Mr. Meteo: Providing Climate Information for the Unconnected

Francis Dittoh
fdittoh@vu.nl
Vrije Universiteit Amsterdam
Amsterdam, The Netherlands

Hans Akkermans
Hans.Akkermans@akmc.nl
Vrije Universiteit Amsterdam
Amsterdam, The Netherlands

Victor de Boer
v.de.boer@vu.nl
Vrije Universiteit Amsterdam
Amsterdam, The Netherlands

Anna Bon
a.bon@vu.nl
Vrije Universiteit Amsterdam
Amsterdam, The Netherlands

Wendelien Tuyp
w.tuijp@vu.nl
Vrije Universiteit Amsterdam
Amsterdam, The Netherlands

André Baart
andre@andrebaart.nl
Amsterdam Business School,
Universiteit van Amsterdam
Amsterdam, The Netherlands

ABSTRACT

A majority of the world remain non-beneficiaries of the World Wide Web due to issues like low literacy and relevance of information. This study presents Mr. Meteo, a system that provides weather information via voice prompts in local languages over voice calls to rural communities in Ghana. The study used an interdisciplinary approach to identify relevant informational needs and socio-economic implications, and a living-labs approach for early end-user and stakeholder involvement. Mr. Meteo was deployed in December 2018 at Bolgatanga, Ghana and represents a novel implementation in terms of delivering actual web data access to rural areas. The interest and positive feedback from farmers, and stakeholder's interest in continuity and scaling upwards, shows this approach to be an appropriate method of development and implementation of information systems for unconnected communities; successful due to end-user and stakeholder involvement, focus on existing technologies, the use of voice technologies to mitigate the problem of illiteracy, and relevance of the information to end-users.

KEYWORDS

Web Access, Digital Divide, ICT4D, Interdisciplinarity, Literacy, Voice Technologies, Climate Change, Sub-Saharan Africa

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1 INTRODUCTION

1.1 Digital Divide

In the past 28 years, the World Wide Web has greatly changed the way the world communicates and has metamorphosized the various aspects of life that are directly or remotely connected to it. The concept of a global village has been aided by the effective communication and access to information that the World Wide Web has provided. The problem remains however, that a large population of the world remain unconnected to the world wide web. A United Nations report [1] in 2017 shows that of the 7.6 billion people in the world, 3.58 billion (48%) are using the internet. Admittedly, this is a step up from the previous year's value of 45.9 percent, however, certain regions retain very high numbers of unconnected. Only 21.8% of Africans are connected to the internet; meaning about 1 Billion Africans have no internet access. In addition, there is an added disparity in gender access in developing countries, especially Africa. The reasons; Lack of Infrastructure, Low Incomes and Affordability, User Capabilities; basic literacy and digital literacy, Lack of Incentives for Access; lack of awareness, relevant content, and cultural or social acceptance [2]

1.1.1 Lack of Infrastructure. The lack of adequate infrastructure in Sub-Saharan African countries, plays a major role in the issue of connectivity for the unconnected. Admittedly, some systems exist and work well to some extent in certain countries. In Ghana, voice-telephony, television and radio are existing systems that function adequately, where radio and voice-telephony are more adopted in the rural areas. However, there is an internal urban-rural divide which means even further deterioration of services in the rural areas [3]. This is clearly seen in the areas of electricity and internet connectivity, which are less available and reliable in rural communities as opposed to urban communities [4].

1.1.2 Affordability. Regardless of infrastructural problems, there are systems that work and are available, if not fully reliable. In Ghana, voice and internet services have national-wide coverage [5], but the cost of hardware required to access some of these services (mainly internet), and the cost of these services remain unaffordable to many in both rural and urban areas. As such these technically feasible services remain financially unfeasible [4].

1.1.3 Literacy. In the unlikely event that all required infrastructure was available, and hardware and services were affordable by everyone, the issue of literacy remains a barrier to the delivery of information in the current World Wide Web formats. Ghana has a literacy rate of 76.67% and a youth literacy rate of 90.6% [1]. However, the rural north, which happens to be a major food source

[1]https://countrymeters.info/en/Ghana

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for the country, retains the lowest literacy rates [6]. Currently 80 percent of online content is available in only 10 languages, which only around 3 billion people speak as their first language [7]. In addition, information available online is heavily biased towards text and thereby discriminates against those who cannot read and write [4].

1.1.4 Relevant Content. The literate, avid internet user does not require (and mostly does not seek out) random information that is irrelevant to their livelihood. A major barrier to connecting the unconnected has been that they do not find the information, even if available, to be locally relevant enough to warrant the effort to gain access to it [2]. The availability of information relevant to the livelihood of the end-user is a viable incentive to get connected.

1.2 Climate Change

An example of possible relevant information is climate and weather information. This is because there has been overwhelming evidence of climate change in recent years; increasing global temperatures, rising sea levels, increased ocean acidity and increase in extreme natural events are but a few obvious indicators [8]. Moreover, local farmers are aware of climate change and have attested to the need for modern scientific knowledge to augment their indigenous climate knowledge [9]. In Ghana, fairly accurate seasonal (regional) rainfall forecast is available from the National Meteorological Services[2] mostly online and during television weather reports (in English). Less accurate, but usable daily and weekly local forecasts are also available through a combination of satellite data and local weather stations which feed open weather sources online. This information however, hardly ever reaches rural farmers except through related Non-Governmental Organizations (NGOs), governmental institutions that directly deal with farmers and companies that work closely with rural farmers. These organizations however would usually work in specific communities and are unable to continuously and regularly provide climate information being restricted by the same barriers aforementioned; lack of infrastructure, affordability and low literacy rates, even though climate information may be indeed very relevant information in the local context.

2 PURPOSE OF STUDY

2.1 ICT4D 3.0

Developing ICT systems in low-resource environments requires a vastly different approach from the methodology utilized in high-resource environments. Known issues (as mentioned above) combined with unknown contextual issues regularly result in unsuccessful ICT4D deployments. Design shortcomings in numerous ICT4D systems leads to delays, high rates of project extension and restructuring, and high failure rates [10]. Previous research by the Web Alliance for Regreening Africa (W4RA) [3] has looked into information dissemination to rural communities [11] [12] [13] [14] and delved into the above issues regarding the digital divide. This study however, builds on this to present a novel, practical, on-the-ground implementation through an iterative, adaptive and collaborative field research methodology (dubbed ICT4D 3.0) [4]. Also, unlike the previous research, it goes beyond localized information sharing to actually connecting the web to rural communities by providing a feasible way of accessing web data in the form of weather forecasts.

2.2 Research Question

We know ICTs can make an impact in access to information [2], however, clear practical cases of development methodologies are still lacking. The purpose of this study is to do exactly that; practically implementing an earlier developed methodology (ICT4D 3.0) [4] in a case study.

This research answers the question of how ICTs can provide rural communities in developing countries with regular access to up-to-date information, from the world wide web?

- Considering the level of infrastructure in these rural areas, what ICTs are feasible and what are the implications of the disruption that may result from the introduction of these technologies?
- How can we technically influence affordability and financial sustainability of the system?
- Information readily available might not always be relevant to a user; what are the methods of determining relevant information for these communities?
- What measures can be taken to circumvent the issue of illiteracy in the delivery of information?
- How can these systems be maintained and further developed within local context?

These questions will be answered by presenting a novel, practical, real-world, local-context use of appropriate ICT4D methodology that has produced a viable information delivery system for rural communities that is of interest to end-users and adopted by stakeholders.

3 METHODOLOGY

This study used a collaborative, adaptive and iterative methodology (see Figure 1) to identify and tackle the issues from a socio-technical standpoint [4].

3.1 Research Area

The research focuses on Northern Ghana which covers about 40% (97,000Km^2) of the nation's surface area. It has a total population of 5 Million and by contrast has a far lower literacy rate compared to the national rate[4]. This area is selected for the case study because its rural areas fit the targeted group; being an agriculture-production region, having impact on the nation's food security, but being more deprived of infrastructure, and with higher illiteracy rates.

3.2 Context Analysis and Needs Assessment

3.2.1 An Interdisciplinary Approach. The study started off with a context analysis phase. Between 27th April and 1st May, 2015, a collaborative workshop, *ICT for Food and Water in Ghana - Collaborative Research by VUA and UDS*[5], was organized in Walewale, Ghana by Vrije Universiteit's Web Alliance for Regreening Africa

[2]http://www.meteo.gov.gh
[3]http://www.w4ra.org
[4]http://www.statsghana.gov.gh
[5]https://w4ra.org/2015/05/06/ict-for-food-and-water-in-ghana-collaborative-research-by-vua-and-uds/

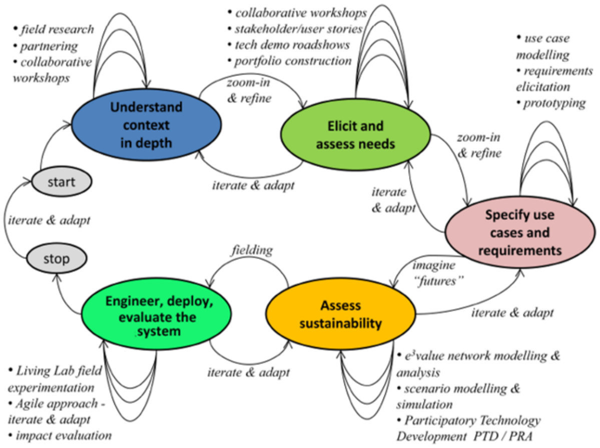

Figure 1: ICT4D Methodology [4]

(W4RA) team, together with a team of researchers from the University for Development Studies, Tamale, Ghana[6] (see Figure 2). The team consisted of a multi-disciplinary group of experts in rural economics, animal science, tropical agronomy, irrigation, microfinance, sustainable land management, gender, value chain development and ICT4D. With some existing work (notably among these being the Digivet Animal-Health Application [15]) by ICT4D master course students in Computer Science, Information Science and Artificial Intelligence, from the VUA as guidelines, the workshop brainstormed around the various technological possibilities for information delivery systems related to food and water security. Experts weighed in from all angles on issues like technological feasibility, financial sustainability, gender inclusion and especially the local context. The buddings of this study was born out of this workshop. The study also had input from work being done in other countries in related research. Workshops involving stakeholders and farmers in Burkina Faso[7] aided in assessing the study further; the contrast of context and needs from region to region gave a deeper insight into the differences and similarities in requirements. Subsequently, other institutions, organizations and individuals were involved iteratively. The Savanna Agricultural Research Institute (SARI)[8] located in Tamale, Ghana, which is working directly with local farmers in the region, and Cowtribe[9], a company that provides veterinary services with the use of ICT-driven technologies provided further insight in the areas of meteorology; the local outlook and understanding of climatic conditions, and communication; language and information dissemination in the local context.

3.2.2 A Living Labs Approach. The above-mentioned workshop in Walewale, Ghana, which formed the starting point of this study, took on a Living Labs approach and accordingly included end-user involvement from the get-go. Workshop participants visited Guabuliga, east of Walewale, a community of about 2000 inhabitants who live from rain-fed agriculture and livestock, where the discussion

Figure 2: Collaborative workshop was organized in Walewale, Ghana

continued with the inclusion of 50 to 60 members of the community. The idea of Mr. Meteo application originated from the rural community during this focus group discussion. Upon giving a general overview of the possibility of information being sent to them, local community members were immediately very vocal in putting forth what information they deemed relevant. Climate information was mentioned and they indicated that this was because climatic conditions had changed from the norm over the years. Subsequently, the mention of climate information had been a recurring theme in most communities visited.

3.3 Use-Case and Requirement Analysis

As an understanding of the context began to form, the authors began to elicit stakeholders and end-users needs of the system, in an iterative fashion. An assessment of the local infrastructure, by field visits and interviews with SARI and other organizations, pointed to the unavailability and/or unreliability of certain information communication technologies that could have been in consideration. Internet access in the rural areas of the northern sector of Ghana were found to be unreliable at best and often slow or unavailable. In contrast, mobile telephony and radio reception was found to be available and often reliable. In addition, all end-users - in the initial interviews and all others subsequently - owned or had access to a mobile phone (Ghana has a mobile penetration of 130.9% [16]). Other research has found very little to no use of SMS and little to no use of smartphones in the rural areas of northern Ghana [6]. This has been found to be due to the inability to read and write. These findings have been further verified during this study. Further assessment of the issue of literacy revealed that, end-users would be open to voice-based information delivered in their own local languages.

3.3.1 Key Idea. An analysis of the above resulted in a fine-tuned key idea - To build a system that provides weather information via voice prompts in local languages over voice calls to rural communities in northern Ghana. Members of rural communities will be able to call in to a local mobile number, upon which the system will answer and read out the weather forecast in their own local language (see Figure 3).

[6]http://www.uds.edu.gh
[7]https://w4ra.org/2016/07/05/w4ra-team-visiting-farmers-innovators-in-gourcy-burkina-faso/
[8]https://sari.csir.org.gh
[9]https://www.cowtribe.com/

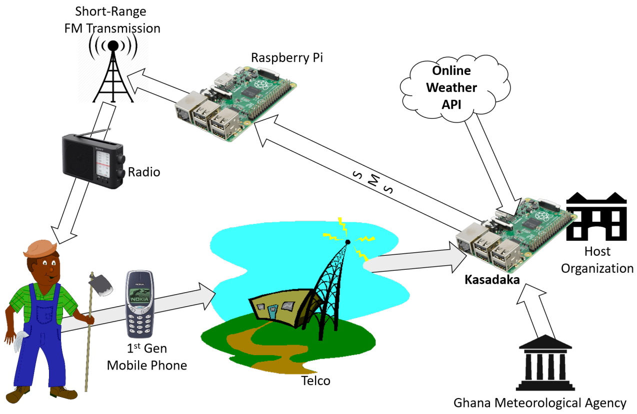

Figure 3: Sketch of Intended System

3.3.2 *Actors and Goals.*

ID	Actor	Description
1	User	Call phone number to get weather forecast
2	Weather Source	Relay Weather Forecasts
3	NGO/Company	Manage Users
4	NGO/Company	Record Voice Fragments for new languages
5	Support	Monitor system; maintenance

3.3.3 Key Requirements. Following information obtained from rural communities as well as considering the technologies available, the following are the key requirements of the system;

Must Have

- Weather forecast source - A reliable and available web-based weather source is needed to provide daily forecasts.
- Localized forecast data - The forecasts must be specific to the local community.
- Rainfall forecast data - Local communities are especially interested in rainfall forecasts as it directly relates to their farming practices.
- Seasonal forecast data - Local communities are interested in seasonal forecast as it helps in long-term planning for the farming season.
- Interactive Voice Response - Due to the inability of the target group to read, a voice interface is required.
- Local Language(s) - Due to the inability of the target group to speak English (or other international languages), the voice interface must feature their own local languages
- Regular Weather Updates - The system must regularly update weather forecast data from the web.

Should Have

- Temperature data - Temperature forecasts, although not of top priority will aid farmers.
- Wind speed data - Wind speed information can be a good indicator of extreme weather and storms.
- Humidity data - Humidity forecasts, although not of top priority will aid farmers.

Could Have

- Subscription-based service - Added collaboration with local telcos could create a subscription-based call-in service with toll-free numbers.
- Short-Range Radio (FM) Transmission of information - Further development could include local community radio transmission of weather information using low-cost, financially sustainable hardware.

3.3.4 *Non-Functional Requirements.*

- Maintainability - Local developers should have the ability to maintain, adapt and replicate the system with relative ease.
- Availability - Users must have the ability to reach the system at all times. As such, barring mobile network issues, the system must be hosted on a platform that will be available at all times.
- Scalability - The system must have the ability to scale to different locations, for any number of subscribers and for multiple languages
- Reliability - The system must ensure that forecasts are as accurate as possible.
- Usability - The targeted user group creates a needed requirement of simplicity in the user interface
- Cost-Effectiveness - The whole system must work together to be affordable and financially sustainable

3.4 Feasibility and Sustainability Assessment

The feasibility and sustainability of the system is assessed by considering the technical and business/socio-economic feasibility as well as possible goal conflicts, dependencies and preconditions required for the system to function as a whole [4]. These issues were discussed in interviews with stakeholders at various levels of the study. Technically, the simplistic nature of the design makes Mr. Meteo feasible. The design focuses on affordable hardware, open-source software and does not require additional technical purchases and/or skills from the end-users. Socio-economically, discussions with stakeholders has shown that effective information flow to and from rural communities has been an ongoing struggle and therefore any technically feasible solution provides them with a way of not only saving time, but also delivering information they would have hitherto not been able to. Climate information falls under this latter category. Preconditions for the system to work include hosting capabilities required from stakeholders (in this case SARI and/or Cowtribe). These capabilities include basically power supply, internet access and access to local telephone network. The end-users are required to have a mobile phone. These preconditions and all dependencies were met and there were no goal conflicts.

3.5 Development and Testing

3.5.1 Kasadaka. Mr. Meteo is built on the Kasadaka Platform [17] [18]. The Kasadaka ("talking box" in a number of Ghanaian languages), enables the development and hosting of voice-based information services, targeted at rural sub-Saharan communities. The hardware and software of the platform are catered to the specific contextual requirements as found in these areas. The hardware forming the foundation of the KasaDaka platform is the Raspberry

Figure 4: Kasadaka Hardware

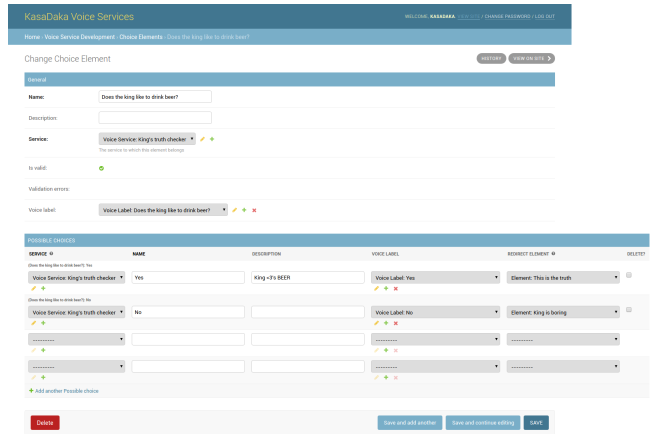

Figure 5: Screenshot of the Kasadaka VSDK.

Pi (see Figure 4), which is a low-resource computer based on an ARM processor. The Raspberry Pi runs a Debian-based Linux distribution. To provide the Raspberry Pi with connectivity to the local mobile phone network, a USB 3G modem is used. The total costs of the hardware is around US $70. The main software component that enables the development of voice services is called the Voice Service Development Kit (VSDK). The VSDK allows for the rapid development of voice service (prototypes) in a web-based development environment. The VSDK also generates VoiceXML files, which describe the possible interactions in a voice service. To serve these interactions in a phone call, the Kasadaka runs a stack of (mostly open-source) applications that provide the different functions that are required for voice-based interactions. Asterisk, an open-source telephony exchange application is used in conjunction with *chan_dongle* (an interface to phone modems) and VXI (a VoiceXML interpreter), to provide the voice-based interactions through the local GSM network [17].

3.5.2 Build and Testing. The system was built on the Kasadaka VSDK (see Figure 5) at the University for Development Studies in Tamale, Ghana. The first stage of setup involved restoring a copy of a Raspberry Pi Image with the Kasadaka VSDK onto an SD-Card fitted on a Raspberry Pi 2.

The audio fragments were recorded locally (in Gurune, the major language in Bolgatanga, for which no TTS and ASR exists), using a normal Android-based Smartphone and sent via internet to Tamale where it was converted to the appropriate formats and integrated into the VSDK. Fragments to support an additional language (Dagbani, also with no TTS and ASR) were recorded in Tamale, also using a normal Android-based Smartphone and integrated into the system to provide a control test case and proof of scalability in terms of language. The structure of the Mr. Meteo application is set up in a way that welcomes the user to the service and then proceeds to the weather forecast for the current day as well as the subsequent day. A total of roughly 5 hours (excluding the time for recording voice fragments) was needed to completely setup the system. The resulting system was deployed and evaluated in several iterations, using a local Ghanaian Network Provider (MTN) and soliciting feedback from Cowtribe, SARI and selected participants. The system is setup to retrieve data (see Figure 6) from Darksky Weather

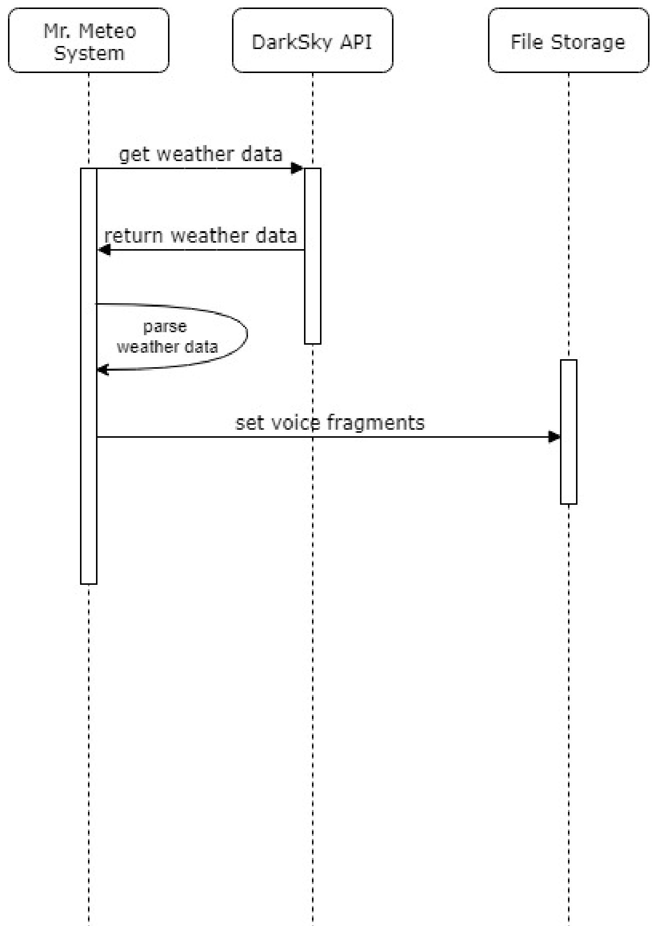

Figure 6: UML Sequence Diagram - Weather Information Update

API[10] for the specific GPS Coordinates (retrieved at the community

[10] https://api.darksky.net/forecast/[Key]/10.7933809,-0.8573095?exclude=currently, minutely,hourly,flags

and verified on Google Maps). Parsing of the data indicates which voice fragments should be accessed during calls into the system. When a user calls in (see Figure 7), Mr. Meteo automatically picks the call and immediately plays a welcome message followed by the predetermined voice fragments. To aid simplicity and in accordance with the particular context, user input is not required for receiving weather information (e.g. for language selection), since all callers to the specific system speak the same language.

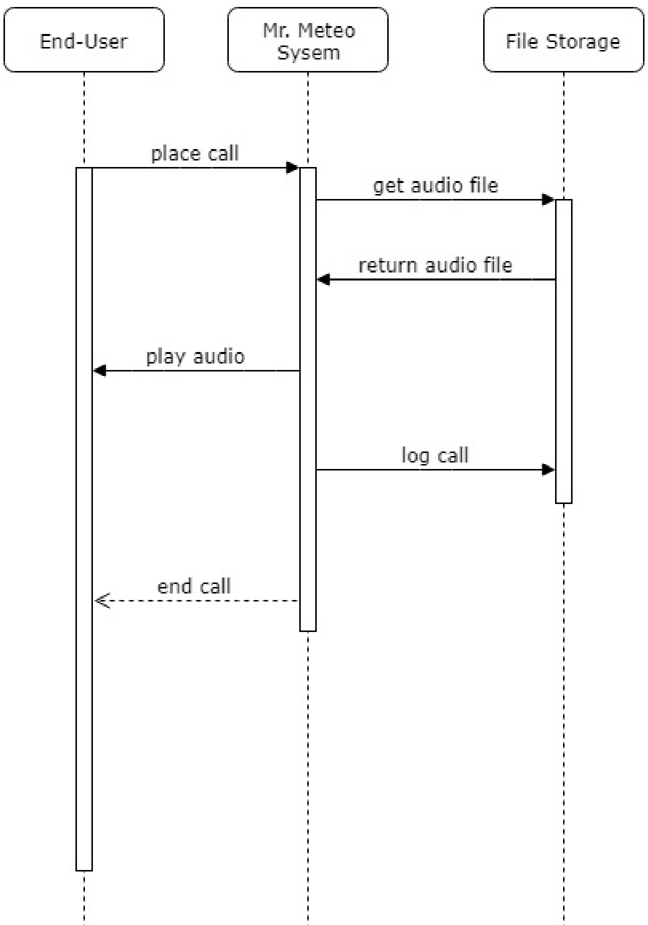

Figure 7: UML Sequence Diagram - Call Management

3.5.3 Challenges. One minor challenge faced was the need for interfacing external data (weather forecasts in this case) which must be accessed daily and parsed to indicate the appropriate voice fragments to switch to. For the test phase, this was not necessary, but during further iterations of the pilot, an update to the VSDK allowed the parsing of daily weather forecast for Bolgatanga, Ghana from Darksky API. In connection to this, internet access, which is not always available and reliable was sometimes an issue during testing and could be a challenge with subsequent regular use by end-users. A solution to mitigate this was to always retrieve a 7-day forecast (the system provides end-users with a 2-day forecast). This provides a backlog of data in the event the system is unable to reach the internet. Future plans to solve this challenge also include working on alternative means of data transfer to the Kasadaka. A major challenge faced involved the availability and readiness of stakeholders and organizations for field tests, workshops and interviews. Budget cuts, unforeseen changes in planning and busy schedules were among the few barriers faced by stakeholders and organizations that contributed to a slower development cycle than expected. A solution to this challenge in this study was to collaborate with a number of stakeholders so as to enable continued work in the event that any organizations had setbacks.

4 DEPLOYMENT AND RESULTS

Figure 8: Deployment Team and some farmers that participated in the Mr. Meteo Pilot

Mr. Meteo was piloted to a group of 50 farmers from 4 communities in Bolgatanga in the Upper East Region of Ghana on the 22nd of December 2018, in collaboration with the Cowtribe team. Due to the wide distances between communities, farmers were transported to a central location from the 4 communities. Some farmers also came along with their animals for veterinary tagging. In terms of farmers statistics in relation to the use of the system, it was found that all farmers owned their own mobile phones and used them regularly to make calls of which more than 50% were said to be related to farming and livelihood. In contrast, none of the farmers used the SMS features on their phones, although they are all aware of the function. Additionally, all farmers owned (or has access to) and radio set. Farmers needed little introduction to the system, since they have been involved in existing mobile-based communication systems for farmers albeit manual and expensive to maintain, and more importantly, farmers' view were previously solicited during the design phase. Farmers tested the system by calling into the phone number; those who did not call personally, listened in on others' calls. A focus group discussion and some individual interviews with farmers and stakeholder was held afterwards to ascertain the success of the pilot and to receive feedback on usability and any possible concerns. A follow up interview with Cowtribe was carried out to discuss the next steps.

4.1 General Impressions

Due to the methodology used in this study (which involved end-users and stakeholders), it was expected that the general impression of the finished system would be positive. This was the case, with there being enthusiastic reception of Mr. Meteo by both farmer and stakeholders.

4.2 Farmers Perspective

A total of 10 questions (see Appendix A) were discussed in a focus group discussion with farmers. The purpose of the focus group was to confirm existing data on mobile-telephony and radio usage (see Section 4) and also to get end-user feedback on the piloted system. Farmers, during the discussions, showed interest in the system and referred to it as being "good" and "helpful". They further indicated that it is a system they would use regularly. However, they also indicated that they would be less inclined to use it during the middle of the dry season, but more towards the end (to know when the rains would start) and during the rainy season (as expected; to know the trend of the rains). In terms of cost implications, most farmers indicated the willingness to make calls into the system to retrieve weather information, however a few were reluctant to commit themselves, even verbally, due to the cost of calling in. Furthermore, one farmer suggested a subscription-based service and this seemed to be more preferable to most farmers. Farmers, on being probed, also inquired of the availability of other types of information such as; disease outbreaks, human and animal health, farming practices and information on their children's schooling.

4.3 Stakeholders Perspective

In an interview with one of the co-founders of Cowtribe, Mr. Peter Awin, he gave his opinion of the system as "innovative and needed". The company was eager during the development period and contributed immensely to its success. They are also eager, and are providing funds, to scale up the system in terms of additional languages for other communities, other relevant content (being a veterinary-centered company, they are interested in information pertaining to animal health) and a future plugin system related to community (Ham) radio transmission (see Section 6). In addition, report of the pilot was presented unofficially to the Savanna Agricultural Research Institute (SARI), Tamale. SARI was originally unable to continue in their role as stakeholders due to certain internal funding issues, but the success of implementation has piqued their interest and they are currently working out avenues for continued collaboration. Stakeholders noted the fact that the low cost of implementation makes it feasible to consider for long-term implementation (see Section 5.2). The total costs of the hardware per implementation is around US$70. Running cost of hardware includes power costs (US$0.40 per month[11]) and internet data cost (only about 237 kilobytes per month is required, but due to internet bundle charges; US$3.80 per month (1GB) [12]). The presence of already existing corporate internet access in stakeholder's offices might offset this amount. These running costs show a financially sustainable system and this further encouraged stakeholders on the system's viability (see Section 5.2).

[11]http://www.ecgonline.info/index.php/customer-care/services/tariff.html
[12]http://www.mtn.com.gh

5 CONCLUSION

The study looked at a number of questions regarding providing rural communities in developing countries with regular access to up-to-date information, from the world wide web (see Section 2.2). The study presents a case study which looks into these questions. Although there is the obvious limitation of being just one case, the lessons learnt here can definitely be applied generally, within context.

5.1 Infrastructure

Infrastructure in the rural areas of Ghana is lacking, but there are ICTs that are available, reliable and in use; namely radio and mobile telephony. This study focused on using these available technologies to connect to the web, as opposed to the introduction of new infrastructure which results in expensive and extremely disruptive implementations. The focus on technologies already in use resulted in lower cost of implementation and being more acceptable by the rural farmers.

5.2 Affordability

Hardware required for getting access to web data and converting to formats suitable of the local rural context can be expensive. The study therefore utilized the Kasadaka; low-cost hardware with open-source software, to implement the system. This resulted in a low-cost system that was feasible to deploy and will be financially sustainable in terms of maintenance and usage costs. Stakeholders are currently working towards scaling up of the system, and this is partially due to the fact that scalability has been made feasible due to the affordability of the hardware and low running costs.

5.3 Relevant Information

Determining relevant web-based information for dissemination can be erroneously assumed to be trivial. Lessons from this study shows that an iterative, adaptive and collaborative field research methodology with early involvement of end-users provides a great determinant of what available web data may be deemed relevant to rural communities. Stakeholders indicated that adoption of these systems by the end-users can rely heavily on this and as such, as learnt from this study, should be considered a top priority.

5.4 Literacy

The study found that the use of text-based systems, which is prevalent for web data access, is not feasible in the context of rural northern Ghana, where people are unable to read and write. The ready adoption of mobile telephony and the preexisting oral-based communication culture informed the use of a voice-based system for disseminating web data. The added value of utilizing local languages merged to circumvent the issue to illiteracy. Granted, this presented an increased complexity due to the need of translations and language recordings, which is not always trivial; technical words and numbering systems are often somewhat problematic to handle although feasible in the long run.

5.5 Longevity

The success of this deployment is incomplete without continuity in the use and upkeep of the system and would be even more of a success if developed further. Long-term deployment and long-term evaluation would greatly increase the study's contribution to web science. This study is therefore in the process of achieving continued collaboration for hosting and upkeep primarily because of its early involvement of stakeholders (see Section 6). Stakeholder involvement resulted in a system that augments and adds value to their work thereby making it useful. Stakeholder involvement during the development phase enabled them to have a deeper understanding of the rudimentary aspects of the system which in turn fostered ideas on further development vis-á-vis their understanding of the local context and the feasibility of further development influenced by a low-cost and financial sustainable system (see Section 4.3)

6 FUTURE WORK

As mentioned, this study is far from being done. The continued development and scaling up of Mr. Meteo are considered imperative for all stakeholders. In the spirit of the iterative nature of our design methodology, the results of this study will form the basis for further development. The current system will be deployed long-term and expanded in terms of language and reach. Additional hardware will be procured to enable the system reach more communities and also deployed to regions that speak other languages. This will aid long-term evaluation of the study and system. In addition, Cowtribe will like to explore the build of a system around the same design to facilitate the dissemination of veterinary-based information to aid animal farmers in rural communities. The added complexity of integrating more varied information into the system will be subsequently delved into. Another future modification is the transmission of pre-recorded audio over FM frequency using a Raspberry Pi in tandem with Kasadaka. The general concept is to setup a device within a community, utilize Kasadaka to call in as administrator and leave recorded messages which the system will then transmit over a pre-determined FM frequency within a short range. This will be useful for delivering variable information which may have been hitherto cumbersome to create pre-existing voice fragments for (e.g. Mr. Meteo - Seasonal Forecasts, Disease Outbreaks, Other alerts) In addition, use cases that only require concatenation of pre-existing voice fragments (e.g. Mr. Meteo -Daily Updates) can also be triggered by SMS containing code for the required concatenation.

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A FOCUS GROUP QUESTIONS

A.1 Probe Questions:

(1) Do you own a mobile phone?
(2) Do you make calls regularly?
(3) How often are these calls related to farming?
(4) Do you send text messages regularly?
(5) Do you own a radio set?
(6) Do you listen to radio regularly?

A.2 Follow up Questions:

(7) What do you think about Mr. Meteo?
(8) Is Mr. Meteo something you would regularly use?
(9) Would you be willing to spend to call into the service?

A.3 Exit Question:

(10) What other type of information would you find useful on a system like this?