# Use case and requirements analysis in a remote rural context in Mali

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**Abstract. [Context & motivation]** Few studies have been reported a systematic use case and requirements analysis of low-tech, low-resource contexts such as rural Africa. This, despite the widespread agreement on the importance of ICTs for social and rural development, and despite the large number of ICT projects targeting underprivileged communities. **[Question/problem]** Challenges for requirements engineering (RE) in such environments, are related to unfamiliarity with the local context and differences in cultural and educational backgrounds between end-users and software engineers. **[Principal ideas/results]** We describe a systematic approach to RE in developing areas, based on the Living Labs methodology. Our approach is informed by extensive field research and based on co-creation within a multi-disciplinary and multi-cultural team of developers and users. This approach creates a shared understanding of the problem and its local context, and optimizes communication. **[Contribution]** We illustrate the approach using a case study of web- and voice-based communication services we developed for a rural context in Mali.

**Keywords:** Use case analysis, African context, Living Labs methodology, market information systems

## 1 Introduction

ICT services are commonly regarded as an important tool in furthering social and rural development in developing economies. Economic growth, socio-economic development and poverty reduction have been attributed to the adoption of ICTs [1]. Information and Communication Technologies for (social) Development (ICT4D) have therefore attracted the attention of international development organizations over the past twenty years. At the United Nations World Summit on the Information Society,

goals were set for developing a *"'people-centered, inclusive and development-oriented Information Society so that people everywhere can create, access, utilize and share information and knowledge..."'*[2]

In recent years the adoption of mobile telephony by rural communities has been extremely rapid. This has opened new opportunities for information and knowledge sharing and associated services in rural areas. Many ICT services have been developed and deployed over the past decade, of which a large number has been technology- rather then demand-driven, supported and financed by international donors. Many ICT4D projects have not survived after the end of the pilot phase [3]. Amongst the myriad of factors that make implementation of ICT services in low-tech, low-resource areas fail, we argue that the lack of a systematic use case and requirements analysis and a user centred approach is an important factor. Detailed descriptions of how use case and requirements analysis was actually done in rural contexts is necessary, especially since ICT4D projects are mainly initiated and led by technologically skilled teams that are usually unfamiliar with the local context.

In this paper we describe a case study of a systematic use case and requirements analysis in a rural African context involving multi-disciplinary and multi-cultural teams collaborating over an extended period. Given the initial unfamiliarity of the developers team with the local context, much time has been spent on studying the context, the identification of the actual problem, and the selection of use cases. Development has been done in subsequent phases, in which feedback by the users led to new requirements, and also to new use cases. Every stage has been characterized by extensive brainstorming sessions, focus group discussions, demos and co-creation. Our approach follows basically the Living Labs methodology.

### 1.1 Living Labs

There are several variations in the definition of a living labs, but generally speaking, living lab refers to a user-centred, open-innovation ecosystem[4], [5]. It integrates concurrent research and innovation processes [6]

Wikipedia describes it *"'The concept is based on a systematic user co-creation approach integrating research and innovation processes, through the co-creation, exploration, experimentation and evaluation of innovative ideas, scenarios, concepts and related technological artefacts in real life use cases. Living Lab approach involves user communities,as a source of creation. This approach allows all involved stakeholders to concurrently consider both the global performance of a product or service and its potential adoption by users. This consideration may be made at the earlier stage of research and development and through all elements of the product life-cycle, from design up to recycling..."'*[7]

Many studies have reported the Living Labs methodology as a valuable tool for innovation, and it has also been applied for innovations in less privileged communities. The Meraka Institute in South-Africa has set up a Living Labs South Africa (LLISA) and described in detail the approach of e-health development for rural communities [8]. Van der Welt et al. have reported on the Soshanguwe Living Lab in a rural township in Tshwane and the Venda Living Lab in Thohoyandou[9]. Both labs were set up for the co-development of ICTs, especially in the fields of health and agriculture. The two case

studies were mentioned as part of an extensive framework description of the Living Labs approach. No description of the actual analysis has been given in this paper, nor the specific services that were co-created in these labs. HewlettPackard Corporation (HP), in India, has done a three year i-community programme aimed to bring access to ICTs and resulting benefits to rural citizens of Andhra Pradesh [10] however, no reports of their detailed approach of use case analysis have been given. Despite the variety of papers that mention Living Lab as a valuable methodology for development context, we were unable to find literature describing any case study or detailed approach.

In our reserach we have adopted an approach of going from a large generic problem to very specific use cases. By carefully reducing the bigger issues to very specific use cases, we avoid that generic solutions are implemented that do not correspond to the specific context and user's needs. This process takes several iterations, in which we are informed by field research, and several phases of requirements validation. Each step helps the further elicitation of the use case and brings new requirements, as soon as an intermediary mockup, pilot or production system has been tested and evaluated in the local context.

The contributions of this paper are:

- An iterative approach to requirements engineering, borrowing from the Living Labs methodology and pragmatically adapted to fit in a low-tech, low-resource environment within a development context.
- A detailed description of two case studies of the development of mobile web-based information systems for a African rural context.

## 2 The approach

The case presented here is located in a specific low-tech, low-resource rural context in Sub-Saharan Africa. It differs from a use case and requirements analysis in a more traditional setting, in the sense that we start with a very generic problem at the start of the project. Therefore, an important phase preceded the actual requirements elicitation, which consisted of systematic, context analysis and problem elicitation.

The main challenge was to come to a shared understanding of the context especially because part of the team of (European) developers, were unfamiliar with the specific environment, whereas the envisaged users had low levels of (computer) literacy, and they had little idea in which way technology might support their local needs.

For this study extensive field research was done by a broad team. Borrowing from Living Labs, we especially aimed for a co-creation environment where both the problem and the (ICT) solution were developed in cooperation with the end-users. We held informal workshops and focus group discussions, brainstorm sessions, interviews, storyboarding and scenarios involving all stakeholders. These stakeholders were local community radios and ICT entrepreneurs, rural extension workers and small-holder farmers. Many field trips were organized to rural regions in Mali, Burkina Faso and Ghana. Radio stations were visited and farmers were interviewed in the field. This was all carried out locally by this multi-disciplinary, multi-cultural team.

Our approach is visualized in Figure 1 as a problem stack, where we started form the big generic problem and gradually narrowed down in several cycles, of subsequent and

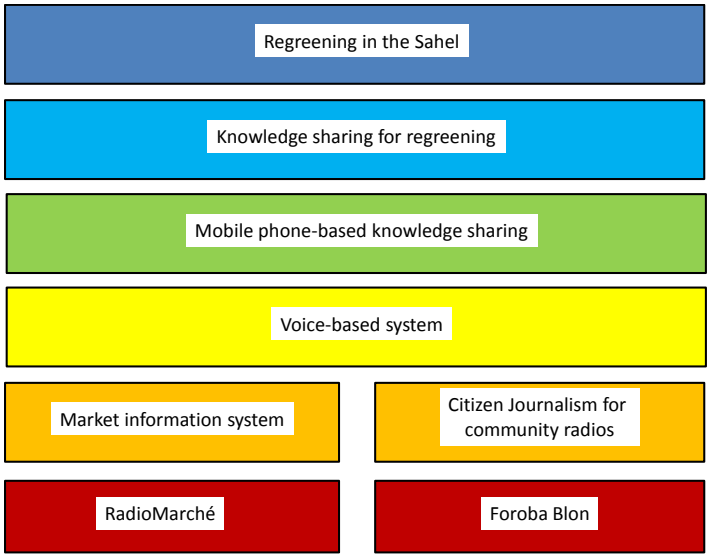


**Fig. 1.** The problem stack: from generic problem to very specific use cases

recurring use case elicitation, user verification and validation, development, co-creation and adjustments. The iterations coincided with our several field trips, as summarized chronologically in Figure 2. In the next sections, we will give detailed descriptions of these field trips and development cycles.

### 2.1 Regreening the Sahel

The case study described in this paper targets people living in small rural communities in Mali. Mali is one of the poorest countries in the world [5]. The main source of income in our target region is agriculture [11]. The production is mainly for subsistence, and the average income here is estimated to be between 1-2 dollars a day.

In the 1970s and 1980s, periods of drought severely deteriorated living conditions for many rural communities in this region. Twenty-five years later conditions have improved through farmer managed natural regeneration (FMNG) of trees. Using simple but effective farming techniques and inexpensive tools, farmers have managed to restore an area of over 5 million hectares. (see e.g. [14], [15]).

The success of the re-greening activities in Africa is mainly due to the rapid exchange and spread of local knowledge amongst large numbers of farmers. Word of mouth and farmer-to-farmer visits are traditional means of knowledge diffusion but today also mobile and community radio communications are important here. ICTs can enhance the latter significantly: combining existing radio and other spoken content with novel ways for voice based access and mobile Web services may enable to further increase the speed and spread of knowledge sharing among farmers.

[5] The Worldbank, Africa Development Indicators

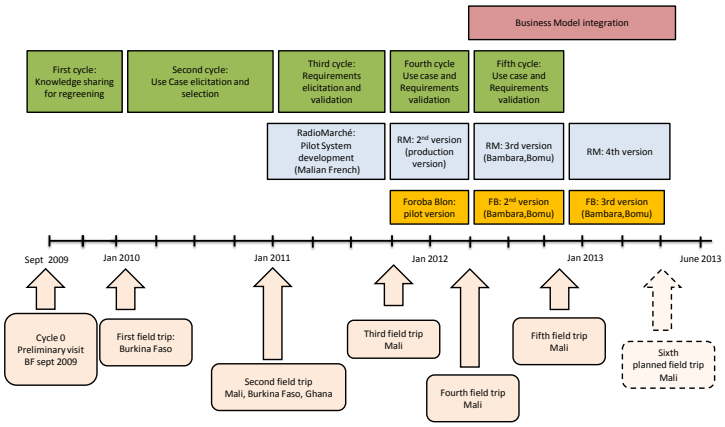


**Fig. 2.** Chronology of the different phases leading to Radio Marche and Foroba Blon

### 2.2 First cycle: Knowledge sharing for regreening

The first cycle activity aimed at creating a better understanding of the actual generic problem the local context and composing a general strategy to allow knowledge sharing in this context. This was done through a field trip to Burkina Faso in January 2010, including a two day workshop involving forty local stakeholders including representatives from farmer organizations, community radio stations, local NGOs in support of rural development, representatives from the local mobile telecommunication and internet providers, local ICT entrepreneurs and radio journalists. The European participants consisted of Web developers, information scientists, ICT4D experts, experts in sustainable land management. The days before and after the workshop, the W4RA group visited several local villages and a number of small-holder farmers, and did several field visits to subsistence farms.

The main outcomes of the field trip to Burkina Faso, were a better understanding of (i) the urgent need to improve knowledge sharing in rural communities; (ii) an understanding of the technical constraints such as no availability of internet connection or smartphones; (iii) the cultural conditions such as many different, under-resourced local African languages and low levels of literacy; (iv) the widespread availability and accessibility of (community) radio and mobile telephony in remote rural areas.

The core team was composed of researchers in web and information science and business modeling, web developers, experts in agroforestry and the local context from Sahel Eco, a local Malian NGO that supports smallholder farmers and local rural communities to improve their livelihoods through farmer-managed natural regeneration of trees, (FMNG). The team was in several subsequent field trips temporarily expanded by experts from other disciplines, that joined the field visits, i.e. Living Labs experts, business experts, and computational linguistics.

We teamed up with new project partners including Orange Labs and North-West University. A formal project was set up (VOICES), in which we focused on attaining knowledge sharing through voice-accessible ICTs, corresponding to the local con-

textual issues of low-literacy and low-infrastructure. The most important technologies identified were (i) an open source voice platform named Emerginov[6], developed by Orange Labs, that enabled the deployment of voice-web services, and that integrated the GSM phone network and the Web, enabling the development and deployment of mobile web-based applications, and (ii) the development of a language-pack for resourcing of under-resourced African languages, by computational linguistics from North-West University in South-Africa.

### 2.3 Second cycle: Use case elicitation and analysis

A second field trip to the region was organized in January 2011 as a two week road show through rural regions of Mali, Burkina Faso and northern Ghana, involving the core W4RA team and many local stakeholders (radio journalists, farmers) who joined the trip. The objective of this road show was to collect use cases through demonstrations of pilot software and show mock-ups. Focus group discussions were held related with farmers, community radio stations and local ICT practitioners. Qualitative data and usability feedback was collected at each demonstration site and was pooled in during subsequent brainstorming sessions to finalize the offering of possible mobile voice-based services, and collect feedback and new ideas from the local stakeholders. An example of a voice-based demonstration during the Road Show of January 2011 went as follows:

*Voice-based Demonstrations*

- Synopsis: the demo is a portal that offers 3 services: 1) listening by mobile phone a broadcast program which offers a song and broadcast on agriculture in Mali in French language 2) recording a message to be broadcasted 3) retrieving the messages that have been recorded
- Goals: the demo shows how voice services work through normal phone. In the field we also added an FM transmitter that demonstrated that a recorded message could be directly transmitted on the radio and received by people with their own radio-sets

Figure 3 shows photographs of co-creation sessions as well as a local radio host.

**Fig. 3.** Left to right: co-creation workshops with local farmers ; demonstration session with local NGO representatives ; host of local radio station Moutian in Tominian, Mali

[6] Orange Labs Emerginov platform: http://emerginov.org

**Use case elicitation** All key learnings from the road show were pooled in to crystallize a set of services, which became the core of the W4RA technology offering. At the end of this two week road show, a large number of interesting use case ideas ad been collected. We used a semi-structured approach to describe the use cases in non-technical terms, to ensure shared understanding of the problem at this stage. The long list of sixteen use case titles and their key stakeholders is shown in Table 1.

| Nr. | Use case title | Main stakeholders |
|---|---|---|
| 1 | m-Milk ordering and delivery service of Tominian | milk producers and NGO |
| 2 | m-Tree protection alert service Sahel Eco | farmers and NGO |
| 3 | mobile-web Event organizer for vaccination of herds | farmers |
| 4 | m-Farmer-expert directory service | farmer organization |
| 5 | NGO info-line about legal issues in several languages | Sahel Eco |
| 6 | Leave announcement or select your favourite song | Radio |
| 7 | Shea butter and honey trading service | Radio and Sahel Eco |
| 8 | Access radio programs and announcements on your phone | Radio |
| 9 | Gourcy seed producers seed certification service | Farmer organization |
| 10 | Radio questions and answers about agricultural issues | Radio |
| 11 | m-collective purchase organizing service | local buyers |
| 12 | m-GIS regreening service | Sahel Eco |
| 13 | m-Farmer social network | Sahel Eco |
| 14 | mobile-web regional market system | Farmer org |
| 15 | Sahel Eco portal to Regreening and access to m-services | Sahel Eco |
| 16 | M-event organizer for re-greening events | Sahel Eco, farmers |

**Table 1.** Long list of use cases

Based on the priority given to each use case by the local parters, and based on feasibility of the technical solutions, we selected two use cases to develop systems. (i) 7 shea butter and honey trading service, to build a voice-based market information system, and M-event, a mobile event organizer. The use cases are described in detail in the following section.

### 2.4 Third cycle: Pilot system development

After the first use case elicitation, a first pilot version of the shea-butter and honey trading system was built, which was named Radio Marché. During the field visit in November 2011 this was shown to the user in Mali for requirments avlidation and verification. In the following section the use case and system is described, a UML model is shown and the user feedback is given.

**Radio Marché** Radio Marché is a voice-based market information system, designed for farmers living and working in the area around the village Tominian, in Mali. Radio Marché is meant as a tool to improve communication between the farmers and their

potential customers. It is designed according to the requirements of the following use case, based on existing procedures. The use case is shown in Figure 4a.

In 2010 Sahel Eco started the Village Tree Enterprise Project, to create a paper-based Market Information System (MIS) involving nineteen small rural villages in the Tominian area, and four local community radio stations. This legacy system was dedicated to promoting sustainable use of forest resources, and developing small businesses based on non-timber forest products. The main product focus of the MIS is on shea nuts, shea butter, honey, wild fruits and nuts. The original MIS distributed up-to-date market information via community radio in the area. Our envisaged system thus started from this already functioning market information system (see Figure 4b).

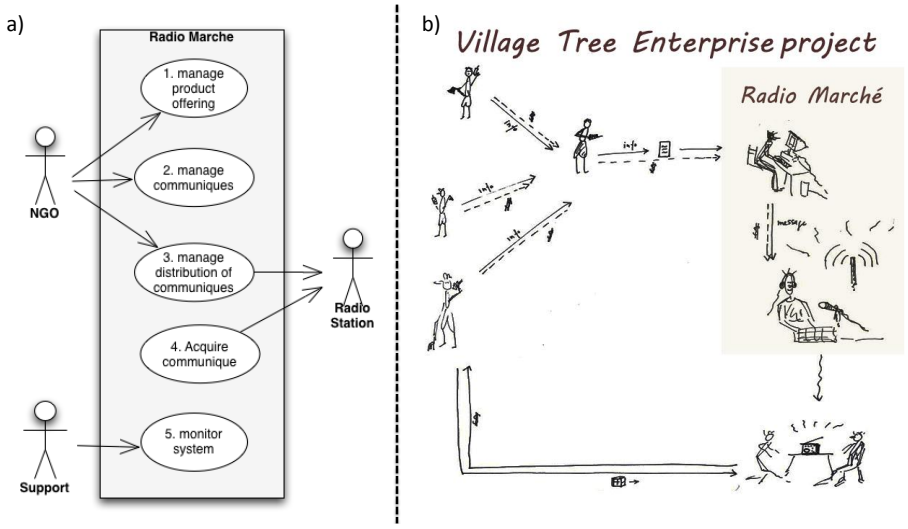


**Fig. 4.** The Radio Marché use case and systematic diagram

The original work flow was as such: An extension worker from Sahel Eco collects weekly market information from farmers in the villages near Tominian, about offerings of shea butter and honey. The information is sent by the producers via SMS or phone. The extension worker aggregates the info (product, quality, quantity, price, and contact phone number etc.) in an Excel sheet on his laptop. This info document is then sent by email from a cyber cafe to three community radio stations, whereas a hard copy of the information is physically brought to he radio that has no internet. The radios broadcast the market offerings information including the phone numbers of the producers. Potential customers either phone Sahel Eco or phone the producer directly to negotiate a trade.

**Summary of key requirements for Radio Marché** The following requirements were collected in the first and second cycles of use case eliciation

– A web-based input-form for NGO extension worker to enter product offerings (honey, shea butter, nuts) received by phone or SMS from producers
– An automatically generated voice-based communiqué offering
– Phone access to the voice communiqué for radio stations on a local line in Mali
– The communiqué must be also accessible for radio station through web
– The audio quality must be high enough for broadcasting over the radio
– The service must be accessible through the internet, so that data can be entered remotely by the NGO extension worker
– The voices in the message should sound familiar, i.e. local dialects or languages in the region of our project, the spoken languages are Malian French dialect, Bambara and Bomu
– The voices of the radio journalists must be used to ensure trust and recognition of the system.

Radio Marché consists of several components: a web-form where the NGO extension worker enters the aggregated offerings he receives from the farmers. This data, entered on the web-form is stored in a database. From this data a voice communiqué is automatically generated as an audio file. This audio file is accessible through mobile phone. The radio journalist calls a given phone number and hears the automated voice message. The voice message is generated using a local Malian voice. The language was one of the requirements collected during the early stages of use case analysis. In the pilot version we used a pre-recorded message spoken by one of our partners in French were used. Radio Marché was described in more detail in [13].

In our fourth cycle we did a new round of use case elicitation. This resulted in a use case for citizen journalism. The use case was a follow up of the Radio Marché system, and built on the experiences gained during the first three cycles. This use case will be described in section 3.

### 2.5 Cycle Four: Development of Second version

The fourth cycle started with a field trip to Mali in November 2011. During this trip, the pilot system was demonstrated deployed in Mali. At the same time, the use case and its requirements were validated. Additional requirements were identified as the results of end-user involvement and feedback:

– Phone access has to be on a local phone line in Mali. The phone lines have to be local, to save costs for the end-users. This is an important requirement for the voice platform if it is to be deployed locally in a production environment.
– The web-form has to be user friendly. The original design has been adapted in several cycles to make it more intuitive. The message is accessible for a certain period through phone, by phoning a local number. The audio quality must be OK, the voice must sound natural.
– The created communiqué has to be issued through voice in multiple languages The original communiqué is in a Malian French dialect. However, it is very important from the end-user's perspective to create voice communiqués in local languages such as Bomu and Bambara because many people, especially those targeted by the

voice systems do not speak French. There is need for a toolbox so that development of speech systems for under-resourced local languages becomes easier.
– Some radio stations do not have an Internet connection where others do. For the bigger stations a web interface where they can download the communiqué, is needed.
– User support, hardware and software maintenance are crucial. Local users will need training. Technical trainings are needed for local entrepreneurs of service providers who want to deploy voice systems.

The modified requirements were used to develop a second version of the Radio Marché system in this cycle. At the same time, the pilot version remained deployed in the local context.

### 2.6 Cycle Five

Cycle five started with a field trip to Mali, to both deploy the multi-lingual city and to evaluate the French version. This trip provided insight into a number of technical and social reasons for why the system was not used as much as expected.

One issue was that Malian phone numbers were not available in the period November 2011- April 2012, due to communication issues with the Malian telecom operator. This flaw was only noticed when the technical team visited Mali in November 2011, and spoke to the radio journalist from the local radios.

Another issue are the seasonal fluctuations in production of non-timber forest products -which were unknown to the developers. In some months, no communiqué swere issued due to absence of offerings. After the dry season, the farmers restarted their trading efforts and send new offerings to Sahel Eco.

In this cycle, automatic speech recognition for Bambara and Slot and Filler Text-to-Speech (TTS) for Bomu and Bambara were developed by the project partners in North-West University in South-Africa. They were added to the second version of Radio Marché. This was especially needed because none of the developers nor language technologists actually speaks Bambara or Bomu.

### 2.7 Final steps

A fifth field trip in November 2012 started the final cycle of development of Radio Marché. During this field trip, the language generation for all three languages was evaluated. The Bambara and French Malian dialect speech were found to be highly intelligible, but a number of problematic issues were identified. These issues are currently being addressed, as a next version of the TTS system is being prepared.

Further integration with local business models will be attained. For example, in a next version we are looking at the possibility of using phone credit for automatic payments of communiqués.

## 3 A second use case: radio platform for citizen journalism

In Mali many community radio stations exist, some of them state funded and connected to the national broadcasting service ORTM (Office Radio Television du Mali), and others privately funded or completely self-supporting. According to their business, funding

scheme, size and location some radio stations do have computers and internet, some have computers without internet connection and some do not have any computer facilities at all. All these radio stations are however situated within the coverage area of mobile telephony. The wish of these radiostations is to have a system for citizen journalism, accessible through phone. Amongst the requiremens are:

- User profiles, to control who is able to call the system
- Voice menu prompts in local languages, where a citizen journalis (CJ) receives the menu in his or her language
- Ability for CJs to retrieve, edit and delete messages
- Ability for Radio administratiors to retrieve, edit, delete and broadcast messages through a Web interface.
- Ability for Radio administratiors to retrieve, edit, delete and broadcast messages through a Voice interface.

According to the use case we proposed to build a Radio Platform, nicknamed Foroba Blon[7] (FB) consists of a data store containing recorded voice messages and related meta-information.

The interface to the FB radio platform is either purely voice-based, through mobile phone for entering new content. Users of this interface are the listeners from the region entering letters to the editor (LTE). These people only have mobile phones and no access to the Internet. Their calls are answered by the system with a pre-recorded welcome message in a local Malian voice inviting them to leave their message. For the sake of user-friendliness, the user interface and the dialogue for this category of users is kept as short and simple as possible, since the expected callers will be unfamiliar with interactive voice response systems and may not respond to a complex computer-generated dialogue asking to press buttons etc.

Another category of users of FB are the trusted reporters calling from the field. They phone in and leave their spoken report for broadcasting. These users are previously registered, having their phone number, name, address and preferred language in FB.

These users will be trained to navigate the voice-menu, and use the IVR system, asking to press a button on the phone to confirm or answer a question about their current location, subject of the message, etc. The FB system always answers the registered caller in his/her preferential language.

The voice messages are stored as audio files in the FB data store, together with meta-information being the date and time of the call, the length of phone call in seconds, the phone number of the caller. Messages from trusted users are linked to the owner, his/her address, and his/her preferred language.

The FB Radio Platform also has a web interface, where internet-connected end-users/customers can access and upload a voice message. Depending of their customer relationship to the radio, they can login to the radio-platform as (i) registered users such as NGOs, and trusted reporters, or (ii) as unregistered users. There is an option to sign up and create a user account by registering the name, phone number, village and

[7] Foroba Blon means a place where everyone may speak in front of the chief; the truth must told respectfully, without insulting anyone

preferred language. Unregistered users can access former broadcasts since this is public information.

For the radio administrator user, FB provides a web-based interface, enabling them to manage the data in the data store. It provides a file list where they can access, listen, broadcast, delete files, and add/update/delete meta-information. The radio station that has no computer nor internet, has only a very limited interface to the RP, since this is the constraint of a voice interface. He receives a welcome message asking if the wants to hear the last 10 messages, or if he wants to manage the welcome messages to the end-users.

The FB radio platform is hosted either locally, on a stand-alone computer or in the cloud. The RP consists of a voice platform running an open source webserver and a local voice browser that handles the voice interaction. The local FB radio platform uses a GSM gateway to process the calls over the phone network. This device handles incoming and outbound calls and streams the voice messages to and from the phone.

The FB radio platform could in theory be physically hosted anywhere in the world, on any webserver, connected to the Internet. However, in actual Malian case this is not possible. Firstly, the radio platform has to be accessible using an inexpensive local Malian phone number. Secondly, the web service accessed over the internet must be accessible locally. The local connectivity is usually of low bandwidth and high latency, making voice web services hosted in datacenters in the US or Europe, too slow for proper deployment in Mali. For these two reasons, the system has to be hosted locally in Mali. In the absence of good and reliable datacenters or hosting providers in Mali, the radios can decide to deploy the service locally at their premises.

### 3.1 Fifth cycle: requirements validation of Foroba Blon

In July 2012, the pilot version of the Foroba Blon system was shown to the end-users. They received a short training. Their feedback was collected. They were asked to test the system in a production environment.

A third system, named Tabale, based on use case nr 16: m-event, was shown to users for the first time. In this paper we do not expand on this use case.

The following feedback was given for FB:

- Visual representation of Call Flow and other usability aspects: We observed early on during the field testing with Radio ORTM Segou that a visual representation of the call flow was the need of the hour to adequately train both the radio staff and the correspondents on the field. We designed such a call flow menu card in French and Bambara and distributed them liberally across the radio stations and correspondents. Snapshot of the call-flow is shown below.

## 4 Next steps: sustainable business and ecosystems

Our sixth cycle, which started during our field trip in November 2012, our systems, were again tested and validated. We received more feedback, now based on real production tests. This feedback has not yet been processed at the time of writing this paper.

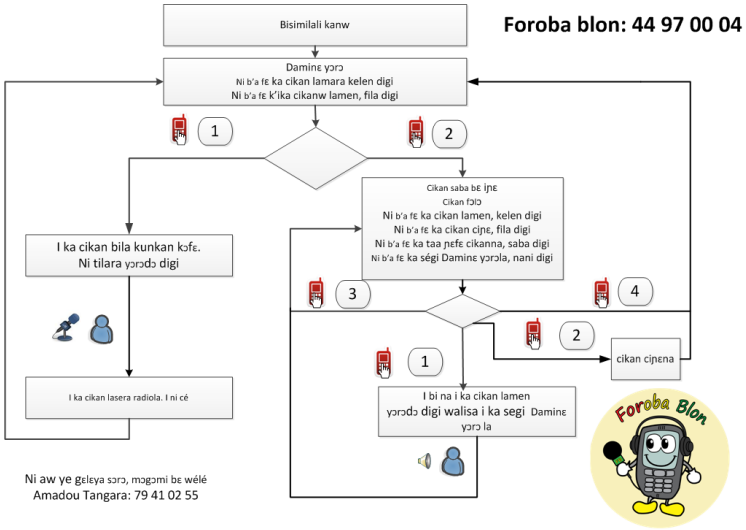


**Fig. 5.** Flow chart in the Bambara language for the Foroba Blon voice menu

One of the conditions for successful deployment of ICT services in a low-resource environment is the emergence of new businesses to ensure sustainability beyond the pilot phase. The affordability of the service is critical, as well as the business models that have to sustain an ecosystem.

At the start of our use case and requirements analysis, we were aware of the importance of sustainability, and we tried to include elicitation of existing trading systems, and tried to model this. However, during the first 20 months this proved to be very difficult. the users were not able to explain us how business would take place involving the newly developed services.

Only since summer of 2012, the first systems have been tested in a production environment. The radio stations have broadcasted market information and trade has taken place. The surprising outcome for Radio Marché was that the demand exceeded highly the supply of sheabutter and honey, that was offered regularly over the radio. This market an unexpected flaw in the Radio Marché service. The ICT service was succesfully deployed, but the underlying value chains were not in place. Our partners made suggestions and discussed how to better organize their sales. This was beyond the scope of our project.

The surprising outcomes of the Radio Marché production test, show that requirement analysis of non-functional requirements, related to sustainable business models, can only be done after the kick-off of the production phase.

Next steps identified for this cycle are:

- Implementing the new speech TTS and ASR systems in Bambara and Bomu in the current voice services.
- Expanding the scale of Radio Marché across more villages, creating new instances of the service;

– Applying Linked Data principles to connect market information to other resources on the Web (of Data).
– Sustainability: Identifying business models for voice services that are feasible from a local business prospective?
– Since the voice platform must be inexpensive and robust, if it is to be deployed locally, we are currently looking at solutions that are easy to maintain technically and inexpensive.

## 5 Discussion

In this paper we have described how use case and requirements analysis was done in a low-tech, low-resource environment. We have applied the Living Lab methodology and shown best practices that worked succesfully in this specific context. We are reporting about work in progress, so no final conclusions can be drawn on the sustainability of the systems.

Although theoretically our approach of spiral development and use case elicitation and user validation and verification is common practice in state-of-the-art requirements engineering, it has not yet been reported from a low-tech low-resource environment before.

Our approach starts from the big picture, narrows into the more specific technological and environmental condition, and then dives into the technologies and finally into use case elicitation. From the experiences of our research we argue that the

Given the great number of failed projects in ICT4D, we argue that best practices in RE in these given environments should be published and shared.

In 2013 we expect to continue the development of more innovative voice web-based services for rural communities in Mali. We will test and do more requirement validation and verification of Radio Marché with the users in their production environment. We will work on the following points:

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