Information Access for Low-Resource Environments

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Information Access for Low-Resource Environments

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1 INTRODUCTION

The digital divide, which is the uneven distribution in the access to, use of, or impact of ICTs between any number of distinct groups, is a problem that has plagued the world since the inception of the World Wide Web. Only about 24.4% of Africans are connected to the internet [2]. In Ghana, where this project was carried out, voice-telephony, television and radio are existing systems that function, but not adequately in the rural areas [4][5]. The cost of hardware and the cost of subscription required to access some of these services are unaffordable to many. The issue of literacy remains a barrier to the delivery of information in the current WWW formats. Ghana has a literacy rate of 76.67%, however the rural north, which happens to be a major food source for the country, retains the lowest literacy rates [6]. In addition to the above, there is an unavailability of information relevant to the livelihood of many in rural areas [3]. In the attempt to circumvent the issues of lack of infrastructure and unaffordability, it is important to center innovation on 'technology-in-use' as opposed to 'technology-as-invention' [7]. It is therefore important to utilize available technologies in ICT4D innovations but also to ensure that they are used with contextual issues (e.g. literacy) in mind. In this paper, we show a case study that tackles the issues stated by; relying on existing systems (Radio and GSM), utilizing low-cost hardware (Raspberry Pi), focusing on voice-technologies (mobile and radio), and utilizing a user-centered design methodology with early stakeholder involvement.

KEYWORDS

ict4d, low-resource, information access, unconnected, digital divide, user-centered design, rural, Sub-Saharan Africa

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The paper contributes the development of a new innovative information system, using user evaluations to provide quantitative metrics of the success of the specific design decisions made based on our ICT4D Methodology[5].

2 REQUIREMENTS ANALYSIS

This study used a collaborative, adaptive and iterative methodology to identify and tackle the issues from a socio-technical standpoint [5]. The study also forms a validation of the methodology by providing a practical application to an information system design and implementation. Through an iterative process, stakeholders and end-users provided insight into the needs of the system. In assessing the local infrastructure, by field visits and interviews with The Savannah Agricultural Research Institute (SARI), Ghana and other organizations, the unavailability and/or unreliability of certain information communication technologies that could have been in consideration was confirmed. The rural areas of the Salaga District (where the study was done) was found to have unreliable internet at best and in most communities often slow or unavailable. In contrast, GSM and radio reception was found to be available and often reliable.

2.1 Pre-Analysis and Findings

Interviews were carried out with 106 community members in five (5) communities, in a total of 2 sessions each; a structured interview, to obtain empirical data on the rural context (prior to development) and a System Usability Scale survey (after deployment), to measure the usability of the system from the end-user point of view. Analysis of the survey guided the project to *specify the use case and requirements*

2.2 Key Idea

To create an information access system for local communities by providing an FM broadcast system. This will enable rural communities to get access to relevant voice-based information in their own language(s). This will involve the design of a low-cost system, built on the Raspberry Pi with Solar Power-Banks that stores recorded voice fragments over GSM calls and broadcasts it over FM on short-range.

2.3 Key Requirements

Following an understanding of the context and the needs analysis, as well as considering the technologies available, the following are the key requirements of the system;

Must Have	Interactive Voice Response
	Local Language(s)
	Regular Information Updates
	Short-Range FM Transmission
	Monitoring
Should Have	Uninterrupted power supply
Could Have	Community-level Subscription-based service
	Wide-Range FM Transmission

Table 1: MoSCoW

2.4 Non-Functional Requirements

- Maintainability - NGOs/Companies and Institutions should have the ability to maintain the system and update information with ease
- Availability - Users should have the ability to reach the system at all times. As such, barring mobile network issues, the system should be hosted on a platform that will be available at all times
- Scalability - The system must have the ability to scale to different locations and for any number of subscribers and the system should be easily replicable
- Reliability - The system must ensure that information is as accurate as possible
- Usability - The targeted user group creates a requirement of simplicity in the user interface
- Cost-Effectiveness - The whole system must work together to be financially sustainable

3 IMPLEMENTATION

The various components of the system were *engineered, deployed and evaluated* in multiple iterations with adaptations in an Agile approach coupled with an adapted living lab approach[5]. The system was built on the Raspberry Pi 3B+ [1], and the Kasadaka platform was used for the system's audio input module. Kasadaka enables the development and hosting of voice-based information services, targeted at low resource environments[9]. The system allows the Information Provider to call and record a message, which is stored in Kasadaka's file storage. The FM Broadcast System was built using Pi-FM-RDS which generates an FM modulation[2]. The system reads the audio files from the file storage system and broadcasts on a loop on FM at 107.9MHz.

4 POST-ANALYSIS AND CONCLUSIONS

4.1 SUS Evaluation

The System Usability Scale (SUS) is designed to obtain subjective feedback on overall usability and user satisfaction[10]. For reliability analyses of the data, the absolute ratings for the 10 statements in SUS were used to calculate Cronbach's alpha[11]. The SUS showed good internal consistency (alpha = 0.743). The system received an SUS Score of 80.52 (an Adjective Rating[12] of "Excellent") with a Standard Deviation of 16.08. Learnability was 71.93, and Usability, a value of 82.67. The high scores for SUS, Learnability and Usability, indicates a high quality of end-user's experience with the system and the ability to utilize it with little to no prior training or help.

4.2 Conclusions

Information access remains a problem in many parts of the world[1]. Developing countries, like Ghana, have numerous rural communities that have little access to up-to-date and relevant information[2]. Available literature points us towards the use of 'technology-in-use'[7]; in the case of Ghana, mobile telephony and FM radio, concentrating on voice technologies[8] and local languages. This paper has presented a case study of an appropriate ICT4D methodology[5] in the development of an ICT4D system which is hosted and used in low-resource environment. We presented a System Usability Score (SUS)[10] which indicate that the requirements of the end-users were met and the system is easily used and learned. Information is a very important commodity for development[13]. The process of Information Systems development for low-resource regions is critical to successfully attaining the Sustainable Development Goals [3]. This process, however, is not trivial and requires an appropriate methodology that is collaborative, user-centered, and iterative.

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