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LIST OF ACRONYMS

NGO	Non-Governmental Organization
WP	Work Package
LMICs	Low Middle Income Countries
IVR	Interactive Voice Response system
DTMF	Dual-tone Multi-Frequency

PREFACE AND SUMMARY

This VOICES deliverable 4.4 contains the end-of-project evaluation of the m-health pilot in Senegal. It follows up on the VOICES deliverables D1.1, D4.1, D4.2, and D4.3.

The main goal of the pilot was to explore how voice and mobile technologies may help medical local authorities (RNL) to strengthen epidemiological surveillance and health workers' (lab technicians) training in medical laboratories.

D4.1 was dedicated to the presentation of m-health use cases and requirements analysis. Four use cases were described. The first use case was an application dedicated to epidemiological data collection. The second and the third use case aimed at supporting lab technicians' to maintain and strengthen their knowledge: the second application is a voice-based quiz application; the third one allows them to listen to different kinds of information created and issued by RNL. The fourth use case was a sort of helpline application that allows lab technicians to submit questions to RNL by placing voice messages through an IVR system. A web portal was also sketched; it aimed at allowing RNL to access data, manage and monitor the usage of the applications.

In D4.1, we presented the technical design of the first, second and third use cases, including the website. D4.2 describes the implementation of the applications, along with the first phase of user testing. D4.3 presents the first results of the deployment of the system (first, second and third applications, including the web site). It also includes a description of the implementation of the fourth use case.

This document D4.4 presents the final evaluation of the pilot. It is structured as follows:

In part I, we give a summary of the pilot rationale and present the general evaluation framework that we have employed for the field pilot.

In part II we focus on three major sub-evaluations: (i) the process evaluation (assessment of what has happened during the project); (ii) the evaluation of observed outcomes (effects concerning stakeholders and their environment); (iii) outlook assessment regarding future perspectives (beyond the project, in particular generalizability, transferability, sustainability).

Part III gives a summary evaluation and highlights some key lessons learned.

One of the most significant conclusions is that the m-health applications which have been used during the field trial were found relevant, appropriate and quite useable by the users. Another significant result is that an IVR-based user interface turned out to be less appropriate for data collection than a graphical touch user interface in the context of laboratories; all lab technicians that participated to the trial preferred the second interface. A third important result is that the implementation of this application has expanded data collection. A fourth significant conclusion is that RNL and lab technicians expressed their willingness to continue to use the applications. This result shows that the pilot's outcomes are likely to be sustainable, depending on the capacity of the ministry of health to take on the cost of the system. The most significant problem that occurred during the pilot was the instability of the

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platform and, to a lesser degree, that of the applications. So, although the conclusions are encouraging, the improvement of these technical aspects should be given serious consideration in order to ensure the sustainability of the whole. Annexes provide more detailed reports supporting the conclusions regarding sustainability and generalizability.

PART I: EVALUATION FRAMEWORK AND METHODOLOGY

This first part summarises the pilot rationale and presents the general evaluation framework we have employed.

Recap: Pilot Rationale

Infectious diseases are a major public-health problem in the developing world especially Africa. To fight these diseases, epidemiological surveillance plays a crucial role. It refers to the systematic collection, analysis and dissemination of health data for the planning, implementation and evaluation of public health programmes. Strengthening epidemiological surveillance in African countries is therefore vital.

The WP4 m-health pilot was precisely designed to address this issue by exploring the benefits of voice and mobile technology for strengthening medical labs' services and capacities in an African country, Senegal, by:

- expanding and facilitating epidemiological data collection by local authorities (Réseau National des Laboratoires) from peripheral laboratories, that is to include more laboratories in data collection
- fostering medical lab technicians training
- expanding expert support provided by local authorities (RNL) to laboratories

Expected benefits are:

- better epidemiological data collection
- better quality of medical diagnosis (e.g. better quality of disease detection, particularly in peripheral laboratories)

These are the goals that have been formulated by the main stakeholders of the project, especially Fondation Mérieux and RNL

The target groups of users of the pilot were:

- Réseau National des Laboratoires (RNL)
- District laboratories
- Medical lab technicians

RNL is a national organization aiming at improving the capacities of peripheral laboratories by training lab workers, monitoring the quality of their activities, and providing them with medical equipment and technical assistance when needed. Another role of RNL is to collect epidemiological data, called "notifications", from these laboratories. Collected data is then sent by RNL to the Department of Prevention (see figure 1) who dispatches it to the World Health Organization and the Department of Planning, Research and Statistics.

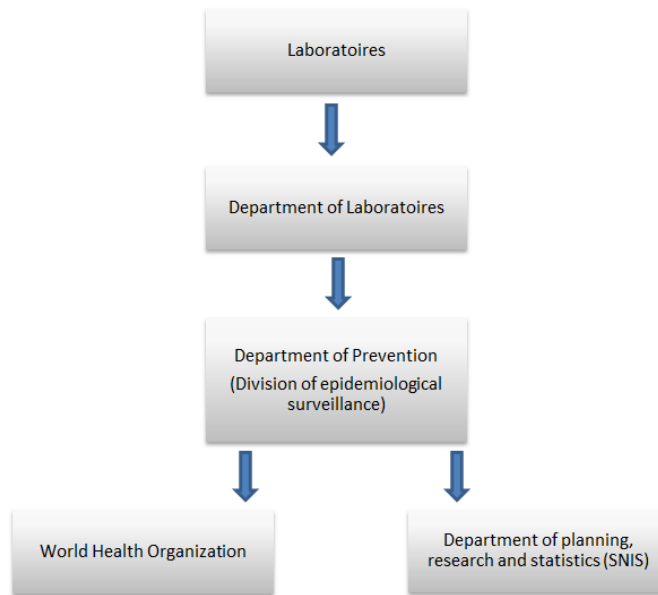


Figure 1: Schematic representation of the flow of epidemiological data.

Lab technicians’ activities: collecting and receiving blood, tissue, and other samples from patients; logging samples and preparing them for testing; performing routine tests and sample analyses; and setting up, cleaning, and maintaining laboratories and equipment.

Timeline of the pilot

As shown in table 1, in the first year of the pilot focus was especially put on understanding the context, developing use cases and, then, the actual applications. From the second year onwards, the applications were deployed and trialed in the field, starting with the epidemiological surveillance application, the quiz and “information of the month” applications, the web portal, and ending with the helpline application.

January 2011-December 2011	January 2012- August 2012	September 2012-December 2012	January 2013-June 2013
Content Creation: - Field trip to Senegal (March) - User needs analysis - Co-creation of four use cases + web portal - Delivery of D4.1	Roll-out 1: - Development of three use cases (m-surveillance, Quiz and Info of the month) and the web portal (first version) - Usability testing in Senegal - 2 nd field trip to Senegal (April) - 2 nd version of the applications and the web portal - Delivery of D4.2	Roll-out 2: - Deployment of the applications and the web portal for field user testing - 3 rd Field trip to Senegal (October): visit of 7 laboratories - Development of the fourth use case (m-help) - 3 rd version of the web portal - Delivery of D4.3	Continuation of Roll-out 2 and final evaluation: -Deployment of the fourth application - 4 th Field trip to Senegal (April): visit of 10 laboratories - Delivery of D4.4

Table 1. Timeline of the project.

Summary of the phases of the pilot

As shown in figure 2, the pilot followed the traditional phases of the user centered approach.

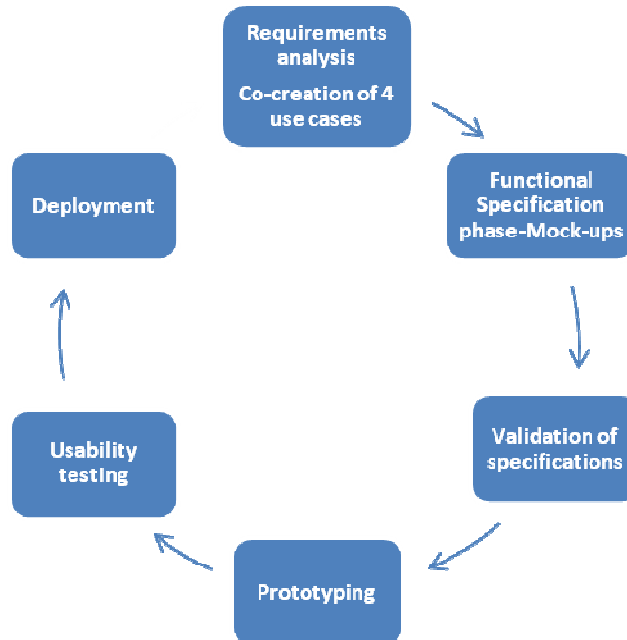


Figure 2: Schematic representation of the main phases of the pilot. Note that the progress of the pilot was actually more complex (e.g. iterations are not depicted).

Summary of the applications

Four mobile applications have been developed and deployed. One application deals with data collection. This application allows lab technicians to send notifications about three diseases (Cholera, Shigellosis and Meningitis) via a mobile phone. Lab technicians were asked to use it on a daily basis. They had to send notifications not only when there is a case of disease but also when no case of disease has been detected. This application can be seen as substitute for the weekly form that was used for collecting data (see D4.1). Our main hypothesis is that laboratories with no computer and no internet access will be able to send epidemiological notifications to RNL. Two kinds of interfaces were designed: a touch-screen graphical interface and a voice interface. The rationale behind this was to investigate the usefulness and usability of voice technology for data collection in laboratories by comparing it to a graphical one. In the graphical interface application (see figure 3), lab technicians open the application by clicking on a widget and enter data either through the phone's keypad or by selecting items via the touch screen, depending on the kind of data that must be entered.

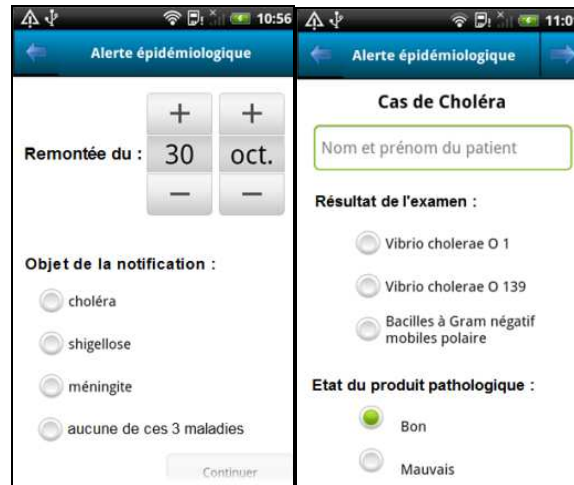


Figure 3: screenshots of the application dedicated to data collection.

The voice interface is based on an IVR system (Interactive Voice System) and DTMF. Lab technicians call an IVR system which invites them to enter epidemiological data by using the phones' keypad; the system's prompts and outputs use text to speech technology (see figure 4).

*IVR: Welcome to the RNL's epidemiological surveillance service! Hello laboratory X. If you are not from laboratory X, please contact Y, otherwise hold on.
Please dial your authentication code.*

User: *(dials her authentication code)*

IVR: To report an absence of disease press 0, to report a case of Cholera, press 1, a case of Shigellosis, press 2, a case of Meningitis, press 3.

User: *(dials 2)*

IVR: Case of Shigellosis. Please say the name of the patient. Speak loudly after the beep and then press the hash key.

User: *(says the name of the patient)*

...

Figure 4.A sample interaction with the IVR system.

As for training, two applications have been developed. One application is based on vocal quizzes. It works as follows: RNL creates and broadcasts vocal quizzes to lab workers. When a quiz is issued, they receive a notification and are invited to take the quiz by calling the IVR system. The quizzes aim at helping lab workers to maintain and strengthen their knowledge in laboratory medicine. The second application, called "information of the month" and recently renamed "RNL's news", aims at allowing RNL to broadcast information (e.g. about a disease or a technical procedure, news) to technicians in the form of voice messages. The goal is to allow lab technicians who work in under-equipped laboratories (no internet connection) to access parts of information contained in the quarterly bulletin (see D4.1). This application is

also meant to help lab technicians to maintain their knowledge and, moreover, learn about RNL’s activities (e.g. forthcoming training sessions). This application works like the quiz one: content is created and issued by RNL; lab technicians receive sms notifications that invite them to listen to the content, which is accessible for fifteen days. All these applications must be seen as complementary to other training means and educational tools currently implemented by RNL (e.g. face to face training, quarterly bulletin).

The fourth application deals works like a helpline. Lab technicians need sometimes to call RNL about a particular medical test (e.g. how to perform it) or a test results (e.g. when a lab technician is uncertain about his/her interpretation of a medical result). The goal of this fourth application is to expand this support by enabling lab technicians to send queries to RNL via an IVR system that stores the queries. Queries are then processed by a person from RNL, who then looks for an expert to find the appropriate answer. When an answer is found, the person records it in the form of a voice message and issues it through the system; the lab technician is then notified by sms that the answer is available and can therefore listen to.

In addition to these applications, a login/password protected web portal was designed to allow RNL to access epidemiological data sent by lab technicians via their mobile phones (figure 5). It also enables RNL to create, issue, and monitor the usage of quizzes and news. Finally, queries sent by lab technicians through the helpline application are also displayed in this portal where RNL can listen and reply to them. A new version of this portal has been recently released.

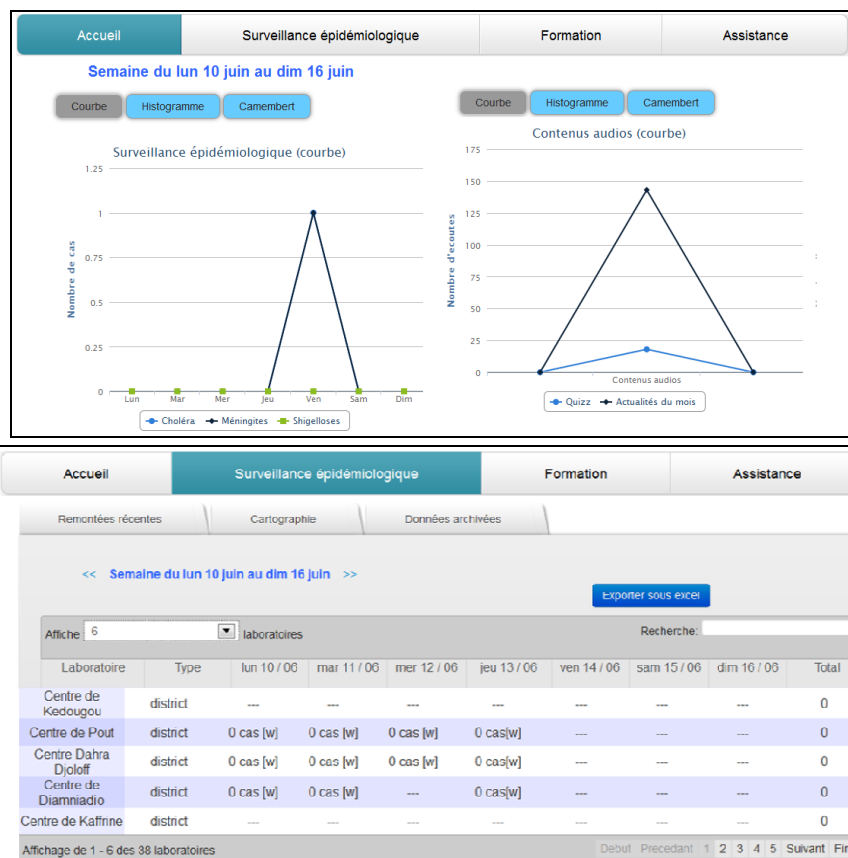


Figure 5: screenshots of the web portal.

The role of each user in the usage of the application is summarized in table 2:

	Data collection	Quiz application	RNL's news	Helpline	Web portal
Lab technicians	Send notification	Take quizzes	Listen to news	Place queries Listen to answers	
RNL	Collect data	Create and issue quizzes	Create and issue news	Treat queries	Access epidemiological data Issue quizzes and news Monitor the usage of quizzes and news

Table 2. This table summarizes the role of users (lab technicians, RNL) depending on the application.

Deployment of the applications

The applications were deployed in September 2012, except the fourth one which was deployed in January 2013. Fourteen medical labs were progressively included in the field trial from September 2012 until March 2013. The list of these labs, which have been selected by RNL, is shown in table 3. The head of each lab was provided with an Android mobile phone* (Samsung I9100) in order to use all of the applications during the trial (the graphical application dealing with data collection was pre-installed on the mobile phone). Each lab technician was assigned responsibility for the device. Regarding the application designed for data collection, they were asked to send notifications on a daily basis either through the graphical interface or the voice interface. As for the quiz and RNL's news applications, they were asked to listen to take quizzes and listen to information as soon as they are informed by SMS that content had been issued. Lastly, they were asked to use the help line application whenever they wanted to post a query to RNL.

* Android was chosen because it is open source.

Lab	Type of lab	Date of integration in the field trial
Kaffrine	district	October 2012
Kaolack	regional	July 2012
Khombole	district	July 2012
ToubaDarouKhoudoss	district	July 2012
Pout	district	July 2012
M'bour	district	October 2012
Diamniadio	district	July 2012
Richard Toll	district	December2012
DahraDjolloff	district	December2012
Foundiougne	district	March2013
Kédougou	district	December2012
Tambacounda	district	March2013
Podor	district	March2013
Louga	district	March2013

Table 3. Labs that participated to the pilot.

Methodology

The evaluation presented in this report is based on data collected from the platform (logs) and two field trips. The first field trip was held in October 2012 (see D4.3); the second field trip took place recently, in April 2013 (from April 15th to April 26th). The goal of these field trips was to collect data about users' experiences, the usage of the system, and its implications for lab technicians and RNL. These data were collected through interviews in the laboratories. Participants were asked about different topics: usefulness and ease-of-use of the applications; how, where and when they used them; difficulties they met, etc. The interview guide we used during these field trips is shown in D4.3.

Ten laboratories have been visited during the second field trip (see figure 6). Because of lack of time, we were not able to visit the remaining four laboratories (Podor, Kédougou and Foundiougne and Diourbel). However, we managed to make telephone interviews with three of them (Podor, Kédougou and Foundiougne). Fourteen lab technicians were interviewed during this second field trip.



Figure 6. Field trip in April 2013 – District laboratory of Pout (top image) and Tambacounda (bottom image).

We also collected logs of usage from the Emerginov platform and asked lab technicians to record problems they met with the applications on a paper diary (see D4.3).

All of the collected data allowed us to document different dimensions that are traditionally addressed in evaluation of interactive systems:

- Usefulness:
- Ease-of-use: this dimension was assessed from the interviews and observations during field visits (we asked lab technicians to use the applications during the interviews)
- Frequency of usage
- Appropriation which refers to how users used and adopted the applications, including the mobile phone
- Acceptability (willingness of users to continue to use the system after the pilot)

In the remainder of this report, we will follow a framework from the literature on evaluation (Scriven, 2007; Davidson, 2004). This literature points out that in each and every case, it is necessary to select the evaluative items and criteria and limit them to those that are actually most relevant and to specialise them to the case at hand. Regarding the m-health pilot, we selected the following evaluation items/criteria:

- *Process evaluation:* this sub-evaluation is addressing the evaluation question what happened during the content construction, design, implementation and roll-out of the "intervention" or "program" and what lessons have been learnt from that. In other words, it addresses the direct outputs of the action.
- *Outcome evaluation:* in contrast, this sub-evaluation is not concerned with the direct outputs or deliverables of an action, but focuses instead on the (observable) effects in terms of outcomes or impacts on stakeholders. Note that these effects may be intended as a goal but also may be unintended, and the latter is also important to include in evaluative studies. In social science research methodology, this is commonly referred to as the issue of "internal validity" of research/knowledge claims or hypotheses.
- *Beyond-the-current-situation evaluation:* this sub-evaluation addresses the issues of generalizability, transferability, sustainability, exportability, etc. In social science research methodology, this is commonly referred to as the issue of "external validity" of research/knowledge claims or hypotheses.

PART II: M-HEALTHFIELD PILOT SUB-EVALUATIONS

This part provides the three major sub-evaluations: (i) process evaluation (assessment of what has happened during the pilot project); (ii) the evaluation of observed outcomes (effects focused on stakeholders and their environment); (iii) outlook assessment regarding future perspectives (beyond the project: generalizability, transferability, sustainability).

Process Evaluation

Process evaluation refers to the assessment of the merit, worth or significance of everything that happens or applies before true outcomes emerge or can be observed [Scriven, 2007]. In the present case it covers the envisioning, content, design, implementation and deployment of the pilot, and focuses on the direct *outputs* delivered.

The key evaluative question here is the *merit of the pilot services as an adoptable and potentially useful innovation*. This central question is addressed by investigating the following aspects or dimensions:

- a) The way stakeholders' needs have been analysed and addressed ("needs assessment");
- b) The way stakeholder involvement during the pilot has been elicited and organized;
- c) The technological quality features of the pilot.

Stakeholder needs assessment and involvement

The pilot followed a User Centred Approach:

- The design of the applications was based upon an understanding of users' characteristics, activities, environments and issues. This understanding was built from interviews and meetings with users/stakeholders, field visits and workshops in Senegal.
- Users/stakeholders were involved throughout design and development. All of the stakeholders participated to the creation of the applications. Use cases were jointly created during workshops in Senegal.
- Design was driven and refined by iterative user testing.
- The design team included multidisciplinary skills and perspectives: RNL brought the user perspective, Fondation Mérieux brought its knowledge and expertise in the domain of laboratory medicine, ESMT took on the development of the applications, and Orange guided and facilitated the design process. So the applications and the whole results of the pilot must to be seen as the result of a collaborative activity.

Technological quality features

Although the pilot has demonstrated the (potential) benefits of the applications developed, a lot of technical problems occurred during the field trial. These problems prevented lab technicians and RNL from, on the one hand, using the applications on a regular basis, and testing all of the applications, on the other. One problem that hugely hampered the pilot was the platform's instabilities. This was partly due to electrical shortages and insufficient supervision of the platform. Moreover the stability of applications was not optimal. One technical conclusion we can draw from the pilot is that the maintenance of the platform and the quality of the applications has to be improved before scaling.

Outcome Evaluation

This sub-evaluation addresses the *observable effects (outcomes or impacts)* that the pilot deployment has had on target groups and downstream stakeholders. Note that this may include intended as well as unintended effects. To assess the pilot outcomes, the following aspects or dimensions are considered below:

- a) The usage that has taken place of the piloted services by stakeholders;
- b) Created wider awareness, visibility, attracted interest, and other external effects;

Applications usage

As revealed by the logs and the interviews, the applications and the mobile phone were used in different ways, depending on the type of application and on laboratories. As for the usage of the mobile phone, we observed different modes of appropriation. The majority of lab technicians kept it all the time for security reasons and in order to be able to use it out of the laboratory. But some of them consider leaving it in the laboratory, particularly in order to allow another lab technician to send epidemiological notifications in case of absence. Lab technicians who did not keep it all the time also told us that they preferred to store it in the lab for security reasons (e.g. avoid losing it). This also enables them to delegate the task of sending epidemiological notifications to a colleague when they are away.

Regarding the usage of the applications, only one lab technician (from Kédougou lab) did not manage to use any of the applications since the beginning of the field trial. The lab technician told us that he had some problems with the mobile phone. As this lab is located very far from Dakar (about 700 Km), we were not able to visit it during the last field visit but we managed to have an interview on the phone. RNL asked the lab technician to come to Dakar by the end of June in order to identify the source of the problem and fix it.

Concerning the m-surveillance application, we observed different usage patterns. Laboratories sent notifications more or less regularly since the beginning of the pilot (see figure 7). In the typical workday, lab technicians sent notifications in the afternoon or in the evening, this task being performed in the lab or at home by those who kept the mobile phone on. As we noted in D4.3, the main issue for lab technicians was to not forget to send notifications. This was an issue because sending notifications every day was a new task for them. So they sometimes forgot to accomplish the task, particularly when they have to send an "absence of disease" notification, which is as important as reporting a case of disease. To help them to cope with this problem, we suggest them to use the alarm of the mobile phone as a reminder, which they did. So, for instance, some lab technicians set the alarm for 4 pm, others for 6 pm. This idea actually came from the lab technician of the Khombole laboratory. Moreover, we also adapted the application to allow them to send notifications concerning the previous day(s) at any time in case they forgot to use the application on that day(s). This adaptation was made after lab technicians told us that they need to have the possibility to rectify oversights. The variations in the regularity of the sending of notifications across laboratories are quite difficult to explain. One laboratory (Kédougou) did not send notifications at all because on the one hand there is a technical problem with the graphical version of the application installed on the mobile phone use by this lab, on the other hand the lab technician did not use the voice version because he did not really understand how to use it. These problems have not been fixed yet because firstly, due to a lack of time, we were not able to go and visit this laboratory during the last field trip (it is about 800 km from Dakar) but we interviewed him by telephone. The RNL is going to visit this laboratory by the end of July in order to reinstall the graphical version and show him again how to use the Voice version for sending data. In order to cope

with this kind of problem which may happen during scale-up, the RNL has planned to visit laboratories more regularly in order to make sure that lab technicians can use the applications and fix the technical problems that may occur.

Moreover, the logs we collected are not complete due to technical problems. For example, the figure seems to show that the application was not much used by Pout lab but this is not actually true because the inspection of the mobile phone shows that the application was used almost every day. The problem is that sometimes notifications did not reach the platform. This problem is in the process of being solved. In spite of these problems, this data shows that the application allowed RNL to collect data from laboratories that were not used to send notifications (e.g. Diamniadio, M'bour, Kaffrine, Dahra Djoloff or Touba).

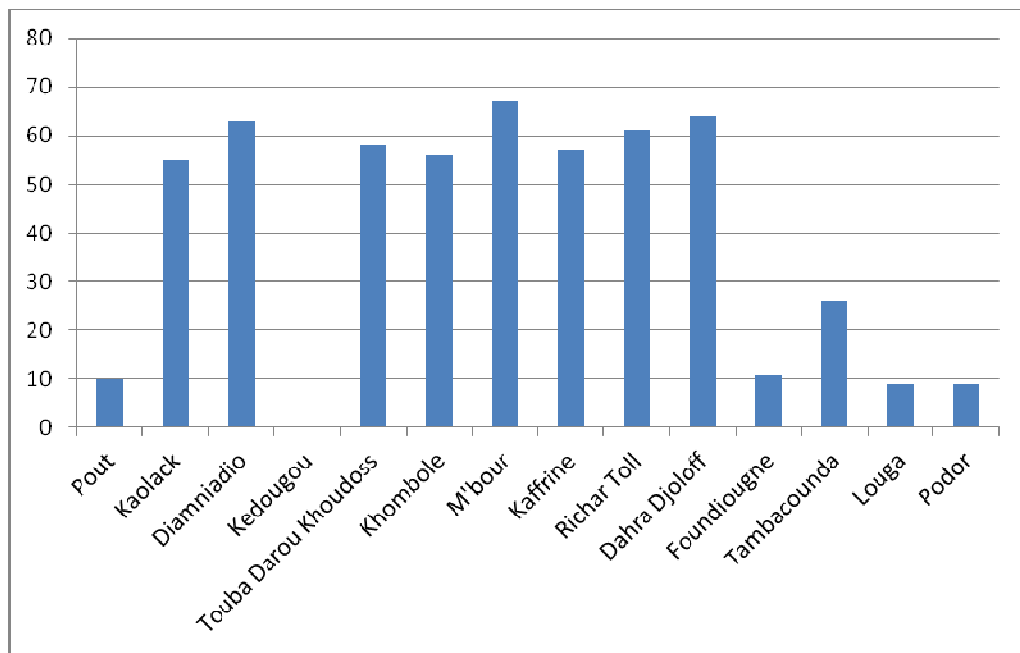


Figure 7. Number of epidemiological notifications (x-axis) sent by each lab (y-axis) every day from 01/01/2013 to 06/05/2013.

The quiz and “RNL’s news” applications were used by almost all lab technicians. Regarding the quiz application, seven quizzes were issued since the beginning of the pilot (see table 4). As for the second application, seven pieces of information were released (see table 4). They enabled them to test their knowledge, learn about new topics and hear of RNL’s activities. Some lab technicians systematically listened to the contents just after they received a notification indicating that a new quiz or a piece of news is available. Some lab technicians shared the contents with other lab technicians who found them interesting. This shows that these contents may be useful not only for the head of the lab but also for all lab technicians that work in a lab.

News	Quizzes
Le Choléra	Le spectre d'activité d'un antibiotique
L'Utilisation du milieu Trans-Isolate-Médium Le Règlement Sanitaire International	Pathologie chronique
Le Bulletin de Liaison du Réseau National des Laboratoires	Transport des selles Les antibiotiques
Direction des Laboratoires	Conservation des produits pathologiques
Evaluation des laboratoires selon la Check List de l'OMS SLIPTA	Résistance à la Méricilline chez le staphylocoque
Surveillance nationale des résistances bactériennes	Antibiogramme

Table 4 Quizzes and pieces of news created and issued by RNL during the pilot.

The helpline application was not used. We identified three main reasons for this absence of usage. The first reason is that the application was not sufficiently stable just after we deployed it. So lab technicians did not have the opportunity to use it since it was deployed. This was also due to the instabilities of the platform. The second reason is that some lab technicians did not understand how to use the application. Finally, the third reason is that lab technicians did not feel the need to use it in the sense that they did not have a question to ask to RNL.

Ease of use and Usefulness

When asked about these dimensions, all lab technicians found the applications easy to use and useful, except the helpline application which was found less easy. Let us detail these results.

Regarding the m-surveillance application, the 4th field trip confirmed that all lab technicians found the graphical version easier to use than the voice interface. The graphical interface seems to be more appropriate and effective in this context. The field trip also confirmed that lab technicians who used to send notifications preferred the VOICES system to the previous method (sending a sheet by e-mail). Furthermore, RNL found the m-surveillance application useful because it enables them to collect data from laboratories that were not used to send notifications. In other words, this application facilitates and expands data collection.

With regard to the learning applications (quiz and information of the month), as we observed during the 3rd field trip (see D4.3), all participants were enthusiastic; they found them useful for their work activities. According to those who were able to listen to the contents, these applications allow one to test his/her knowledge, "refresh his/her memories", acquire new knowledge and get information about the RNL's activities. These applications were found easy to use by all participants. This opinion is confirmed by the results of usability tests (see D 4.2) and observations when we visited labs.

The m-help application was not used by lab technicians. One reason of this lack of usage is that the majority of lab technicians did not really understand how to use it. A second reason is that those that try it did not manage to submit queries because of the instability of the platform

Created awareness and other external effects

In order to raise awareness among laboratories and health centers, RNL disseminated information about the pilot in the RNL's Quarterly bulletin (see. figure 8. This bulletin is sent to all laboratories.

VOICES : Le Mobile au service du Laboratoire

Le RNL du Sénégal s'est engagé depuis Janvier 2011 dans un projet européen intitulé VOICES afin d'explorer les possibilités offertes par les technologies mobiles, internet et vocales pour renforcer la surveillance des maladies à potentiel épidémique et la formation continue des professionnels de laboratoire.



Financé par la Commission Européenne, ce projet a récemment lancé une expérimentation de trois applications mobiles et vocales, en collaboration avec l'Ecole Supérieure Multinationale des Télécommunications de Dakar, Orange et sa filiale Sonatel, et la Fondation Mérieux. L'une de ces applications permet de notifier trois maladies à potentiel épidémique (Choléra, Méningite et Shigellose) et vise ainsi à offrir une meilleure couverture nationale et un raccourcissement des délais de notification ; les deux autres permettent au réseau de diffuser aux professionnels des laboratoires différents types de contenus pédagogiques sous forme de messages vocaux (des informations variées et des quizz pour tester ses connaissances). Ces applications ont été conçues en étroite collaboration avec les partenaires et des professionnels de laboratoire. Elles sont actuellement en cours de tests dans sept sites : Kaolack, Kaffrine, Pout, Diamniadio, Khombole, Touba et Mbour. Un site internet a été également développé pour permettre au RNL de visualiser les données épidémiologiques

collectées par mobile et suivre l'utilisation des contenus pédagogiques. Une quatrième application est en cours de développement dont l'objectif est de permettre aux professionnels de laboratoire de soumettre des questions au RNL à n'importe quel moment sous forme de messages vocaux via un serveur vocal. Le but du RNL sera de fournir une réponse pertinente à l'expéditeur (par message vocale ou sms) dans les plus brefs délais. Les premiers usages et retours des laboratoires qui ont testé les trois premières applications ont été positifs et sont prometteurs. L'expérimentation est en cours d'extension à d'autres laboratoires. Cette phase de test est importante car elle permettra d'évaluer l'utilité réelle des applications pour tous les acteurs des laboratoires et, à moyen terme, son extension à tout le territoire.






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Figure 8: description of the Pilot in the RNL's quarterly bulletin dated November 2012

Assessment of Future Perspectives

Process and outcome evaluation both refer to observable results (outputs and outcomes, respectively) obtainable within the course and duration of the action. In contrast, this chapter provides an evaluation of the *perspectives beyond the end of the project*. Although also this assessment is as much as possible *evidence-based*, presented data will necessarily be more indicative rather than fully conclusive. For the present pilot, the future perspective assessment is addressed by investigating the following aspects or dimensions:

- a) **Generalizability:** the possibility to expand the piloted technologies to other use cases, services, domains, and countries.
- b) **Transferability:** the capabilities made available to transfer required knowledge regarding voice-based service development, maintenance, and use to various stakeholders and interested third parties.
- c) **Sustainability:** the likelihood that developed services will be further adopted and maintained by stakeholders on a continuous basis, beyond their current initial development (project RTD stage).

Generalizability

Fondation Mérieux has expressed interested in deploying the applications in other sub-Saharan countries (Mali, Burkina-Faso, etc.) within the RESAOLAB project. The goal of this project is to reinforce these regions' abilities in analysis and epidemiological surveillance by putting into place a network of biology labs. The project is piloted by Fondation Mérieux and financed by the Agence Française de Développement. The project VOICES was presented at RESAOLAB's meeting where the representatives of countries involved in the project (Mali and Burkina-Faso) expressed their interest in the applications.

There is also an interest for the data collection application from the department of prevention of the ministry of health in Senegal. This department is interested in using the application to collect data from health posts, which are rural health care structures. One of the duties of health posts is to send disease notifications to the division of epidemiological surveillance located in Dakar. These notifications are paper-based. So the idea is to use the VOICES application to speed-up and facilitate data collection from health posts. This shows that this application has the potential to be applied to various contexts where data collection is an important issue.

Transferability

The applications were developed by two local students in Senegal under the supervision of ESMT. VOICES allowed them develop knowledge regarding voice-based service development. Another result of the pilot is that it helped the installation of the Emerginov platform in Senegal. As this platform is open source, this can support ICT innovation by locals. In WP6 online learning modules have been created in both English and French, covering technical and business aspects of the voice-based service development. This content is available for free on W3Cs Moodle platform DevCampus, so the knowledge built-up in this platform can be transferred to local entrepreneurs.

Sustainability

RNL clearly expressed its willingness to continue to use the applications after the end of the VOICES project. Prof. Sow, who is the head of RNL and the department of laboratories in the ministry of health, commented that: "We are willing to continue the pilot in order to

strengthen the applications before scaling up » (see Annex B). However, the applications and the maintenance of the current platform have to be improved before extension and scale. So it has been decided to continue the pilot for six months. However, the question remains as to how the continuation of the pilot will be financed. Orange is considering the possibility of taking on the expenditure related to the running and the usage of the platform during the extension of the pilot, RNL will take care of all communication expenses. After this six months period, RNL (and thus the Ministry of Health) would need to find financing not only for taking on communication expenses but also the usage of the platform (maintenance, data storage, etc.). In this view, Orange will make a commercial proposal. In this case RNL would become a customer of Orange. So sustainability will depend at least on two factors:

- The stability of the applications and the platform. Orange is currently consolidating the applications and will propose to RNL to use a more robust platform in order to ensure the stability of the whole system.
- The capacity of the ministry of health to take on the applications' and the platform's costs.

PART III: M-HEALTH PILOT EVALUATION SUMMARY

This part gives a concise summary evaluation analysis and highlights some key lessons learned.

Final Evaluation Conclusions

One of the important results of the pilot is that the m-surveillance application enabled RNL to collect data from district laboratories that were not used to send notifications. It means that this application helped to expand and facilitate data collection. Moreover, lab workers who used to send notifications via the document-based procedure found the m-surveillance application and the mobile phone more convenient and less time consuming for performing this task than the usual procedure (filling in a form on the PC).

The pilot also showed that voice technology is an interesting tool for developing applications that support life-long learning. As we saw, the quiz and "RNL's news" applications may help lab technicians to maintain and enhance their knowledge in laboratory medicine.

The pilot also showed that voice technology, in this case IVR systems, is not adapted to data collection in laboratories as all lab technicians preferred to use the graphical interface. One of the goals of the project was to develop voice applications that exploit native languages. This goal was not achieved within the m-Health pilot. It turned out that using French in the applications' interface, which is spoken fluently by lab technicians, was not a problem for them. So, it was decided, in concert with them and RNL, to use French. One conclusion we can draw from this is that the relevance of using a local language in voice applications may depend on the context.

In their Policy White Paper on "mHealth Barriers and Gaps", Mechael et al. (2010) have identified six key points concerning the application of m-health to epidemiological surveillance. As this White Paper is based on a comprehensive literature review, it is interesting to assess the VOICES pilot in relation to these key points, especially in order to examine its main contributions to the field of m-health.

Key point # 1: *"Majority of the literature studying data collection focuses on comparing data quality, accuracy, time, training required, and cost between traditional paper and pen methods and mobile technology. Results were found to be inconclusive with effectiveness varying depending on the type and complexity of data being collected."*

The WP4 pilot focused on the comparison between two modes of data entry (graphical VS IVR). Results have clearly shown that the graphical mode is more effective in terms of speed and ease of use.

Key point # 2: *"Many data collection software programs have been developed using an open source platform, resulting in widespread adoption among small pilot projects (i.e., EpiSurveyor, PDACT, RapidSMS), many of which have not been documented or evaluated."*

The application developed within the pilot is based on an open source platform.

Key point # 3: *“Studies were found to primarily use PDAs, an older model of mobile phones and not as applicable in the current marketplace. Further studies are required to investigate*

data collection using low-end mobile phones found in LMICs and smart phones found in

high-income countries and increasingly in LMICs.”

The pilot explores data collection using a smart phone. The main result of the pilot is that the touch-screen feature of this kind of mobile phone facilitated data entry.

Key point # 4: *“Data collection using mobile technology was found to be implemented using SMS, voice, and electronic forms. Increasingly, as mobile technology advances, GPS information is being used to tag data to specific locations. Further studies are required that investigate the effectiveness of different data collection methods using mobile phones.”*

We did not explore new data collection methods like GPS. The benefit of this kind of technology in the context of data collection from laboratories is not obvious.

Key point # 5: *“The primary gap in data collection is the focus on implementation as an independent system in comparison to partnering in the development of initiatives such as electronic health records that can act as a repository from which data can be extracted. Additionally, further integration between local, regional, and national data collection and access is required so that data being collected is benefiting the communities from which the data is taken.”*

Up to now, there are no electronic health records in district laboratories but only paper-based records, from which epidemiological data is extracted. However, it should be noted that a laboratory Information Management System (LIMS) is being currently installed in some district laboratories by Fondation Mérieux within the RESAOLAB project, in partnership with RNL. The goal is to facilitate the management of health information in laboratories. For security reasons, this system will function only locally, that is with no internet connection. So it will enable lab technicians to send notifications via internet. From a technical point of view, this system and the VOICES application will function independently. As long as the LIMS will not be connected to internet, these systems have to be seen as complementary.

Key point # 6: *“Barriers related to security, confidentiality, and ownership of data is central to this mHealth thematic area.”*

Security and confidentiality of epidemiological data is a crucial topic in mHealth. In the pilot, these aspects have been addressed at different levels: data entry, data transmission, and data storage and access. A security framework is described in the document titled “WP4 Security framework”. Data is currently stored in the Emerginov platform in Dakar at Sonatel (a subsidiary of Orange in Senegal). In other words, data is not stored at the ministry of health. This raises the question of whether the hosting of epidemiological data by third-parties is an

acceptable solution to the ministry health after the pilot. This question is currently being treated.

Another important result of the pilot is that the ministry of health (RNL) is willing to continue the usage of the applications. But this is not the end of the story. There are many aspects that must be improved. One of the most important aspects is the technical stability of the applications and of the platform.

Mecheal et al. (2010) also identified some barriers to the implementation and sustainability of m-health in LMICs. Let us examine how we addressed these barriers in order ensure the sustainability of the applications developed within the pilot.

A first barrier is the “persistent reliance on donor funding which highlights the need for an eventual transition to alternative and diversified revenue sources (e.g. government contracts, insurance or direct payments from consumers) to bring effective programmes to scale.” Regarding the future of the VOICES pilot, the cost of the system is likely to be taken on by the ministry of health. The head of the department of laboratories, which is part of the ministry of health, is indeed determined to finance the usage of the applications. He is expecting a financial proposal from Orange/Sonatel (subsidiary of Orange in Senegal). Hopefully, the funding will rely on a government funding. This bodes well for the future of the applications.

A second barrier has to do with “problems with end-user acceptance of the technology.” The implementation of a user centred approach in the pilot allowed us to steer clear of this barrier. The applications were designed by taking into account users’ feedback all along the design process.

A third barrier is the “lack of the necessary infrastructure to provide reliable electricity and internet access.” We experienced this barrier in the pilot. Due to power cuts, the Emerginov platform crashed several times, which impinged in a big way on the usage of the applications. A better management of this kind of problem will be necessary in order to ensure the sustainability of the whole.

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ANNEXES

- A. Letter from Prof. Sow, head of RNL and the department of Laboratories of the ministry of health.

Received by e-mail on May 11th, 2013

Projet VOICES : un apport certain à la surveillance épidémiologique

Au Sénégal, un Réseau National de Laboratoires a été mis en place pour relever le plateau technique et permettre au sous-système des Laboratoires de participer pleinement à la performance du système de santé.

Parmi les attentes vis-à-vis du laboratoire, la participation active à la surveillance épidémiologique. Le laboratoire devrait en effet notifier régulièrement les cas confirmés de maladies sous surveillance ; or, il s'agit-là d'un des points faibles de notre organisation, les personnels de laboratoires n'étant pas habitués à la notification et les structures peu équipées (fax, matériel informatique, accès Internet).

Pendant plusieurs années, nous avons donc peiné à faire assurer la promptitude et la complétude requises. C'est pourquoi le Projet VOICES est venu à son heure et nous n'avons pas hésité à donner notre accord pour y participer.

Il avait comme pour objectif principal d'étudier comment la technologie vocale de la téléphonie mobile peut contribuer à l'amélioration de la surveillance épidémiologique et de la formation continue des professionnels des laboratoires des districts.

Pendant trois ans (2010-2012), trois applications ont été développées :

- . l'envoi de données de laboratoires via le mobile, à partir des centres de santé et hôpitaux périphériques, avec une interface web pour les statistiques,
- . la diffusion d'informations à partir de la coordination du RNL, à destination des personnels de laboratoires via le mobile,
- . la formation continue grâce à système de quizz (questions posées au personnel) ou demande de précisions auxquelles des experts peuvent apporter des réponses.

Après développement des applications et réalisation des tests dans une quinzaine de laboratoires, nous apprécions à sa juste valeur la portée de cet outil même s'il reste à le parfaire.

Nous souhaitons donc poursuivre l'expérience le temps de consolider les performances des applications, avec les mêmes structures avant d'envisager un élargissement voire une généralisation.

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Nous sommes aussi preneurs de toute proposition visant l'acquisition des applications dans un futur proche.

Pr Iyane Sow
Directeur des Laboratoires du Sénégal