

Improving certification process of cereal seeds in Mali

May 22, 2023
Amsterdam, Netherlands

Elias Anderlohr - 2796689

Zheng Zhang - 2748843

Jonas Kouwenhoven - 2683311

Ellis Donders - 2779195

Michelle Schifferstein - S2586115



Semences Certifiées

**Modernisation du Processus de Certification des
Semences au Mali**



Change Log

Version	Modification	Authors
2.0	Worked on Report	Elias, Ellis, Michelle Jonas and Zheng
2.0	Conducted interview with Joost Westerhout	Ellis, Michelle and Jonas
2.0	Completed basic interactive voice application in VXML	Zheng and Michelle
2.0	Implemented backend for database (RESTful API)	Elias
2.0	Incorporated database into VXML application	Elias and Zheng
2.0	Finished front-end of website	Ellis and Jonas

Document History

Version	Date	Modification	Pages
0.1	19 April 2023	<p>Initial version includes:</p> <p>Chapter: Short Summary, Actors and Goals, Context and Scope, Use Case Scenario Script, Interaction and communication</p> <p>Appendix: Name & Logo of SemencesCertifiees, BPMNs, UML, Interview Transcript, Project Planning, Code Description, Pitch Deck</p>	1-20
0.2	2 May 2023	<p>Chapter: Information Concepts, Technology Infrastructure, Cost Considerations, Key Requirements, Feasibility and Business Sustainability, Ethics</p> <p>Appendix: E3 Value Model, Website Flow Diagram, Interview Transcript, MoSCoW list of requirements</p>	1-26
0.3	19 May 2023	<p>Chapter: Prototype Description, Pointer to the Application, Accessing the Application, Short Usage Scenario, Feedback Questions, Discussion of Scope and Fidelity, User Evaluation, Updated VoiceXML Code and Code Description, Conclusion</p>	1-44

1 Introduction

Recent developments in laboratory-developed seeds have led to Malian farmers using new seeds that result in higher yields. However, this new seed system requires farmers to undergo a lengthy certification process that involves clearing their land and applying pesticides and fertilizers. Once they have completed this process, farmers are presented with a paper-based certification. Unfortunately, this certification system is prone to unreliable mailing services in Mali, which could lead to certificates getting lost in the mail. Furthermore, since the certificates are paper-based, there is a chance that farmers may counterfeit them and sell fake seeds, posing a significant challenge to trust in the seed business in Mali.

The aim of this project is to modernize the seed certification process for farmers in Mali by introducing a voice-based system for certification, and thereby replacing the current paper-based certification system. This solution is proposed to address the challenges faced by farmers due to the lengthy certification process and the potential loss of certification papers during mail delivery. Given that only 31% of the population in Mali is literate (1), we propose the development of voice-based instructions in French and English. Our approach involves initially designing and implementing a voice-based system in English, which can later be converted to other languages. Our objective is to develop two distinct systems to facilitate the certification process for farmers. The first system is an Interactive Voice Response (IVR) system that will cater to farmers who do not have smartphones. Farmers can call a designated number and interact with a set of menus to obtain information on the status of their seed certification. This will allow farmers to start their production process with confidence. The second system we want to develop is a website called SemencesCertifiées, which is aimed at farmers who have a smartphone and allows laboratories to upload certificates. With this website, farmers can access and laboratories can upload certificates.

2 Actors and Goals

Actor	Goal/Objective	Responsibility in the Envisaged System
Farmer	To obtain their digital certification quickly	Use designated information to login to the system
AOPP farmer umbrella	To improve the efficiency of the seed certification process for cereal seeds between the national certification laboratory and the seed producing farmers in the country	Deliver the system to local farmers
Labosem	To provide farmers with fast results	Upload certifications to the server
Seed buyer	To purchase high-quality and certified seeds	Verify the authenticity of the digital certification
Postal service	To earn money by delivering the certificate to the farmer	Will be made redundant or less important as certificates can be accessed online or via phone
Developers (us)	To provide Malian Farmers with a secure digital seed certification system	Making sure the system is prone to fraudulent activities

Table 1: Actors and Goals

3 Context and Scope

Diagram

The process flow is elaborated in section 5 and is presented visually using a UML Sequence Diagram (see Figure 5) and a BPMN (see Figure 6 and 7). Both these diagrams can be found in the Appendix for reference.

(External)-Stakeholders

The stakeholders and their roles in the seed certification process in Mali are listed in 1. The table includes the farmer, the AOPP farmer umbrella organization, Labosem, the seed buyer, and the developers along with their respective goals and responsibilities. The farmer's goal is to obtain digital certification quickly by logging into the system. The AOPP aims to improve efficiency by providing the system to local farmers, while Labosem strives to provide fast certification results by uploading certifications to the server. The seed buyer seeks high-quality and certified seeds and verifies digital certification authenticity. Finally, the developers aim to implement a system that can help all Malian farmers retrieve their authentic certificates.

Scope of the Scenario

This scenario explores seed certification challenges faced by farmers in Mali. It examines community-based certification systems and the potential of a digital platform to facilitate and oversee the process. Fraud in seed certification, including forged certificates

and non-certified seeds, is a significant challenge highlighted in the interview with Anna Bon (section 19). Despite efforts to address it, this remains a major issue.

Performance Measurements

To evaluate the seed certification system's performance, we consider the following factors:

- **Participating farmers:** The number of farmers involved demonstrates their interest and investment in the system.
- **Seed quality:** Certified seeds must meet or exceed government and other certification bodies' quality standards.
- **Ecological sustainability:** Certification should encourage environmentally-friendly practices. Soil health, water use efficiency, and biodiversity can measure this.
- **Fair trade:** Fair compensation is essential. Performance measures include certified vs. uncertified seed prices, prompt payment, and farmers' ability to negotiate.
- **Security and authenticity:** Certification must guarantee seed authenticity and prevent tampering. Measures include authenticity verification and anti-fraud measures.

Satisfied Conditions

For certified seeds, farmers must be able to sell them. However, in some cases, the government or organizations purchase them to distribute to those in need, limiting farmers' sales. Infrastructure is also important. Preventing fraud is another key consideration.

4 Use Case Scenario Script



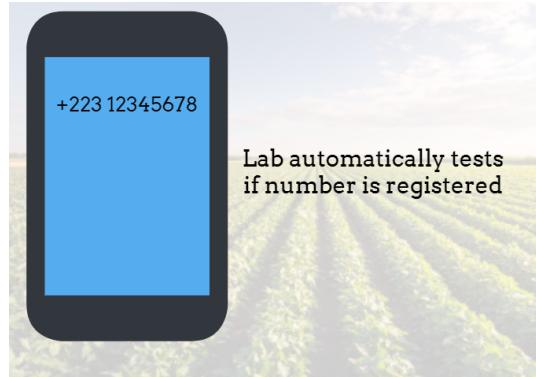
(a) Title Page



(b) <farmer><calls><lab>



(c) <lab><welcomes><farmer>



(d) <lab><checks number><farmer>



(e) <lab><gives information certification><farmer>



(f) <lab><gives more information><farmer>

Figure 1: Storyboard of Voice-Based System

5 Interaction and communication

Interactive Prototype

The first version of the prototype (section 20) demonstrates a simple login system using voice input. It was developed to get used to the mechanisms of VoiceXML. It prompts the user to provide their username and password and validates the input using

grammar. If the credentials are valid, the user is redirected to a new file, and if not, the user is informed about invalid credentials, and the input fields are cleared.

The second and final version of the prototype includes both a web-based and voice-based approach. A detailed explanation of these systems is given in section ??.

System Flow

The SemencesCertifiées system comprises two modules. The first module can be accessed through both phone and website, accepting inputs in the form of visual, text, or voice. It provides end-users with the necessary services. The second module, which enables laboratories to upload certificates, is solely accessible through the website and accepts text inputs.

Module 1 (Access Certificates - Phone with Voice)

The core prototype of SemencesCertifiées consists of a voice-based service that users can access via a simple phone call. The system then offers the user certain options on how to proceed. The user selects these options by pressing a number key on the phone. Based on the input, the system changes the status and the user receives more information about possible further options.

The process flow is elaborated below and is presented visually using a UML Sequence Diagram (see Figure 5) and a BPMN (see Figure 6). Both these diagrams can be found in the Appendix for reference.

1. **Phone Number Recognition:** Upon calling the SemencesCertifiées system, users are greeted and the system checks if the phone number is saved in the system. If the caller's phone number is known to the system, the saved language of the user is applied and they proceed to step 5. If not, they move to step 2.
2. **Language Selection:** They are prompted to choose their preferred language (e.g., English by pressing 1, French by pressing 2). After selecting the language they proceed to step 3.
3. **Unregistered Phone Number Menu:** Unregistered callers are informed that their phone number is not in the system and are presented with a choice menu. Options include returning to the previous menu (press 9), getting information on the certification process (press 1), or accessing the Frequently Asked Questions (FAQ) by proceeding to step 4.
4. **FAQ for Unregistered Users:** In this menu, users can select from various issues, such as phone numbers not being recognized (press 1) or other problems not listed (press 8). For unlisted issues, users are instructed to call or email the support team.
5. **Registered User Menu:** For recognized phone numbers, the system greets the caller by their name and offers a choice menu with options such as retrieving information on a certificate (press 1) or accessing the FAQ (by proceeding to step 6).
6. **FAQ for Registered Users:** In this menu, registered users can select from various issues, such as downloading a certificate (press 1) or reporting a missing certificate (press 2). For unlisted issues, users are instructed to call or email the support team.

Module 2 (Upload Certificates - Website)

The second module of SemencesCertifiées facilitates the upload of certificates by certified laboratories. The process flow for this is depicted in the BPMN diagram (7) in the Appendix.

The process begins with the laboratory receiving a request from a farmer to test their seeds. The laboratory conducts the testing and then uploads the resulting certificate to SemencesCertifiées. The system automatically generates an account for the farmer's telephone number, which the laboratory provides to the system. Additionally, the certificates can be sent to the farmers via post.

This upload process is exclusively accessible through the website and is restricted to certified laboratories. The laboratory personnel responsible for uploading certificates must possess the ability to read and write.

6 Information Concepts

Figure 2 shows an entity-relationship (ER) diagram of our MySQL database, which illustrates the important information concepts used in our project. This diagram provides information on the static data structures used in our project.

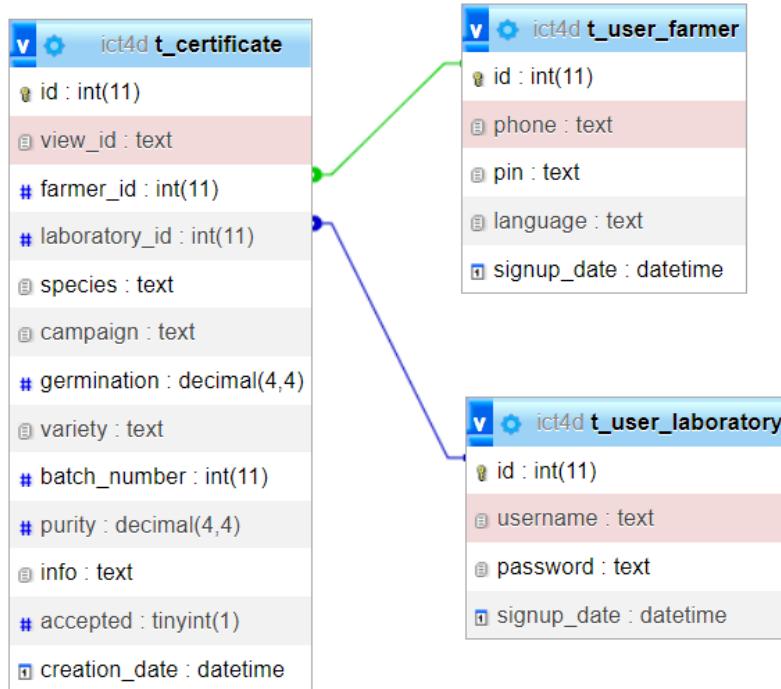


Figure 2: ER Diagram of the database

7 Technology infrastructure

Figure 4 (see Appendix) shows a UML diagram of the technology infrastructure that will support the scenario. This diagram identifies the various technology components that are required, and how they interact with one another to enable the desired functionality.

8 Cost considerations

Technology	Operational Costs	Investment Costs	Development Costs	Responsibility for Costs
Website Hosting	\$15/year	\$0	\$0 (volunteer development)	AOPP
Database Management	\$712/year	\$0	\$0 (volunteer development)	AOPP
IVR Software	\$180/year	\$0	\$0 (volunteer development)	AOPP
Phone Services	\$2.76/Month	\$0	\$0 (already available)	Farmer

Table 2: The approximation of the cost considerations for SemencesCertifiées

Table 2 shows an approximation of the costs for various technologies used by SemencesCertifiées. The cost estimates were based on various sources, such as the cost of 1GB of data in Mali for phone services, which is roughly \$2.76 dollars a month (2). The average cost of website hosting in Mali is at its cheapest \$15 a year (3). The typical cost estimate for IVR software is approximately \$180 a year(4), and an hourly rate for data hosting is roughly \$0.0813 an hour which is roughly \$712 a year (5). While these estimates provide a useful approximation for cost comparisons, actual costs may vary depending on the specific requirements and location of each technology.

9 Key Requirements

Table 3 (see Appendix) shows the MoSCoW list of requirements (Must have, Should have, Could have, Won't have) as a starting point for further architecture design, and system and component development. This table can be used to prioritize requirements and features in the developmental process of this project.

10 Feasibility and Business Sustainability

What is the technical feasibility of the scenario (e.g. [project] risk analysis, technical obstacles to overcome, system-level impacts)?

The scenario seems possible from a technical standpoint, but there are a few potential challenges. One of the main difficulties is creating voice instructions in multiple languages due to the diverse range of languages spoken in Mali. Mali has many languages like Bambara, Soninke, Tamasheq, Songhay, Fulfulde, and more (6). To ensure the system can understand and respond accurately to voice commands in different languages, it is essential to develop robust language recognition and processing capabilities. Developing such robust systems is far beyond the scope of the research project; therefore, our main focus is on the more widely spoken languages, such as French and English.

Above that, we also want to make sure that the system is easy to use, especially considering that about 70% of the population aged 15 and above in Mali is illiterate(1). To address this challenge, it is important to design a user interface (UI) and user experience (UX) that is specifically catered to people with limited literacy skills. By including simple

and intuitive icons in the website's design, we can make navigation and interaction easier for all users.

Lastly, we need to ensure that people in all parts of Mali can easily access the website without any issues. This means making sure that the server hosting the website and voice platform is accessible from anywhere in Mali. Whether someone is in a remote area or a bustling city, it needs to be ensured that they can retrieve their certificates without facing any difficulties or limitations due to their location.

What is the business and (socio-)economic feasibility and sustainability of the scenario?

The proposed system aims to simplify the certification process for farmers in Mali and address the literacy gap. To make certification more accessible, the solution involves an Interactive Voice Response (IVR) system and a website for seed certification. This approach could improve accessibility and efficiency, potentially benefiting the agricultural sector, increasing farmers' income, and enhancing seed quality. It is important to note that ensuring economic sustainability requires making the solution available to all farmers, regardless of their financial resources. This may involve exploring options like subsidies or financial support for small-scale and poor farmers to ensure their participation. Additionally, continuous funding will be needed to maintain and update the system for long-term sustainability.

What are possible goal conflicts and dependencies in the collaboration between the actors in the scenario?

Possible conflicts and dependencies in the collaboration between the actors in the scenario include conflicts between different types of farmers. There may be conflicts between farmers who can afford to invest in fertilizers and pesticides required to grow the certified seeds and those who cannot. Poor farmers who cannot afford these resources may continue using old seeds, while wealthier farmers can grow the new, certified seeds. This economic disparity between farmers could lead to tension and conflict. Another potential conflict is between non-registered farmers and Labosem, as these farmers may be tempted to engage in fraudulent activities such as copying certificates. This could result in conflicts between these farmers and the AOPP organization, as well as with Labosem.

Are there important general preconditions for the scenario to work, and is it sufficiently interoperable with the wider context both in a business process and a technical sense?

The success of the proposed seed certification system relies on a few important factors. Firstly, having a reliable telecommunications infrastructure is crucial, as farmers need access to basic phone services or smartphones to use the system effectively. Secondly, providing training and raising awareness among different actors is vital for the system's successful implementation. It helps users understand how to use the system and its benefits. In terms of usability, considering that many potential users may be illiterate, utilizing clear and intuitive icons and user interfaces can greatly assist farmers in navigating the platform effortlessly. Additionally, since Mali has diverse languages spoken, it is important to understand how these languages are used and integrate them into the system's interactive voice response component. This ensures that the system is functional and accessible to all users, regardless of the language they speak.

11 Prototype Description

Name & Logo of SemencesCertifiées

Our system is named *SemencesCertifiées*, with the slogan *Modernisation du Processus de Certification des Semences au Mali*. We chose French as the language for both the name and slogan since it is the primary language in Mali (7). *SemencesCertifiées* translates to *certified seeds*, and the slogan to *Modernisation of the Seed Certification Process in Mali*. The slogan emphasizes our mission to modernize the seed certification process in Mali. These choices reflect our commitment to a clear and concise message that accurately represents our goals.



Logo Type 1 – Simple



Logo Type 2 – Wide with Slogan

SemencesCertifiées

**Modernisation du Processus de Certification des
Semences au Mali**

Figure 3: Two types of the SemencesCertifiées Logo

In the case of the logo 3 a stylized certificate with a seed at its core is used to symbolize the primary objective of the project. This visually appealing and easily understandable symbol represents the commitment to providing fast and secure access to certificates. The seed, as a central element, signifies growth, potential, and the future of agriculture in the region.

The colors chosen for the logo also demonstrate the project's dedication to promoting sustainable farming practices and environmental stewardship. Dark yellow, on the other hand, holds significance in communicating the project's values. The use of green represents growth, nature, and agriculture, emphasizing warmth, and sunlight.

Our logo comes in two designs. The first design places the logo as the main focus, while the second incorporates the slogan and text alongside the logo. Depending on the requirements, either design type 1 or type 2 can be chosen.

Design Decisions

Several key concepts needed to be taken into account during the design of our application. Below, we highlight the most important choices we have made.

Privacy & Security

Seed certificates are personal. The one possessing the certificate must be the rightful owner of it, as it represents their right to sell their seeds.

To access the application, authentication is required. For the voice-based application, besides a basic privacy guarantee, it is mostly a matter of convenience: a registered farmer is generally interested in their certificates only. Thus, we have chosen to automatically detect the caller's phone number, to verify they are a registered farmer, and to only provide them with information about their certificates.

For the web interface, a login with a phone number and pin code is required, since a phone number alone would not suffice to authenticate a user. Moreover, this more secure way of authenticating means that the digital certificates could in the future possibly be used as official certificates for legally selling seeds.

User illiteracy

We assume many farmers in rural Mali to be illiterate. We can however reasonably assume that they know numbers since this knowledge is generally necessary for engaging in trade. Thus, our primary application consists of a voice-based application with number-based choice menus. The web interface is secondary and serves as an administration tool for lab operators (whom we can assume to be literate), as well as a platform for farmers to view and possibly print their certificates. To make it as accessible to farmers as possible, we decided on pin codes as authentication methods for the web interface. It is moreover kept as simple as possible, with the use of symbols and little text.

Usability

Besides the considerations for illiteracy, we made several other choices to improve usability.

- We incorporated a FAQ in our voice-based application, that provides quick support for any common issues a user of the application might face, such as why their phone number is not recognized or information about one of their certificates is missing. It moreover informs them how to reach out in case of other problems.
- We made our application available in both English and French, with French being the main official language used in Mali. Users can easily switch between languages on the web interface, and get a language menu at the start of the voice-based application. Moreover, for registered users, the voice application is automatically provided in their (known) preferred language.
- Every menu in the voice-based application includes an option to return to the previous menu, in case the user made a wrong choice. This is presented as their first option, so they can immediately continue.

Data Model

The implementation of this use case requires minimal data, which includes information associated with farmers and their seed types. The following data is saved and stored in the backend of our prototype:

- **Phone:** Phone number associated with the farmer.
- **Pincode:** Pincode associated with the farmers, which also serves as their password for website login.
- **Language:** The language spoken by the farmer.
- **Species:** The type of seed species produced by the farmer.
- **Campaign:** The year in which the seeds were certified.

- **Germination:** Germination rate of the seeds.
- **Variety:** The variety of the seeds produced.
- **Batch Number:** The batch number assigned to the tested seeds.
- **Purity:** The purity of the seeds, with a minimum requirement of 98

12 Pointer to the Application

Web-based Prototype

The prototype website that was created for our use-case can be accessed through the following link: <https://semencescertifiees.elch.cc/>.

Voice XML

To access the VoiceXML prototype call +31203697664 and use pincode 889117.¹ If you do not register your phone number beforehand, you will be redirected to the menu for unregistered users. To access the menu for registered users, where you can access your certificate applications, you will first need to create a certificate on the website with your own phone number, through the laboratory login.

Git

The code from both the website and the Voice XML can be accessed through the following link: <https://github.com/elianderlohr/SemencesCertifiees.git>

13 Accessing the application

This section includes four videos demonstrating the installation and utilization of our web-based approach. The videos are as follows:

- API Installation: Learn how to install the API by watching this video: [Link: <https://youtu.be/nXtTi3-H33w>]
- Website Installation: Follow the instructions provided in this video to install our website: [Link: <https://youtu.be/IEKkDgm12kQ>]
- Using the Website as a Farmer: Discover how to utilize our website as a farmer by watching this video: [Link: <https://youtu.be/I0xUc3P2rck>]
- Using the Website as a Laboratory: Gain insights into utilizing our website as a laboratory by watching this video: [Link: <https://youtu.be/ebfN0SwusSQ>]
- A detailed written API documentary: [Link: <https://github.com/elianderlohr/SemencesCertifiees/wiki>]

Please click on the respective links to access each video and learn more about the installation process and how to make the most of our web-based approach.

¹At the time of writing, the server was down (which also stagnated the last development cycle).

14 Short Usage Scenario

In this section, we present a brief usage scenario that allows anyone to test our services. Follow these steps to try it out:

- Access the web-based prototype by visiting <https://semencescertifiees.elch.cc/>.
- Locate the "Laboratory's Login" button in the bottom left corner and click on it. This will redirect you to the login page for certified laboratories.
- Currently, we have implemented a placeholder in the login system, enabling anyone to log in as a laboratory. Simply press the login button, and you will be redirected to the page displaying all active certificates.
- On this page, you can view, edit, and delete existing certificates. Since our goal is to create a new certificate, click on the "Add new Certificate" button, which will redirect you to the page where laboratories can add new certificates.
- Fill in the required details, making sure to provide your own phone number as it will be necessary later on. Remember to also note the PIN you entered. The remaining data can be filled according to your preferences.
- Once the certificate is created, you can leave the website and access your certificate through our voice application. To do this, dial +31 20 369 76 64 and enter the PIN code 889117. If everything goes smoothly, the system will recognize the phone number from which you are calling and link it to the corresponding certificate. This is why it is essential to include your own phone number when creating the certificate.
- Please note that there may be occasions when the voice-based application is inaccessible due to issues with the voiceXML platform. However, farmers can still access their certificates through the website. So, if needed, return to <https://semencescertifiees.elch.cc/> and log in as a farmer using your phone number and the PIN code you set during certificate creation. This will redirect you to the page where you can view your certificates and share their respective links.

15 Feedback Questions

The peer review feedback we received for the second iteration of our use-case document was broadly positive, indicating that our document had successfully met multiple objectives. Peers acknowledged our website implementation as a significant accomplishment and expressed confidence in the voice-based application, despite testing challenges, due to the voiceXML platform being down. Our project documentation was praised for being clear, concise, and for its detailed ethical considerations. We received excellent feedback on the UI/UX of our web-based prototype. Our commitment to creating a professional and visually appealing user experience was highly appreciated and contributed to the positive reactions to our project.

Besides the overall positive feedback, we also received several suggestions. We took steps to address this feedback and made several improvements to our project. We have improved the readability of our document, moving images closer to the corresponding

text to create a smoother narrative. Responding to feedback on the E3-value model, we have refined the model for it to better adhere to the requirements of a successful E3-value model. In line with the suggestion for language expansion, we have now started to add French to our application and plan to introduce more languages in the future. Furthermore, we had already addressed the concerns about the presentation pitch and logo by incorporating these elements into our document.

16 Discussion of Scope and Fidelity

In section 3, we outlined the scope of the scenario, including the challenges related to fraud, such as forged certificates and non-certified seeds. Our platform addresses this issue by implementing a secure system where each farmer has their own personal account and password (4-number pin code). This authentication process enhances security and makes fraudulent activities more difficult to carry out.

In the second round of project pitches, we received a valuable tip that we immediately implemented into the system. The tip we received was to implement automatic language recognition for registered phone numbers. This enhancement eliminates the need for farmers to navigate through a language selection menu when making a call. The system intelligently detects the farmer's language automatically, streamlining the process and providing a more user-friendly experience.

Moreover, we have successfully implemented most of our proposed ideas. As intended, the website is available in both English and French, ensuring accessibility for farmers who can choose their preferred language. While we expected laboratories to be able to understand and speak English, we recognize the importance of accommodating multiple languages, including French and potentially Bambara, for future usability and inclusivity.

Some future recommendations for the project are then implementing the other languages in the laboratory section of the website and the Voice Based System. Another possible recommendation for the future is to enable Excel and CSV import/export functionality. This will empower users to import data from existing spreadsheets, streamlining the process of creating certificates. Additionally, offering the ability to export certificate data in these formats will facilitate further analysis or integration with other systems. Lastly, consider incorporating QR codes into the certificates. Similar to the QR codes used for COVID vaccination certificates, these codes should expire every 10 minutes. This time-based expiration adds an extra layer of security, reducing the risk of fraudulent activities. Scanning the QR code should reveal relevant certificate details and a timestamp, enabling users to easily verify the authenticity of the certificate within the expiration window.

17 User Evaluation

To evaluate the effectiveness of our solution, which includes both VoiceXML and a web-based approach, we asked for feedback from Sven Preng. Sven Preng conducted his master's thesis on a similar topic as our use case titled 'Digitalizing Cereal Seed Certification in Rural Mali: A Practitioner's Perspective on ICT4D' (8). We requested Sven to evaluate both applications and provide answers to some questions. However, at the time of writing, the VoiceXML servers were down, preventing him from evaluating our voice application. The following is the extremely thorough feedback we received from Sven:

- I see that you have indeed considered both perspectives and developed a website. The website is user-friendly and available in both French and English. Considering that French is one of the most spoken languages among educated groups in Mali, this was a wise choice for a prototype.
- I tried calling your application as well. The prompts are not always clear. I remember during ICT4D in 2020, my team and I recorded our own prompts, understanding the limitations of the tools used. So, this is not your fault, but it is something you could consider in your report.
- It seems that you have thought about the flow a caller goes through. It's good that the VoiceXML application provides information about the process. During my thesis, clear communication about the user interface of the tool I built was always crucial. When interacting with stakeholders in Mali, I always made demo videos with written explanations to clarify how the system works effectively.
- I think the three languages you have chosen would be sufficient for an initial pilot of the application. In my conversations with Malians, it quickly became evident that English was not spoken at a professional level. Therefore, I adjusted all my communication to French. Besides Bambara, there are several other languages spoken in Mali. It is important to be aware of the linguistic diversity in the region.
- The graphical interface of the website is relatively simple. I understand the time constraints you have, and I am not aware of your background as developers. During my thesis, I had enough time to build an application that remained simple to use. However, I do notice an inconsistency in the data in the table and the column names; I think they should be swapped. Perhaps, in the interface for farmers, you could consider using "Status" instead of "Accepted"?
- Personally, I think a voice interface would be a good addition. The challenges faced by Malian farmers and the Malian government are complex, especially in an environment where IT is not as prevalent. Voice interfaces make it possible to interact with applications using a simple mobile device.
- Privacy sensitivity and data security are important considerations when designing applications. However, I understand that the complexity of ICT4D and applicable techniques make it difficult to address these aspects in such situations. Think about assigning the right roles and permissions for data access, ensuring that users only have access to their own sensitive information.
- I tried to incorporate as many of my own findings as possible when answering your questions. The most important aspect for me was communication. It was essential for me to demonstrate to stakeholders that I understood the situation well, but I also needed their input. My proposal would only have a chance if farmers and farmer organizations see the value in the improvements I proposed and are willing to think about usability in an environment like Mali. Make the interface as clear as possible and provide simple instructions where necessary to clarify everything. Look at the interface from the perspective of someone with little computer experience and ask yourself if it is logical to use a certain button or function.

Extra's

In this section, we will present additional research findings that are not covered by questions 0-18 in the use-case document.

E3 Value model

The e3 value model of SemencesCertifiees is depicted in Figure 8 (see Appendix).

Ethics

The proposed ICT service for seed certification in Mali has the potential to improve the efficiency and accessibility of the certification process. However, it is important to consider the potential ethical implications of such a system. One major concern is the potential for fraudulent activities due to easy counterfeit certificates. The digital nature of the system may make it easier for individuals to create fake certificates, which could undermine the trust and legitimacy of the certification process.

In addition, it is important to consider the impact that the digital seed certification system may have on the livelihoods of poorer farmers in Mali. The requirement for expensive fertilisers and pesticides needed to grow the new seeds may limit their adoption to only those farmers who can afford them. This could lead to a widening gap between rich and poor farmers, where only the wealthy benefit from the higher yields. Furthermore, increased competition from these wealthy farmers may displace poorer farmers who struggle to compete and maintain their livelihoods.

Another ethical concern that needs to be considered is that the fertilizers and pesticides required for this project are often produced in more developed regions, such as Europe. As a result, European countries profit from this project, contributing to the substantial outflow of money from Africa.

In order to address these ethical concerns, it will be important to implement measures to ensure the security and authenticity of the certification process, as well as to provide support for poorer farmers to access the necessary resources to adopt the new seeds. This could include providing subsidies for fertilisers and pesticides or offering training and education programs to improve farming practices. By taking these ethical considerations into account, the proposed ICT service can be developed and deployed in a responsible and sustainable manner.

18 Conclusion

In conclusion, we have successfully developed a Voice Interactive System (VIS) to simplify the certification process for farmers. Additionally, we have created a user-friendly website that caters to both literate farmers and laboratory workers, facilitating the certification procedure. While we have currently implemented support for both English and French languages, for future project enhancements we want to also consider the inclusion of Bambara.

Throughout the project, we have taken ethical considerations into account. One concern is the potential for this digital seed certification system to exacerbate the socioe-

conomic gap between wealthy and less affluent farmers. There is a possibility that only financially advantaged farmers would benefit from increased yields, potentially leaving poorer farmers at a disadvantage.

In summary, this project shows great potential for success and presents intriguing opportunities. Although we couldn't test the Voice XML component due to platform issues, we successfully developed both the website and the interactive voice system. There are certain ethical considerations associated with this project. Nevertheless, we are proud of our accomplishment in creating this solution and potentially simplifying the certification process for farmers.

Bibliography

- [1] "Mali literacy rate," April 2023.
- [2] Statista, "Price for mobile data in mali," 2021.
- [3] Sagicamhost, "Mali web hosting - cheap web hosting in mali, africa."
- [4] G. C. Forwarding, "How much does ivr cost?," 2021.
- [5] OVHcloud, "Public cloud pricing," no date.
- [6] S. Omondi, "What languages are spoken in mali?," *World Atlas*.
- [7] "Language data for mali," Jul 2022.
- [8] S. Preng, "Digitalizing cereal seed certification in rural mali: A practitioner's perspective on ict4d," 2023.

Appendix - Extra Infromation

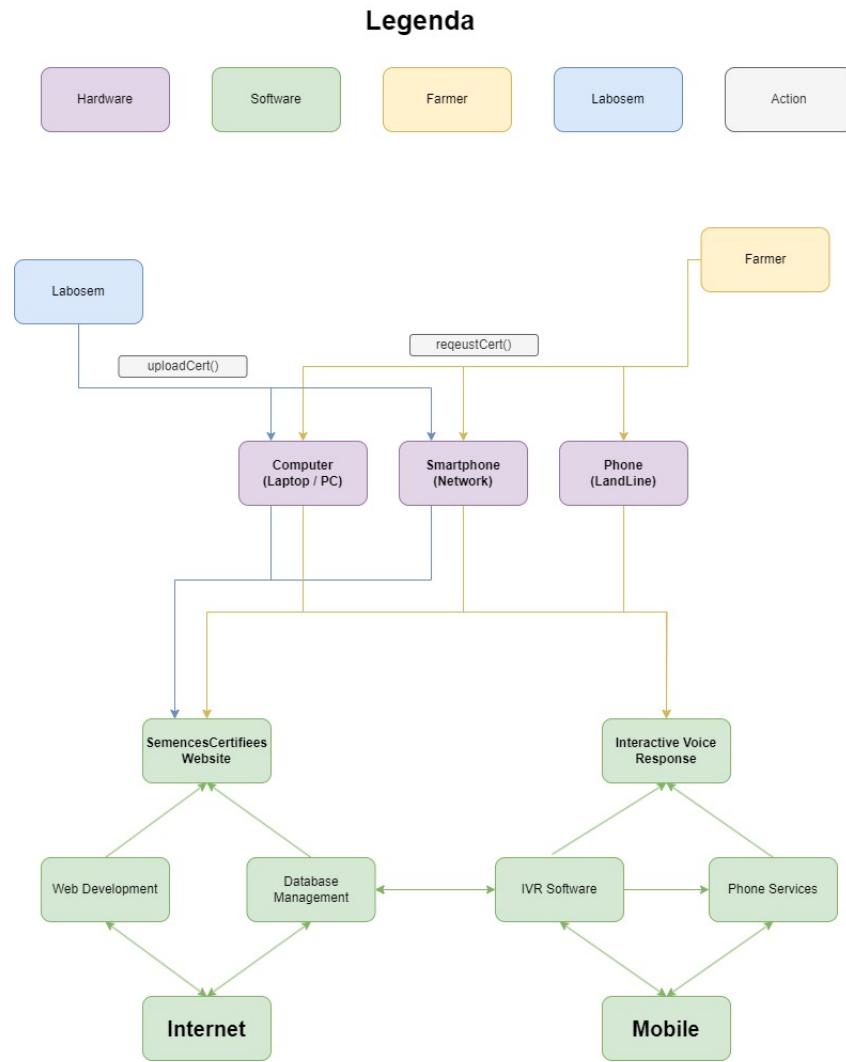


Figure 4: UML diagram of the technology infrastructure supporting the scenario.

Category	As a	I want to be able to	So that	Priority
Basic	Registered farmer	Return to the previous menu from any menu Retrieve the status of any of my processed certification requests Retrieve the data about any of my issued certificates	I don't get lost I have timely access to this information and can prepare accordingly I have timely access to this information and can prepare accordingly I know I have to first apply for certification or all my applications are still pending	MUST
Basic	Registered farmer	Know that I am not registered yet	The authentication process requires as little effort from the user as possible	MUST
Basic	User	Obtain access to the correct part of the system based on my phone number	I am more likely to understand what is being said	MUST
Basic	User	Choose the system language from a set of common languages	Making a wrong choice is easily corrected	SHOULD
Basic	Registered farmer	Return to the previous menu at any time	I can learn how to make use of the system	SHOULD
Basic	Unregistered farmer	Get information on the certification process	My certificates can be linked to a new number	SHOULD
Basic	User	Receive information on updating my phone number	I am even more likely to understand what is being said	SHOULD
Basic	User	Choose the system language from a set of common and local languages (e.g. Bambara)	I can troubleshoot some of the easy problems myself	SHOULD
Basic	User	Access a FAQ that addresses common problems (e.g. calling with another phone from your own, certificates that do not appear in the menu)	I get access to download options in a safe way	COULD
Download	Registered farmer	Access a web interface with my phone number & pincode	I can start selling my product legally	COULD
Download	Registered farmer	Download any of my issued certificates	I can print them and attach them to the corresponding bags of seeds	COULD
Download	Registered farmer	Download the tickets linked to any of my issued certificates	The farmer can access the results	COULD
Admin	Lab operator	Add information about a farmer's certificate once its application is processed	The database does not become overpopulated	COULD
Admin	Lab operator	Delete expired certificates	Possible mistakes can be amended	COULD
Admin	Lab operator	Update information about a farmer's certificate	The farmer can decide during application which option they prefer	COULD
Admin	Lab operator	Use a flag to indicate whether certificate and tickets should be downloadable or sent by mail	Fraud is made more difficult	COULD
Admin	Lab operator	Control the number of ticket downloads	I have a convenient overview of processed certificate applications	COULD
Admin	Lab operator	Download an Excel file with all certificates present in the database	We can help local farmers 24/7	WONT
Admin	Lab operator	24/7 costumer support	Allow the system to recognize the individual farmers by their voice	WONT
Admin	Lab operator	Voice Recognition	To combat fraudulent activities, thumbprints could be used to correctly identify farmers and their seeds.	WONT
Admin	Lab operator	Thumbprint Recognition	The Labosem could use social media to raise awareness of the new seed certificate system.	WONT
Admin	lab operator	Social Media Integration	Farmers may prefer to preserve their brand identity by using customized certificates (e.g. with their logo and name) that reflect their brand.	WONT
Basic	Registered farmer	Costum Certificate Appearence	The current system only benefits wealthy farmers due to expensive fertilizers and pesticides, but we aim to add a FAQ on obtaining microfinance to enable even the poorest farmers in Mali to buy seeds.	WONT
Basic	Possible new farmer	Microfinancing application		WONT

Table 3: MoSCoW list of requirements (Must have, Should have, Could have, Won't have) as a starting point for further architecture design, and system and component development.

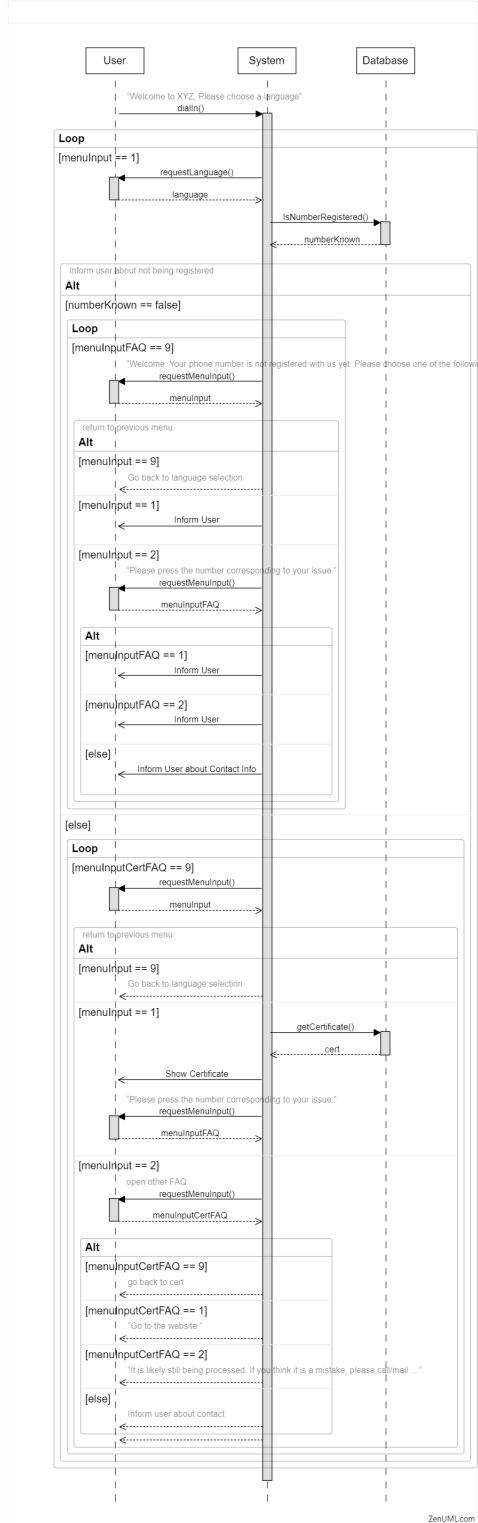


Figure 5: BPMN of the SemencesCertifiées Prototype Module 1

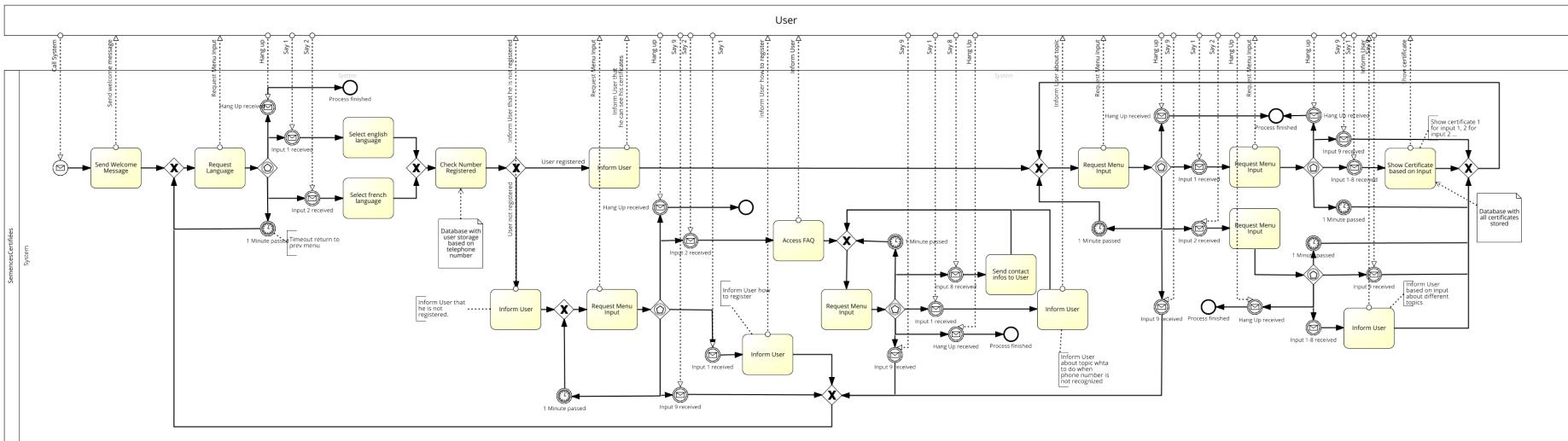


Figure 6: BPMN of the SemencesCertifiées Prototype Module 1

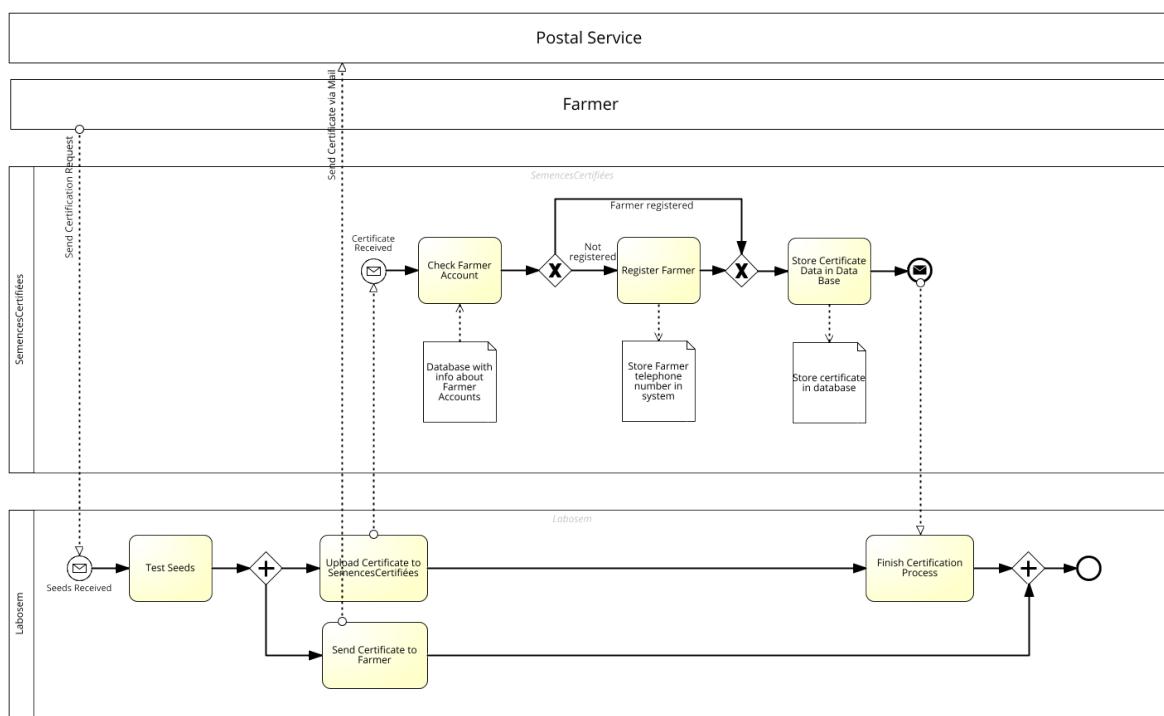


Figure 7: BPMN of the SemencesCertifiées Module 2

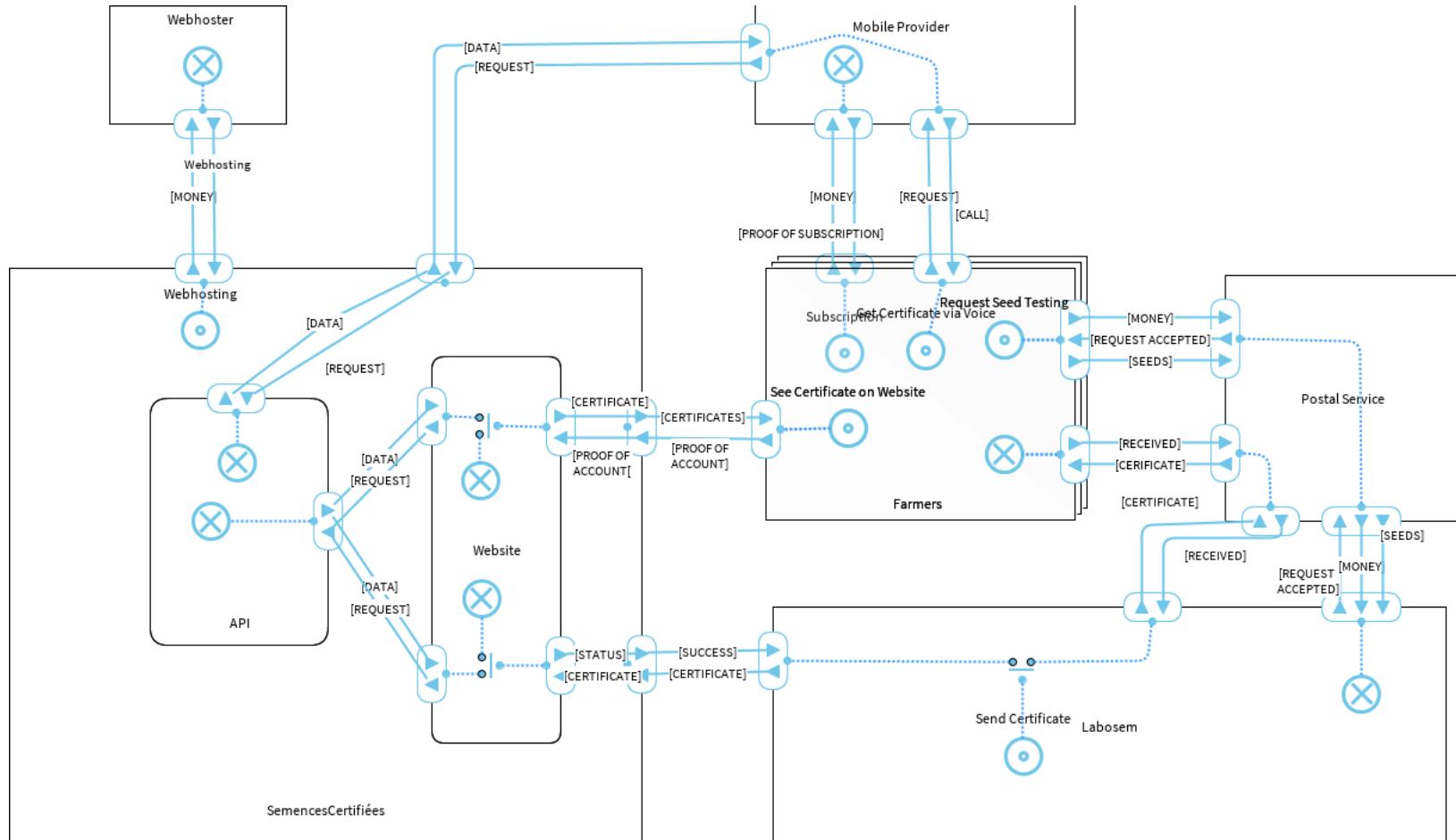


Figure 8: E3 Value Model

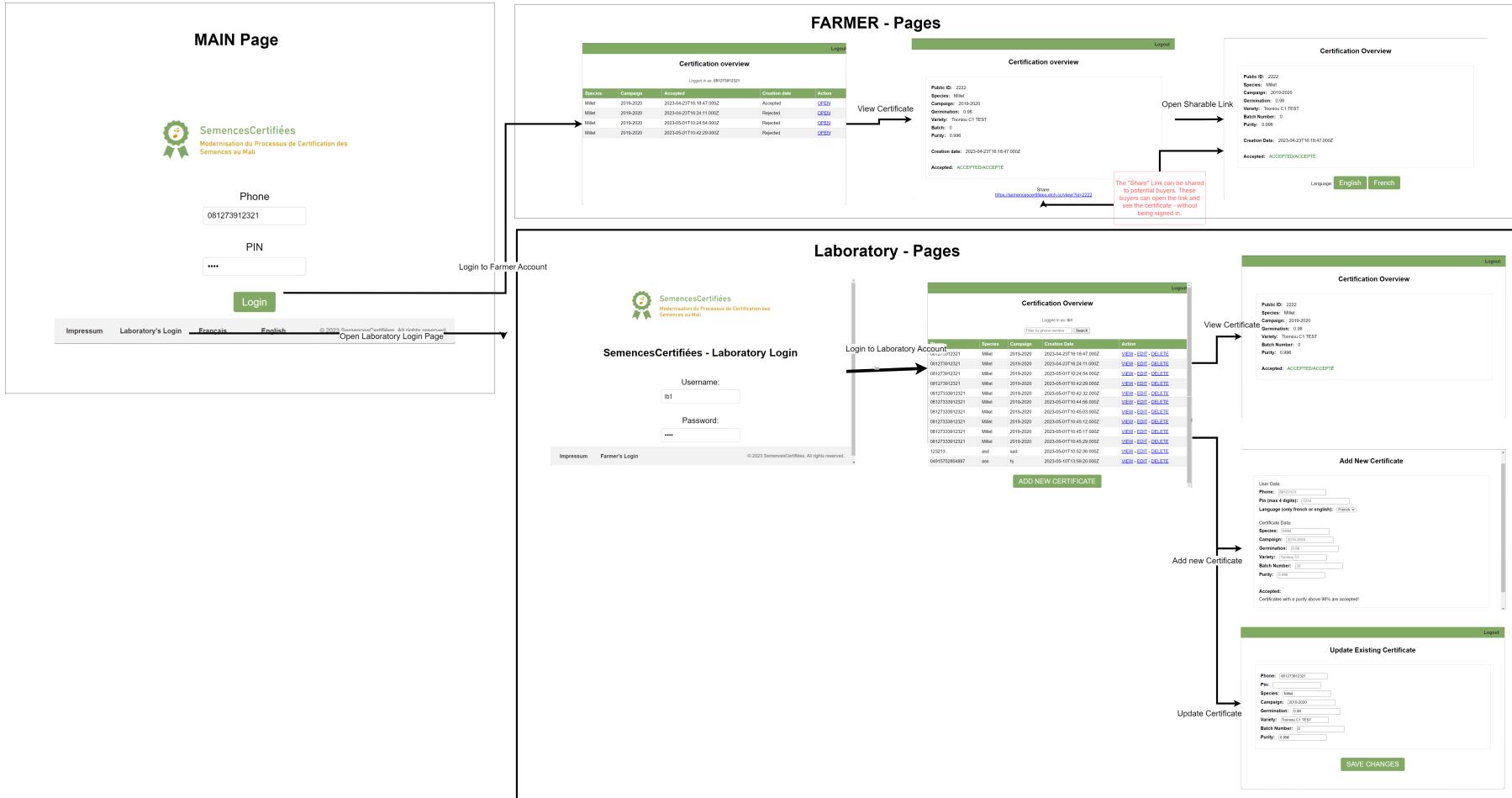


Figure 9: The Website Flow Diagram

19 Interview Transcription

This section contains transcripts of the interviews we conducted throughout our research.

Interview Anna Bon

The following is a transcription of the interview we conducted with Anna Bon on Friday, April 14th.

Q1: So first of all, we would like to know in what kind of situations or settings the farmers would make use of their certificate. So when do they need access to it and maybe show it to others somehow?

Since 2009, we have been working in Mali to support local farmers and agricultural organizations. We began by working with a local organization focused on ICT for research projects, which helped us connect with the Association of Organizations of Professional Farmers (AOPP). AOPP is an umbrella organization with members all over the country, including small cooperatives, farmer organizations, pastoralists, cattle rearers, and fishermen. They are a very interesting organization because they represent almost everyone who does small business or small production in Mali.

Our work with AOPP started with an interest in seeds. In Mali, there are two seed systems: the traditional one where farmers produce seeds for themselves and exchange the surplus for other goods like chickens or goats, and the newer system introduced by development corporations that focuses on improving seeds for higher yields. The new system has a certification process and is promoted by the Malian government, NGOs, and organizations like the Bill and Melinda Gates Foundation.

The certification process involves high standards and quality control to ensure the seeds are pure and not cross-pollinated. However, this system requires farmers to clear their land, use pesticides and fertilizer, and undergo a lengthy certification process before they can sell their seeds. While some farmers have seen success with this system, it presents disadvantages, especially for the poorest farmers who cannot afford the upfront costs and do not have access to markets to sell their seeds.

We have been conducting workshops with farmers in recent years to explore these issues and have found that many seed producing farmers are unable to sell their seeds due to market barriers. This has led to a growing interest in agroecology, which promotes traditional farming practices that are more sustainable and better for the environment. Agroecology is a bottom-up initiative that seeks to address the human and biodiversity/ecological axes, but faces political pressures from those who support the formal seed agriculture system.

To address these issues, we have been working with local NGOs to explore community-based certification systems. These systems would allow for community-driven standards for quality control, ecological sustainability, and fair trade, rather than relying on government or external certification processes. We are currently exploring the possibility of developing a digital system to support community-based certification and monitoring of seed production.

From my perspective, the community-based certification initiative faces a major challenge in ensuring that the seeds are genuine and have not been tampered with. The lab that previously evaluated the seeds is now replaced by the community, and there must

be a process to verify that the seeds are authentic. This challenge arises because certificates can easily be forged or counterfeited, and it's difficult to determine what's inside the seed bag just by looking at the label. We have been trying to address this issue for years, exploring different solutions, including blockchain technology and other forms of verification, but the problem persists. However, we are always open to new ideas and are actively brainstorming with the community to come up with innovative solutions to ensure the authenticity of the seeds. If you have any suggestions, we would be happy to hear them. Our goal is to create a small system that will allow the community to collect data about the seeds, report any issues, and provide feedback on the quality of the seeds.

During our discussions with the laboratory, we discovered they have an Excel sheet with information on farmers, including their location, produce, and quality categories. However, the current certification system is fraud-sensitive, and we brainstormed on ways to improve it. The lab was interested in our proposals, and we are currently working on designing a more secure system.

Q2: So how do you use the certificates? Like you have a bag of seeds and you have the certificate somehow attached to it or something?

Yeah, I think they put it on the bag or they have a kind of stamp.

Q3: Do they sell bags at once with the certificates?

So we discussed with the farmers about the bags they sell, which are quite big. We were concerned about fraud, as people could easily use the same certificate on another bag. We discovered that some people only buy the bags and then put cheap stuff in them to sell. It's challenging to control for this kind of fraud, and we thought about how to improve the system. We considered reducing the time between issuing the certificate and giving it to the farmer, and also ensuring that those who visit the fields bring data to the lab about the approval of the field. We were discussing various use cases to improve the certification process for farmers, and one idea we came up with was to make it more convenient for them. For example, they could call a number and hear whether their certification has been approved. This would save them time and make the process more appealing. The voice dialogue could recognize the farmer's number and provide them with information about their lot, whether it has been approved or disapproved. It's just one aspect of the use case, but it could be a simple and effective solution.

Q4: What are the advantage of these certified seeds except from their yield? Because it seems like it's a lot of process. It doesn't really contribute to biodiversity. You have to wait six months to get your certificate. It's very fraudulent. Why would anyone want to use the certificate? Why would one want to grow this besides the yield?

Yeah, that's a great question. From what I've seen, some of the farmers who have been able to successfully sell their crops have become quite prosperous. I can think of one cooperative in particular that has a really impressive website and seems to sell a lot of product. They claim that if you're well-organized, you can make a lot of money with the certified seeds because there's a big market for them both domestically and in neighboring countries. With the laboratory's quality certificate and the high yield, it can be a very profitable business.

But the key is to be extremely well-organized and to have the right training and resources. These farmers need to know how to properly store the seeds, ensuring that they remain dry and don't get moldy. It takes a lot of investment and hard work to succeed in this business, which means there's a bit of a division between the farmers who have the resources and knowledge to do it right, and those who are still struggling to get by.

Q5: So you mentioned that a farmer could check by phone, whether their stock has been certified, for example. But how could they use their certificate if it's only digital?

Sure, I understand what you're saying. You're suggesting that perhaps there could be a way for farmers to download their certificates from a website, rather than having to physically go to the lab to collect them. This could be especially useful for those who live far away or have limited access to transportation. By having access to their certificates, farmers can start preparing for the selling process, such as packing and advertising their produce. It also allows them to know whether their produce has been certified or disapproved, which can help them make informed decisions on whether to sell it for consumption or wait for certification. Overall, having easy access to their certificates can help farmers save time and streamline their selling process.

Q6: Because I assume that people who buy the seeds want to see the certificates, right?

Yes, when it comes to selling products on the market, official certification is mandatory. To give you a better idea, it's similar to how things work in a market or a shop. Additionally, larger seed companies also require certification to operate. It's a necessary aspect of doing business in this industry. Without it, you can't legally sell your products.

Q7: But then if they download this certificate, they would also need to print it themselves or?

That's absolutely true. However, I've noticed that they do have a method for printing because they also print the numbers on the bags. It might be worth investigating this further to gain a better understanding of how they manage the printing process.

Q8: Are there any other big organizations in Africa that are implementing a similar seed certification processes?

Yes, that's correct. However, we only have contact with a few of them. You can find a lot of information online, but the use cases we're focused on are based on people we've personally interviewed and know well. One website that may be of interest is a union called USA. They sell rice, maize, and millet and are very well organized, providing finance for farmers and even giving out loans. They have tractors and other machinery, showing how cooperative they are. They operate in Mali, Niger, and Burkina Faso, with over 2,000 members, including 1,000 women. We met the coordinator of this organization and visited their union. Although it was somewhat dangerous to travel there due to the area's instability, we found it to be a peaceful and friendly place. We had lunch, visited the farmers' fields, and got a feel for how well-organized they are. Not all unions are as well-organized as they are, making them a success story. Another organization we've looked at is Alpepe, but their website is not as nice as USA's. They have a stock and

a database of seeds, but it doesn't work very well. They offer a variety of seeds such as rice, soya, sorghum, groundnuts, and maize, which could be useful for your use case. If you make a dropdown menu, you can see a bit more about what they produce. This provides some context for the seed market and the organizations we're examining.

Q9: Just to be clear, so now we're just not really focusing on the community-based, but more on the individual farms?

It's completely up to you. You have the freedom to choose whichever use case you prefer. Every use case has many different aspects to consider, so you can start with a small angle and expand or delve deeper into it as needed. In the next phases, you can improve your technology and make it more advanced or even work on making it more fraud-proof, for example. The choice is entirely yours, and you have the flexibility to mold your approach to your preferences.

Q10: Who creates the farmers account? Like, is it like the laboratory or do we assume that the laboratory does a lot of work?

Our initial expectation was that there would be a designated platform for the party, likely hosted by the lab. It would involve creating accounts, which would require personal information such as names and phone numbers to be registered with the lab. Currently, this information is collected on paper forms, either submitted or presented in person to a representative in the field who then collates the data. While we are not certain of the current process, this is how it was done previously.

Q11: So does that mean that the agency can then just whenever they have done their certification, just link their phone number to basically a yes or no or more data?

It seems likely that the lab has a database of information that includes the data we need. We were able to obtain a picture of their screen and view their database, which includes information on the certificate, the year, the percentage of germination, the lot number, and the type of seed. However, we didn't see any names attached to the data, only reference numbers. Additionally, we were able to obtain pictures of certificates and other related documents, including quality analysis results and reference numbers that correspond with specific individuals. The organization of this data is quite simple, with different colored papers for different types of seeds and straightforward certification processes. We also observed the lab's tools and materials for evaluating seed quality, as well as the process for certification, which involves sending samples along with reference numbers. We have a variety of pictures that document our observations, including shots of seed buyers and sellers, farmers' fields, and bags of rice and sorghum. Overall, the information we have obtained is quite interesting and informative.

Q12: Can you provide some context on the technical background of the project?

In our course, we emphasize the importance of creating voice-based applications. This is because there are always individuals who may not have smartphones or who may be illiterate. While having a web interface for your system is nice, it's important to also develop some kind of voice application that allows access to basic data, such as whether or

not a certificate has been issued, or information on produce for sale or purchase. Ideally, the application should also provide some basic instructions in the local language. In our case, this would include French and sometimes Bambara, as these are the most commonly spoken languages in the area. It's important to have a good prototype that demonstrates the use of multiple languages, as well as providing options to switch between them. We've learned through experience that allowing users to select the wrong language can cause problems, so thorough testing is essential to ensure the application runs smoothly. In conclusion, it's crucial to make sure that any voice-based application is accessible and user-friendly, and can provide text-based instructions when necessary.

Q13: So you also want to be able to get information about your certificate in text, like the data that's on the certificate or? Could be. Like on the speech?

We think it's helpful to include the option to download a picture of the certificate, as well as providing access to the website or other resources. However, it's important to keep in mind that voice applications can be challenging to understand and interact with, so it's best to keep the design simple and straightforward. We recommend avoiding overly complex menus with too many options, and including options to return to the main menu or hear previously entered data. For the first assignment, it's important to develop the model and application, but we are currently unable to test it on our platform. We anticipate being able to test it in the second phase, once Andre has completed the rebuild. Ultimately, the model is the most crucial aspect of the application, and there are plenty of voice XML examples available online that can be used as a reference.

Q14: Should we focus on the basic for the basics for the first version?

To get started, it's important to have a plan. During our Wednesday pitch sessions, everyone presents their plan for the next three to four weeks. Even if the plan changes, it's important to have a clear goal and problem to solve. We welcome feedback during this iterative process, and it's part of our requirements analysis. It's good to aim high, but we also need to be realistic and adaptable to changes.

Interview Joost Westerhout

Hey Joost Thanks for helping me with the interview. Let's start with you introducing yourself and telling us a little bit more about Sommalife?

Okay, I'm Joost, co-founder of the social enterprise Sommalife. It's a Dutch-Ghanian startup that we started in 2020 together with two Ghanian partners and two Dutch guys. It's five people, so it's been three years. The goal of Sommalife is to make an impact on small-scale farmers in rural areas in West Africa. We started in Ghana and we're now working together with 20,000 farmers in the five regions where shea trees grow. These shea trees are a source of income for women. Traditionally, women produce raw materials from these trees. Shea is a type of shea and is widely used in the food and cosmetics industry. We make sure that we exclude the average person, so that we can offer women in the countryside a high price for their products. All the profits we make, we put back into impact projects, so that we can make sure that these women can become independent entrepreneurs and stand on their own two feet. We keep all the impact we make in our own software that we have developed. It's called TreeSight. Every woman we work with

has a profile of how many children she has, where she lives, what her primary source of income is, what she is up against, but also every engagement we have with these women. We give them training on how to make high-quality products. We give them training on nature restoration, how to plant trees, product differentiation, so that they don't just get a high price for a product, but that the impact is really long-lasting.

Okay, and how do these women use the technology, the software? The women themselves don't use it, but we work with community agents, and those are agents who go to the communities where these women live. They have those kind of tablets with fingerprint scans on them. So everything, every interaction we have with these women, for example the price we pay, we let them approve with the help of a fingerprint. And that way we can make sure that what we say we do, so the price we pay to these women, can be certified, and that it's certain that we've actually paid that price to these women. In addition, we give them training, so when those women, we go to the field, we give them training, and we keep track of how many, who are all present, we keep track of how active they are in the training, so we can see, okay, this person is very active, this person is a little less active, and we can put that next to the production, how much did you produce in the year, how much did you sell? We can see, okay, this woman has done her best, and has sold a lot, but you can also see, this woman has done a lot less, where does that come from? And then we can see, okay, this is, actually she wasn't very active in those trainings, she never was, so we can see, okay, this person needs extra interaction, to make sure, okay, learn a little more, it doesn't happen by itself, you really have to do your best, to ultimately let yourself cross the poverty line.

Okay, great, and how did you develop that software? We, it's actually a Ghanese company, and software engineers work there, there are now 15 software engineers who work there, they are just full-time developing from the ground up, to the product we have now, and that's just a team where you get guidance every week, and they do sprints, sprints every week, and then they try to develop the product further, and every week we also have feedback moments from the agents, who use the software in the field of the KNH. Unfortunately, this didn't work well this week for me, and then we can integrate that, to make the product better and better.

And what do you think is the importance of the software developers living and working in the neighborhood where the product is used, where the software is used? I think it is very important that they have an affinity with what they are doing it for, and therefore they also better understand the consumers of that software. And I think that if you would develop it here in the Netherlands, you need a culture of the product that is being made, that it is also easy to use for those people there. And that's why it's very important to us that they are very close to each other, and not that every time they have problems, those agents have problems, that they have to go to a team in the Netherlands to give feedback, but that the lines are very short to keep it as efficient as possible to continue developing it.

Okay, because as a software developer in the Netherlands, I know little about the state of ICT use in Mali. Can you sketch an image of the current state of ICT use among ordinary people in Ghana?

Yes, that's actually quite funny, because there is a whole leap between fixed telephony, when it started in the West, in the South, Global South, it's actually not like that at all, but when the mobile phone came up, they did come up with it reasonably a few years after the smartphone and such was used in the West. So they never really had a fixed phone, but they immediately jumped from nothing to a mobile phone. And you can see

that they are much more involved, and can suddenly get a lot more information than they used to, because they are connected to the internet. But because of that, you can see that there are a lot of beautiful innovative startups that are working on it. I call it the FarmerLine, for example, I also did an internship for three months there, and they use voice messaging to provide the local farmers in their local languages with weather forecasts, also about what kind of pesticides and insecticides they should use, and they get training with that. And that's a very nice thing, that you can send that directly to your customers, and that they get it in and that it's within reach. And that they don't have to go to a garden hall first to get that information, because very often you have farms that are kilometers away from the garden hall, and they don't have to go to the garden hall every time to get that information, but they can just get it at their own farm, so that's a big step forward. Yes, because that's a very big step, if you don't go straight from technology to 3G, where the network goes and actually crosses the entire landline. I think that also had an effect on the acceptance of that technology. Yes, I think it was a very eye-opener, because you live in your own bubble there. We also organize toy donation actions. And actually the only three professions you have there are police officer, farmer, and if you're lucky, taxi driver. For the rest, it's nothing. Here in the Netherlands, it's very natural that you think about all kinds of things, like, okay, I'd like to become this, and you also learn a lot with toys. We also saw when we were handing out toys there, that you really make a huge impact, because you start thinking a lot more out of the box, and that technology makes that jump that you suddenly made, that you're much more accessible to the outside world, that also plays a role in that. So it really broadens the horizon for those people there. Yes, I can imagine that. And it certainly improves the living conditions there, because they suddenly have access to information they never had before.

Yes, but I can imagine that when you take that big step, that for some people in that community there is a kind of restraint towards accepting and fully accepting such new technology, isn't it?

Yes, certainly. They are always very reserved in everything, actually, all new things, because they have passed on everything that has been passed on for so many generations. And they find it very difficult to accept that there is something else. We certainly see that. And you have chiefs working in those villages. They are actually the heads of those communities. And it is very important that you sit down with the chief and make it clear to him that this is the importance of it, and these can be the effects. And often, if you come up with a good story, especially with the local population, they have to tell him that and make sure that he is convinced that it can have a positive impact. And if you actually turn the chief, if the chief is around, then it is quite easy to eventually get the community to use it.

And have you had the pleasure of meeting the chief with the iPad and the software?

Yes, certainly. We have been able to meet the chief a few times. It is special. They are always very old men and they are lying there lying around. And they do pretty little for the rest. But everything has to go through them to get permission to get something through.

Are there other challenges or problems that you have encountered when introducing your ICT system? Well, you have women's inequality, which is a big problem. So everything has to be approved by the man. Often, the women want to do more for themselves. And then they are told by a man that they should be home more often to cook and take care of their children. That is a pretty big problem. But that is precisely

the barrier that we want to break through. By really improving the women empowerment. And we also work with a lot of our agents, who are also women, but also men. And you can see that when you finally deal with the chief, it is much easier to sit at the table with those women and make sure that those women can do something without being stopped by the man.

20 Code Description

The provided VoiceXML code is a voice application that uses the VoiceXML 2.1 standard to create an interactive voice interface for retrieving information on seed certificate applications. It consists of multiple forms and menus to guide the user through different options and functionalities.

The code starts with a form called "phone_check" that checks if the user's phone number is registered by making a POST request to an API endpoint. The response determines the language preference of the user, and they are redirected to the appropriate menu based on that preference.

The code also includes forms for retrieving certificate information. The "certificates" form sends a request to the API to fetch a list of certificates associated with the user's phone number. The "certificate" form allows the user to enter a certificate ID, and upon submission, it sends a request to the API to fetch detailed information about the specified certificate.

Additionally, there are menus for frequently asked questions (FAQs) and other functionalities such as returning to the previous menu or accessing application process information. These menus provide options for users to navigate through the application and find the information they need.

In summary, this VoiceXML code demonstrates the implementation of an interactive voice application that integrates with an API to retrieve and present seed certificate information. It utilizes forms, menus, and API requests to facilitate user interactions and deliver the desired information through voice prompts.

Please note that the provided VoiceXML code has not been tested due to the unavailability of the platform it is designed for. The code is presented as a reference or example and may require modifications or testing to ensure proper functionality in a live environment.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE vxml
PUBLIC "-//W3C//DTD VOICEXML 2.1//EN"
"http://www.w3.org/TR/voicexml21/vxml.dtd">
<vxml version = "2.1" xmlns="http://www.w3.org/2001/vxml">

<!-- Author: Zheng Zhang &amp; Michelle Schifferstein
ICT4D group 9

Interactive voice application for retrieving information on seed certificate applications
Comes with a web application for viewing and downloading certificates.

Version 1.0 (M. Schifferstein - 20-24/04/2023) - phone number recognition with redirect,
menus for FAQ's, viewing certificates, getting info on process. All endpoints lead
back to the previous menu. All menus have a return option. All data is hardcoded.
Version 2.0 (Z. Zhang - 01-19/05/2023) - API plugin, phone number check &amp; certificates
list &amp; certificates detail interaction with backend
--&gt;

<!-- Check whether phone number is registered. Redirect user to the appropriate menu. --&gt;
&lt;form id="phone_check"&gt;
    &lt;var name="phone" expr="session.telephone.ani"/&gt;
    &lt;var name="apikey" expr="a13c2c03-f82f-4d39-935f-228a638988a7"/&gt;
    &lt;block&gt;
        &lt;submit method="post" next="https://api.semencescertifiees.elch.cc/
voicexml/user-exists.xml" namelist="apikey phone" enctype="application/x-www-form-urlencoded" /&gt;
    &lt;/block&gt;
    &lt;script&gt;&lt;![CDATA[
        var code = serverResponse.documentElement.getElementsByTagName("Code").item
        (0).firstChild.data;
        var userLanguage = serverResponse.documentElement.getElementsByTagName("Language")
        .item(0).firstChild.data;
    ]]&gt;&lt;/script&gt;
    &lt;block&gt;
        &lt;if cond="code == '200'"&gt;
            &lt;if cond="userLanguage == 'en'"&gt;
                &lt;prompt&gt;Welcome to the English menu.&lt;/prompt&gt;
                &lt;goto next="#en_farmer_select"/&gt;
            &lt;/if&gt;
        &lt;/if&gt;
    &lt;/block&gt;
&lt;/form&gt;</pre>
```

```

        <elseif cond="userLanguage == 'fr'" />
        <prompt>Bienvenue dans le menu fran ais.</prompt>
        <goto next="#fr_farmer_select"/>
    </else/>
    <prompt>Invalid language attribute.</prompt>
</if>
<elseif cond="code == '500'" />
    <prompt>Server Error: There is a problem with the server.</prompt>
<elseif cond="code == '401'" />
    <prompt>Unauthorized: The API key is invalid.</prompt>
<elseif cond="code == '400'" />
    <prompt>User does not exist.</prompt>
    <goto next="#languageform"/>
</if>
</block>
</form>

<form id="certificates">
    <var name="phone" expr="session.telephone.ani"/>
    <var name="apikey" expr="a13c2c03-f82f-4d39-935f-228a638988a7"/>
    <block>
        <submit method="post" next="https://api.semencescertifiees.elch.cc/
voicexml/user-exists.xml" namelist="apikey phone" enctype="application/x-www-form-urlencoded" />
    </block>
    <script><![CDATA[
        var code = serverResponse.documentElement.getElementsByTagName("Code").item(0).firstChild.data;
        var count = serverResponse.documentElement.getElementsByTagName("Count").item(0).firstChild.data;
        var firstId = serverResponse.documentElement.getElementsByTagName("id").item(0).firstChild.data;
    ]]></script>
    <block>
        <if cond="code == '200'" />
            <prompt>
                <s>Here are <value expr="count"/> Certificates found
                .</s>
                <s>The id of first Certificate is <value expr="firstId"/>.</s>
            </prompt>
        <elseif cond="code == '500'" />
            <prompt>Server Error: There is a problem with the server.</prompt>
        <elseif cond="code == '401'" />
            <prompt>Unauthorized: The API key is invalid.</prompt>
        </if>
    </block>
</form>

<form id="certificate">
    <var name="phone" expr="session.telephone.ani"/>
    <var name="apikey" expr="a13c2c03-f82f-4d39-935f-228a638988a7"/>
    <field name="cid" type="digits">
        <prompt>Please enter the certificate id that required to query</prompt>
    </field>
    <filled>
        <assign name="certificateid" expr="cid" />
    </filled>
    <block>
        <submit method="post" next="https://api.semencescertifiees.elch.cc/
voicexml/user-exists.xml" namelist="apikey phone certificateid" enctype="application/x-www-form-urlencoded" />
    </block>
    <script><![CDATA[
        var code = serverResponse.documentElement.getElementsByTagName("Code").item(0).firstChild.data;
        var farmer_id = serverResponse.documentElement.getElementsByTagName("farmer_id").item(0).firstChild.data;
        var issued_at = serverResponse.documentElement.getElementsByTagName("issued_at").item(0).firstChild.data;
        var expires_at = serverResponse.documentElement.getElementsByTagName("expires_at").item(0).firstChild.data;
    ]]></script>
    <block>
        <if cond="code == '200'" />
            <prompt>
                <s>Certificate found.</s>
                <s>The famer id is <value expr="farmer_id"/>.</s>
                <s>The issued date is <value expr="issued_at"/>.</s>
                <s>The expires date is <value expr="expires_at"/>.</s>
            </prompt>
    </block>

```

```

        <elseif cond="code == '500'" />
            <prompt>Server Error: There is a problem with the server.</prompt>
        <elseif cond="code == '401'" />
            <prompt>Unauthorized: The API key is invalid.</prompt>
        </if>
    </block>
</form>

<menu id="languageform" dtmf="true">
    <prompt>
        <s>For English, press 1.</s>
        <s xml:lang="fr">Pour le fran ais, appuyez sur 2.</s>
    </prompt>
    <choice next="#en_unregistered_select"/>
    <choice next="#fr_unregistered_select"/>
</menu>

<!-- English menu for unregistered users. Contains return, application process information and FAQ options. -->
<menu id="en_unregistered_select" dtmf="true">
    <prompt>
        <s>Welcome. Your phone number is not registered with us yet.</s>
        <s>Please choose one of the following options.</s>
        <s>To return to the previous menu, press 1.</s>
        <s>To get more information about the certification process, press 2.</s>
        <s>To access the answers to frequently asked questions, press 3.</s>
        <s>To fetch sample data from the API, press 4.</s> <!-- Added new menu option to fetch API data -->
    </prompt>
    <choice next="#unreg_language_select"/>
    <choice next="#en_process_form"/>
    <choice next="#en_unreg_faq_form"/>
        <choice dtmf="4" next="#enfetchapidata"/>
    </choice>
</menu>

<!-- Provides information on the application process. Returns to previous menu afterwards. -->
<form id="en_process_form">
    <block>
        <prompt>
            <s>This application is used to quickly access the status of your seed certificate applications.</s>
            <s>To apply for certification, send a sample of your seeds to our laboratory.</s>
            <s>You can find more information at www.placeholder.net.</s>
            <s>Once your application has been processed, you can call this number to obtain the results.</s>
            <s>You will now return to the previous menu.</s>
        </prompt>
        <goto next="#en_unregistered_select"/>
    </block>
</form>

<form id="enfetchapidata">
    <data name="apiData" src="https://api.semencescertifiees.elch.cc/test/docuExampleApplicationHeader.xml"/>
    <script><![CDATA[
        var last = apiData.documentElement.getElementsByTagName("last").item(0).firstChild.data;
        var ticker = apiData.documentElement.getElementsByTagName("ticker").item(0).firstChild.data;
        var name = apiData.documentElement.getElementsByTagName("name").item(0).firstChild.data;
        var change = apiData.documentElement.getElementsByTagName("change").item(0).firstChild.data;
    ]]></script>
    <catch event="error.badfetch">
        <prompt>
            <s>There was a problem fetching the data. Please check the URL and try again.</s>
        </prompt>
        <exit/>
    </catch>
    <catch event="error.unsupported.fetchmode">
        <prompt>
            <s>The fetch mode is not supported by the platform. Please contact support for assistance.</s>
        </prompt>
        <exit/>
    </catch>
    <catch event="error.unsupported.format">
        <prompt>
            <s>The fetched document format is not supported. Please ensure the document is in a supported format.</s>
        </prompt>
        <exit/>
    </catch>
    <catch event="error.semantic">
        <prompt>

```

```

        <s>There is a semantic error in the fetched document. Please check the |
          document for errors and correct them.</s>
        <s>Problem is <value expr="event.message"/>.</s>
      </catch>

    </block>
    <prompt>
      <s>The information from the API is as follows:</s>
      <s>The ticker is <value expr="ticker"/></s>
      <s>The name is <value expr="name"/></s>
      <s>The change is <value expr="change"/></s>
      <s>The last is <value expr="last"/></s>
    </prompt>
    <exit/>
  </block>
</form>

<!-- An FAQ menu for unregistered users. -->
<menu id="en_unreg_faq_form" dtmf="true"> <!-- TODO: more options? -->
  <prompt>
    <s>You now get a list of frequently asked questions. Please press the number
      corresponding to your problem.</s>
    <s>To return to the previous menu, press 1.</s>
    <s>If your phone number is not recognized, press 2.</s>
    <s>If you want to know how to register, press 3.</s>
    <s>If you have another problem, press 4.</s>
  </prompt>
  <choice next="#en_unregistered_select"/>
  <choice next="#en_phone_form"/>
  <choice next="#en_process_form"/>
  <choice next="#en_otherproblem_unreg_form"/>
</menu>

<!-- FAQ answer: Explains why one's phone number may not be recognized by the system. -->
<form id="en_phone_form">
  <block>
    <prompt>
      <s>You can only call with your own phone, with which you applied for
        certification. Make sure to use your own phone.</s>
      <s>If you changed your phone number, you need to contact us by mail so that we
        can register your new number in the system.</s>
      <s>Certification results will appear once processed. If your application is
        still pending, your phone number may not have been registered yet. Please
        be patient.</s>
      <s>You will now return to the previous menu.</s>
    </prompt>
    <goto next="#en_unreg_faq_form"/>
  </block>
</form>

<!-- FAQ answer: Explains how to reach out in case of other problems. -->
<form id="en_otherproblem_unreg_form">
  <block>
    <prompt>
      <s>If you have another problem, please contact us by mail.</s>
      <s>Our apologies for the inconvenience.</s>
      <s>You will now return to the previous menu.</s>
    </prompt>
    <goto next="#en_unreg_faq_form"/>
  </block>
</form>

<!-- English menu for registered users. Contains return, listing certificates and FAQ
  options. -->
<menu id="en_farmer_select" dtmf="true">
  <prompt>
    <s>Welcome, <value expr="session.telephone.ani"/>. Please choose one of the
      following options.</s>
    <s>To return to the previous menu, press 1.</s>
    <s>To retrieve information on a certificate, press 2.</s>
    <s>To access the answers to frequently asked questions, press 3.</s>
  </prompt>
  <choice next="#reg_language_select"/>
  <choice next="#en_cert_form"/>
  <choice next="#en_reg_faq_form"/>
</menu>

<!-- Selection menu for retrieving information about any of the processed certificate
  applications. Contains a 'return' option. -->
<menu id="en_cert_form" dtmf="true">
  <prompt>
    <s>You now get a list of your processed certificate applications.</s>
    <s>Please press the number corresponding to the certificate you want to know the
      status of.</s>
    <s>To return to the previous menu, press 1.</s>
    <s>To get the status of certificate 1, press 2.</s>
  </prompt>
  <!-- TODO: choices -->
  <choice next="#en_farmer_select"/>

```

```

        <choice next="#encert1form"/> <!--placeholder -->
</menu>

<!-- Placeholder certificate -->
<form id="encert1form">
    <block>
        <prompt>
            <s>Your application has been approved.</s>
            <s>You will now return to the previous menu.</s>
        </prompt>
        <goto next="#en_cert_form"/>
    </block>
</form>

<!-- An FAQ menu for registered users. Contains a 'return' option. -->
<menu id="en_reg_faq_form" dtmf="true"> <!-- TODO: more options? -->
    <block>
        <prompt>
            <s>You now get a list of frequently asked questions. Please press the number
                corresponding to your problem.</s>
            <s>To return to the previous menu, press 1.</s>
            <s>If you want to know how to download or print a certificate, press 2.</s>
            <s>If one of your certificates is missing from the list, press 3.</s>
            <s>If you have another problem, press 4.</s>
        </prompt>
        <choice next="#en_farmer_select"/>
        <choice next="#en_download_form"/>
        <choice next="#en_missing_cert_form"/>
        <choice next="#en_otherproblem_reg_form"/>
    </block>
</menu>

<!-- FAQ answer: Provides information on downloading certificates from approved
     applications. -->
<form id="en_download_form">
    <block>
        <prompt>
            <s>Downloading a certificate to print can be done at our web application.</s>
            <s>Go to www.semencescertifiees.net.</s>
            <s>Obtain access by entering your phone number and your personal four-digit
                pincode.</s>
            <s>You will now return to the previous menu.</s>
        </prompt>
        <goto next="#en_reg_faq_form"/>
    </block>
</form>

<!-- FAQ answer: Explains why an application may not be listed. -->
<form id="en_missing_cert_form">
    <block>
        <prompt>
            <s>Certificates appear in the list once your application has been processed.</s>
            <s>Most likely, your application is still pending.</s>
            <s>Please be patient.</s>
            <s>It should take around 30 days to process your application after we receive
                it.</s>
            <s>If you believe it is a mistake, please contact us by mail.</s>
            <s>You will now return to the previous menu.</s>
        </prompt>
        <goto next="#en_reg_faq_form"/>
    </block>
</form>

<!-- FAQ answer: Explains how to reach out in case of other problems. -->
<form id="en_otherproblem_reg_form">
    <block>
        <prompt>
            <s>If you have another problem, please contact us by mail.</s>
            <s>Our apologies for the inconvenience.</s>
            <s>You will now return to the previous menu.</s>
        </prompt>
        <goto next="#en_reg_faq_form"/>
    </block>
</form>

<form id="fr_farmer_select"> <!-- TODO -->
    <block>
        <prompt>
            <!-- TODO: language can't be defined in 'prompt' -->
            <s xml:lang="fr">Bienvenue, fermier. Veuillez choisir l'une des options
                suivantes.</s>
            <s xml:lang="fr">Pour revenir au menu précédent, appuyez sur 1.</s>
            <s xml:lang="fr">Pour recuperer des informations sur un certificat, appuyez
                sur 2.</s>
            <s xml:lang="fr">Pour acceder aux reponses aux questions frequemment
                poses, appuyez sur 3.</s>
        </prompt>
    </block>
</form>

<form id="fr_unregistered_select">
    <block>
        <prompt>
            <s>Placeholder.</s>
        </prompt>

```

```
|     </block>  
|     </form>  
|</vxm1>
```

21 Presentation Pitch



Figure 10: Pitch Deck (link: <https://drive.google.com/drive/folders/11Au1xmcc2qyjQoA4\x0ceH9LT4ofCc13a>)