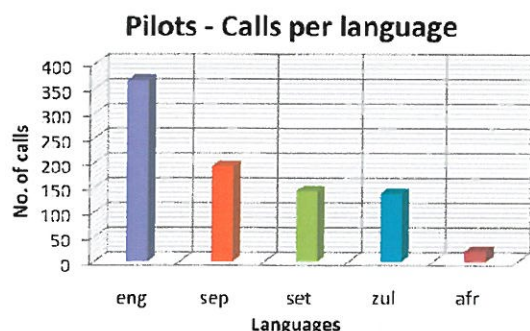


Figure 2. Total calls per language across pilots

These results show that the pilot deployments experienced much higher usage of non-English options than expected (based on the initial user study). Thus, we conjecture (not empirically) that user preferences (for a local language or for English – see [7] for further examples) may vary across user studies and real world deployments due to longer term and more frequent interactions.

Language variety: This factor considers the choice of dialect that should be used for a particular language. For the SML, we used the standard varieties of the official South African languages, whilst ensuring that the language usage was simple and clear to understand for children.

Geographical distribution: Various languages can be offered within an application based on the dominant languages of the areas. We chose to offer the most commonly spoken languages within the provinces in which we piloted, based on our investigations and references to national language statistics [14]. For example, for North-West Province we offered English, Setswana and Afrikaans, since these are the three dominant languages in the province. (In addition to the dominant languages, we also offered isiZulu and Sepedi during piloting in order to explore whether users would actually use these languages. In the two schools in which the SML was piloted in North-West Province, we found that 78% of the calls in the one school and 90% of the calls in the other, were in the three dominant languages (English, Setswana, Afrikaans) of the province. The remaining 22% in the one school and 10% in the other were in non-dominant languages (isiZulu and Sepedi)).

Linguistics: Some languages in South Africa are mutually intelligible, since they belong to the same language group in a language family. Thus, [13] suggests that documents may be produced in six

languages – one from each language group. For the SML we chose to rather focus on design simplicity since our target audience was children, and thus opted to cover the most prominent languages in an area as opposed to covering all language groups (e.g. we included both Sepedi and Setswana, two languages from the same language group, but which are both widely used in our targeted schools).

External drivers: Often the socio-political context of the application setting plays a role in the decisions around language offering. Since the SML is a government-funded initiative, there is more impetus to provide the application in all 11 of the official languages of South Africa. However, we balanced this factor with that of caller demographics and linguistics, by choosing the most prominent languages in a region since our pilots took a phased approach. We foresee that going forward, the SML will be expanded to be available in the 11 official languages, with the most prominent local languages of a province being provided upfront.

History: This refers to the previous language offering of the enterprise, where adding/removing a language may be challenging for historical reasons. This factor did not apply to the SML, since there were no previous and/or similar channels to the SML.

In offering language choices, various strategies are available for providing more personalized language offerings. These include dedicated telephone numbers, upfront language menus, delayed language menus, automatic language identification (LI) using ASR, caller line identity, and computer telephony integration based-approaches. For the SML, we chose not to use personalised approaches since there is often shared phone usage in developing countries: a number of children had mentioned that they would use the phones of their family and friends to call the SML. Automatic LI was also not feasible since it poses many practical challenges for closely-related languages [8]. Dedicated telephone numbers were considered to be cognitively cumbersome for children. We therefore used an upfront language menu and selected a limited number of languages based on the various provinces' dominant languages (as opposed to providing all 11 languages). In the absence of sufficient call statistics, we cannot yet determine whether the sequencing of the language options has an impact on usability. As future work we intend to verify these language menu choices through user focus groups and call log analysis.

Our conclusion around language offering is that there is much need for language attitude research in designing IVRs for multilingual environments in general. In particular, and as pointed out above, we found that children's preferences varied across the user study and in-situ contexts.

3.2. Persona design

Persona design relates to the “character” of the voice, including age, gender, accent, brand and corporate image, etc. For the SML we considered, amongst others, the following issues identified in [7, 8]:

One, multilingual voice artist vs. several voice artists:

While scouting for potential voice artists, it soon became apparent that very few professional voice artists are willing or able to do voice work effortlessly and without accent, in more than two or three languages. If accented speech (see next paragraph) is not an issue, then one could use a single voice artist to cover a few languages; it is doubtful, however, whether one would find a voice artist who could cover all eleven South African languages. For the SML, we did not consider employing only one voice artist to be of critical importance.

Accented speech: Very little – if any – research exists on language attitudes of children, which makes it impossible to make assumptions about how accented speech would be received. Since we soon realised that the trustworthiness of the persona would be an important design factor, we opted for an accent neutral design, in line with the likeness principle (i.e. that users are more likely to be attracted to a persona similar to themselves [15]).

Consistency across personas: To ensure consistency across personas for different languages, the voice director and sound engineer played pivotal roles during the recording process. We also found that it helped if different voice artists attended each other’s recording sessions, although this could be a costly endeavour.

Human-like vs. machine-like: In the call-flow and prompt design of the SML our assumption was that inexperienced, young users would relate better to a more human-like persona [16]; our designs therefore tended to lean more towards a human-like persona without being frivolous. This assumption has not been tested empirically, and is certainly an interesting question for future research.

Our conclusion here is that the design choices regarding a persona is often not a critical one, especially where limited information is available on language attitudes and cultural differences. We also learned that trust is a very important issue, and it could be impacted on negatively in multilingual environments if the design and development process is not sensitive to cultural and other differences.

3.3. Input modality

The topic of input modality in terms of using speech input vs. touch-tone/DTMF is a widely-researched one. Varying results have been obtained, depending on the user community and the nature of the task and/or application, in both the developing and developed world contexts [17, 18,

19, 20]. It has also been found that user preference does not always relate to user performance.

In the SML user study [9], we found no significant differences in task performance but a strong user preference for speech input. In addition, children were comfortable with providing speech input and limited keyword input in particular, where close to 75% of the utterances were in-vocabulary and 14% were on-task (but out of vocabulary). This finding aids in determining the feasibility of using speech input with children in terms of children being verbose with the system vs. using the prescribed limited keywords.

Since producing an ASR system in an under-resourced language(s), specifically for children’s voices, is non-trivial, we chose to use touchtone for the initial SML pilots. These initial pilots also act as a bootstrapping mechanism to gather further speech data in-situ with the SML, which will in turn be used to assist in developing an ASR system for children’s voices.

Our results suggest that although children are able to comfortably use touchtone (as they did over the pilot period), the substantial effort required to develop a speech input-based interface for this target group may well be justified, based on the expressed preferences (during the user study); we plan to address this in our future work.

4. CONCLUSION

The SML is a typical example of the opportunities which South Africa holds for multilingual IVR systems: it operates in an environment where there is a high prevalence of telephones, particularly cell phones; it supports the South African Constitution by enabling users to exercise their linguistic human rights; and it helps to address socio-economic development needs that pose challenges with regard to access to information by large numbers of users in technologically illiterate communities characterized by widespread poverty. In future research on the business drivers for multilingual IVRs we would like to determine whether the drivers applicable to the SML are typical of government service delivery-type IVRs; apply our model to a commercial IVR use case; and undertake business modeling to determine the effect of the business drivers on the sustainability of multilingual IVRs. Future research may also consider user feedback on the actual deployment to validate the design decisions taken.

The analysis of the design decisions taken around the SML highlights the importance of thoroughly understanding the context of use for multilingual IVR design for emerging markets. For example, users’ language preferences can vary across experimental and deployment contexts and issues such as trust play a significant role in persona design. Overall, we find that language attitude research for multilingual environments plays a crucial role in answering such questions, and we intend to address these issues in

future work. In this regard, we also surmise that continuous call log analysis and user feedback will prove to be critical for fine-tuning multilingual IVR designs.

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6. REFERENCES

- [1] S.K. Agarwal, A. Jain, A. Kumar, P. Manwani, and N. Rajput, "Spoken Web: creation, navigation and searching of VoiceSites," *Proceedings of the 16th international conference on Intelligent user interfaces*, Palo Alto, California, pp. 431-432, 2011.
- [2] A.S. Grover, and E. Barnard, "The Lwazi Community Communication Service: Design and Piloting of a Voice-based Information Service," *Proceedings of the 20th International World Wide Web Conference 2011*, Hyderabad, India, pp. 433-442, March 2011.
- [3] E. Barnard, M. Davel, and G.B. van Huyssteen, "Speech Technology for Information Access: a South African Case Study," *Proceedings of the AAAI Spring Symposium on Artificial Intelligence for Development (AI-D)*, Palo Alto, California, pp. 8-13, March 2010.
- [4] Datamonitor, "An introductory guide to speech recognition solutions: understanding the technology, the vendors and the market," Whitepaper, Datamonitor, London, 2006. [Web: ftp://ftp.scansoft.com/nuance/whitepapers/wp_datamonitor.pdf; Accessed on: 2012/01/06.]
- [5] DMG Consulting LLC, "IVR to the rescue! A Benchmarking study of 2010 enterprise, contact centre and IT priorities and the critical role of IVRs in achieving these goals," Industry report, DMG Consulting, West Orange, 2010.
- [6] A.S. Grover, and E. Barnard, "Comparing Two Developmental Applications of Speech Technology," *Conference on Human Language Technology for Development 2011*, Alexandria, Egypt, pp. 81-86, May 2011.
- [7] G.B. van Huyssteen, A. Sharma Grover, and K. Calteaux, "Voice user interface design for emerging multilingual markets", *Festschrift in honour of Prof. Justus C. Roux*, to appear.
- [8] G.B. van Huyssteen, A. Sharma Grover, and K. Calteaux, "Offering multiple languages in interactive voice response systems," submitted: *Southern African Linguistics and Applied Language Studies*.
- [9] A. Sharma Grover, K. Calteaux, E. Barnard, and G.B. van Huyssteen, "A voice service for user feedback on school meals". *Proceedings of the Second Annual Symposium on Computing for Development (ACM DEV 2012)*, Atlanta, USA, March 2012, to appear.
- [10] Department of Basic Education, "National School Nutrition Programme: Annual Report 2009/10," Department of Basic Education, Pretoria, South Africa, 2009.
- [11] Republic of South Africa, *The Constitution of the Republic of South Africa, Act 108 of 1996*, Government Printers, Pretoria, South Africa, 1996.
- [12] Republic of South Africa, "South African Languages Bill", Department of Arts and Culture, Pretoria, South Africa, 2011.
- [13] Republic of South Africa, "National Language Policy Framework", Department of Arts and Culture, Pretoria, South Africa, 2003.
- [14] Statistics South Africa, "Digital Census Atlas", Statistics South Africa, Pretoria, South Africa, 2001. [Web: <http://www.statssa.gov.za/census2001/digiAtlas/index.html>; Accessed on: 2012/01/19.]
- [16] Balentine, B. *It's Better to Be a Good Machine Than a Bad Person: Speech Recognition and Other Exotic User Interfaces at the Twilight of the Jetsonian Age*, ICMI Press, Annapolis, USA, 2007.
- [15] Nass, C., and S. Brave, *Wired for Speech: How Voice Activates and Advances the Human-Computer Interaction Relationship*, MIT, Cambridge, USA, 2005.
- [17] K.M. Lee, and J. Lai, "Speech Versus Touch: A Comparative Study of the Use of Speech and DTMF Keypad for Navigation," *International Journal of Human-Computer Interaction*, 9(3), pp. 343-360, 2005.
- [18] B. Suhm, J. Bers, D. McCarthy, B. Freeman, D. Getty, K. Godfrey, and P. Peterson, "A Comparative Study of Speech in the Call Center: Natural Language Call Routing vs. Touch-Tone Menus," *Proceedings of the Conference on Human Factors in Computing Systems (CHI'02)*, Minneapolis, USA, pp. 283-290, April 2002.
- [19] A.S. Grover, M. Plauché, C. Kuun, and E. Barnard, "HIV health information access using spoken dialogue systems: Touchtone vs. Speech," *Proceedings of the International Conference on Information and Communications Technologies and Development (IEEE)*, Doha, Qatar, pp. 95-107, April 2009.
- [20] N. Patel, S. Agarwal, N. Rajput, A. Nanavati, P. Dave and T.S. Parikh, "A comparative study of speech and dialed input voice interfaces in rural India," *Proceedings of the Conference on Human Factors in Computing Systems (CHI'09)*, Boston, USA, pp. 51-54, April 2009.