

# English Summary

Information dissemination in its right format and context, especially in rural Africa, is crucial sometimes even for the survival of market value chains and whole communities. However, many proffered and popular solutions are, oft-times, outside the reach of many rural dwellers in Africa. For example, the World Wide Web (WWW) is a major global platform for knowledge sharing and information exchange. From television through pocket personal digital assistants to publishing, its impact on every facet of life in this age, especially in the developed worlds, is unprecedented. However, the fact still remains that despite this success of the Web, over a billion others in the world cannot access the wealth of information available on the Web [Aart et al., 2011]. This inaccessibility is mainly due to some important barriers that still exist [Boyera, 2008; BuddeComm, 2011; Cottrell, 2013] namely that,

1. The Web lacks specific *relevant content* to people in underprivileged communities. The reason is that availability of accessible and locally relevant content can be an incentive for people to access and use the Web. For example, language-wise, there is very little content on the Web in Bambara, predominantly spoken in Mali, or Dagbani spoken in Ghana, even though the two languages, put together, are spoken by over five million people.
2. *Access barriers* to the Web exist which include illiteracy, language barriers, and other major technical obstacles.
3. The development and adoption of ICT worldwide has not been even with most of the developing countries lagging behind the developed world. Many studies show great disparities that exist between countries with access to ICTs, the so-called *global digital divide*. For example, in the case of the WWW and Internet international submarine fibre optic cables have reached several African countries for the first time in 2009 and 2010.

That notwithstanding, Africa's mobile telephony infrastructure and subscriber base is one of the fastest growing in the world [Aker and Mbiti, 2010; Boakye et al., 2010; Hellström and Tröften, 2010]. A recent report by *Afrobarometer*, in fact, suggests that "more Africans have access to cell phone service than piped water" [Mitullah et al., 2016]. Radio technology is yet another technology that has taken a firm foothold in everyday life in much of sub-Saharan Africa. Radio has been referred to as the number one medium for information flow in rural Africa [Myers, 2008]. With this success comes opportunities to reach many with relevant information and aid information dissemination and knowledge sharing efforts in innovative ways.

In the context of this research, I describe one such initiative in which indigenous knowledge on soil reclamation are shared on a farmer-to-farmer basis in re-greening efforts in parts of the Sahel threatened by desertification. In the past, there have already been many attempts

at information dissemination for other such services in health, market information broadcast services among others. Those attempts, however, have mostly concentrated efforts on using SMS and USSD technologies offered by mobile service providers. Unfortunately, inherent deficiencies in these technologies have prevented such efforts from achieving substantial results and much needed impact. All such efforts are what have culminated in a broader area of research brought under the umbrella of ICT4D. With this background, my research primarily investigates new modalities for reaching out to the technologically underprivileged using speech technologies together with Web technologies to fill an information dissemination gap under a selected use case with rural farmers in Mali.

Chapter 2 investigates the history of speech systems (broadly referred to as Spoken Dialogue Systems) and what their applications have mainly been in developing countries. In the chapter also, the challenges and past experiences are discussed as well as the tools, platforms and how they can be leveraged for building such systems.

In Chapter 3, I describe strategies that can be useful when soliciting for requirements for any software project in rural Africa. In particular, I share practical experiences in Mali and some of the useful insights that led to eliciting and compiling use cases for this research. I also argue in the chapter that, essentially, traditional requirements gathering processes should be conditioned, when necessary, to suit the environment within which they are employed for adequate results. I share experiences on frequent technology demonstrations, on-the-spot improvising methods, bottom-up and collaborative strategies and show that they go a long way to direct conversations and aid requirement elicitation processes in a rural setting.

In Chapter 4, I describe the actual systems that are built from the use cases. That involves building a market information system (*RadioMarché*) and a messaging system (*Tabale*) for farmers using the technologies I describe in Chapter 2. The two systems were the actual implementations for two selected use cases from stakeholders in Mali. In both of these systems voice or speech technologies are employed in innovative ways to help solve local challenges and meet real needs. The main argument of the chapter is building systems that satisfy local requirements using available local infrastructure.

Chapter 5 describes a general purpose evaluation framework for evaluating any ICT4D project. I demonstrate how to extend the participatory/agile approach of software engineering to ICT4D and how to evaluate such projects as well. The evaluation includes analysis of data from system logs and compiled answers to designed user-satisfaction questionnaires which were collated as part of the results of the research. I also argue in the chapter that evaluation should be integrated into requirements gathering, implementation and roll-out phases of an ICT4D project and not be an outside, after-the-fact activity.

The final chapter of the thesis, Chapter 6, is where I generalize the findings of this research. In particular, I explain a bit the concept of development as regards this research and the role that the Web, speech/voice technologies play in information dissemination and knowledge sharing. I also explain further the part that context plays in this type of research and then discuss a strategy that has proven useful for contextualisation. I then examine the implications this research has on broader subjects such as curriculum and tertiary education in Africa.

# Nederlandse Samenvatting

WWW, het World Wide Web, staat universeel bekend als het wereldwijde platform voor kennisdeling en informatieverbreiding.

Maar als we dit iets preciezer bekijken: het is wel groot, zelfs hoogstwaarschijnlijk het grootste sociotechnische netwerk ooit, maar het is nog niet *echt* wereldwijd.

Immers, momenteel hebben zo'n 2,5 miljard mensen toegang tot het Web. Dat betekent dat zo'n 4,5 miljard mensen op deze planeet daar (nog) geen toegang toe hebben. Er zijn namelijk (nog steeds) miljarden mensen op de wereld die niet kunnen lezen en schrijven, of die geen Internet en Web hebben, of zelfs geen electriciteit.

Maar dat wil natuurlijk niet zeggen dat zij geen interesse hebben in of belang hebben bij het verwerven van nieuwe informatie en kennis van elders. Het proefschrift "The Web, Speech Technologies and Rural Development in West Africa — an ICT4D Approach" van Nana Baah Gyan, zelf wonend en werkend in Ghana, richt zich op dit vraagstuk. Hoe kunnen we informatieverbreiding en kennisdeling realiseren zoals het wereldwijde web WWW dat mogelijk maakt, maar dan in situaties waarin Internet en Web niet beschikbaar zijn, zoals in grote delen van Afrika buiten de grote steden?

Als Internet en Web niet beschikbaar zijn, moet men andere alternatieven voor massacommunicatie en kennisdeling zien te vinden. In ruraal Afrika, en in het bijzonder de Sahel-regio van West-Afrika waar het proefschrift zich op richt, is dit alternatief: mobiele telefonie + spraakdiensten + lokale/regionale 'community' radio.

Het promotie-onderzoek van Nana Baah Gyan vond plaats in het Network Institute onderzoekprogramma W4RA (Web Alliance for Regreening in Africa, [www.w4ra.org](http://www.w4ra.org)), en laat zien dat zulke alternatieven levensvatbaar zijn. Centraal in het proefschrift staat de ontwikkeling van Radio Marché, een ICT-toepassing waarmee lokale boeren in Afrika beschikbaarheid en prijs van hun producten (zoals honing of shea butter) bekend kunnen maken via mobiele telefoon plus communicaties uitgezonden over de radio. Dit draagt bij aan de vorming van agrarische waardeketens, en wel met een bereik veel groter dan de al bekende lokale markt, en bovendien in meerdere regionaal gesproken talen.

Radio Marché is uitgerold in Mali in samenwerking met lokale NGO's op het gebied van regreening en met diverse regionale radiostations. De toepassing heeft inderdaad geholpen de verkoop van producten zoals honing te vergroten. Men kan Radio Marché zien als een rurale pendant van eBay of Marktplaats.nl, maar dan gebaseerd op het gesproken woord.

Het proefschrift beschrijft voorts uitvoerig hoe lokale wensen ten aanzien van ICT-toepassingen in kaart kunnen worden gebracht, met behulp van veldonderzoek en workshops met lokale

gemeenschappen, dorpen en kleine boeren. Op basis van deze *'bottom-up'* gegevens uit het veld kunnen applicaties voor informatieverspreiding en kennisdeling, zoals Radio Marché, technisch worden ontwikkeld, doch op een wijze die nauw en aantoonbaar aansluit bij levende informatiebehoeften van lokale gemeenschappen.