Assignment 3: Implementation Prototype

Michel Cojocaru, Dora Kerdic, Ilayda Temir, Mihail Tomescu

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1 Introduction

In this report, we introduce the implementation prototype of our weather prediction and alarm application; LEZA. Our goal is to provide an application that is accessible for the inhabitants with the lowest cost possible.

Evaluating the W4RA use cases, we concluded that there is a need for daily rainfall forecasts in order to facilitate farmers irrigation, crops planning and resource management. Although the farmers already use different local forecast techniques, they are demanding meteorologically based forecasts because their local indicators are no longer reliable (Ingram, Roncoli & Kirshen, 2002). In order to ensure a good prediction quality we have decided to combine datas from two different weather APIs.

In May 2017, floods and violent winds have killed three people, injured eighteen and more than seven hundred fifty houses were destroyed. In total 5129 people were affected by the extreme weather event ("West and Central Africa:Weekly Regional Snapshot", 2017). Thus we also decided to include alarms to warn the inhabitants about the upcoming extreme weather events along with the weather forecast. By providing alarms and information about the wind; severity and direction, we are aiming to help the inhabitants prepare in advance for extreme weather conditions. Preparing in advance for farmers may include reinforcing house roofs and planting trees to break the wind.

The lack of internet and smartphones, with the low rate of illiteracy directed us to develop a voice-based application. Ultimately, we are developing LEZA to produce an early warning system and an improved weather forecast system that is accessible by inhabitants of Burkina Faso with their already existing devices, namely mobile phones.

2 Contextual issues

Application design, user interface, implementation and deployment are each affected by the context to which the application will operate. The appreciation of the biggest influences and how to acknowledge their impact will contribute to better outcomes. When anticipating our approach for the implementation, we tried to contemplate all possible contingencies, risks and behaviours that we may encounter. The issues we will mention here are not all of those that may arise, however the main ones and the most probable ones to have the most influence will be discussed.

Since most African countries became independent sovereign states later than most of the countries and there is a lack of data, the economic research is more challenging (Ram & Singh, 1988). Having not enough data resulted in less economical research for the area. However, from our research, we concluded that there is a need for minimization in cost.

The contextual issue that we found the most difficult to solve was the language. Burkina Faso has French as their official language but they remain a multilingual country. As any other African country they have a lots of spoken languages. We wanted to implement for Mossi language which is the most used one. However we could not use google translate because there was no such option. We decided to not to go further than French and English because of the time limitation but that should be one of the first things to implement if one is willing to further develop this application. Also from the feedback we received from Burkina Faso, we realized that the accent we used was not appropriate for Africa. So, the french voice needs to be pronounced in african accent.

Another contextual issue that we faced was that the inhabitants do not possess smartphones.However they do have cellphones which gave us an opportunity to develop an application reachable by calling a telephone number. This intersects well with the fact that most of the inhabitants are illiterate, according to World Data Atlas %37.7 was literate at 2015. Considering these two contextual issues we decided to develop a voice-based application that can be accessible by cell phones that has local cell phone line.

One of the contextual issues that led us to develop LEZA was that weather is getting more and more unpredictable in the area which makes farmers life harder. Almost all (97.5) of the inhabitants agreed that the weather became less predictable (Boansi, Tambo & Müller, 2017). By giving multiple day time options in the application we aimed to solve this problem as well.

3 Theoretical background

The majority (87%) of the households in Burkina Faso agree that there is a decrease in rainfall and an increase in dry spells (Boansi, Tambo & Müller, 2017). Dry seasons and droughts along with floods and water inundation are inducing losses in yields. Since the agriculture is the main sector in the area, this is influencing income and food security locally and nationally (Barron, Benedict, Morris, de Bruin, Wang & Fencl, 2015). Even though the yield of smallholder farming is increasing, the crop systems in SSA produce less than a quarter of biophysical potential, lower than any other region in the world (FAO, Food and Agriculture Organization of the United Nations), 2011; Mueller et al., 2012). We may state that this is one of the main problems in the area. As a solution, rainfall and water management strategies in different scales are surely needed to assure crop growth (Barron, Benedict, Morris, de Bruin, Wang & Fencl, 2015).

In Sub-Saharan Africa the main source for water in agriculture is the rainfall, which makes the sector contingent on dry spells (Sanfo, Barbier, Dabiré, Vlek, Fontana, Ibrahim & Barry). Having a lots of dry spells is one of the major reasons for crop failures in the area. The timing in cropping season and the duration of the dry spell are determinants of crop failures (Barron, Rockstrom, Gichuki & Hatibu, 2003). This fluctuation affects the primary production, the daily food intake and revenue of families from farms along with food supply (Failler, 2014). As a solution, farmers developed different solutions for this situation called Soil and Water Conservation techniques (SWC), an example would be fertilizer applied in the roots of crops (Zougmoré, Jalloh & Tioro, 2014). However techniques that the farmers came up with are no longer reliable if the dry spell is superior than two weeks (Roose, 1993).

As an escalation in extreme weather events are participated, new techniques that tackle rainfall variability whilst enhancing rainfall predictability is needed in the area. One example would be supplemental irrigation, this technique reduces harm caused by excessive water. In order to apply supplemental irrigation in Burkina Faso, one should consider water availability along with technical and financial considerations (CNID-B, 2009). Unfortunately this technique assure just a fraction of production and studies do not questioned the economic impact of supplemental irrigation at the farm scale (Sanfo, Barbier, Dabiré, Vlek, Fontana, Ibrahim & Barry).To conclude, development in agriculture has an urgent need for better practises in sub-Saharan Africa to support climate, food security and income growth problems in the near future (Barron, Benedict, Morris, de Bruin, Wang & Fencl, 2015).

Furthermore, least developed countries are more vulnerable to climate variability and they happen to experience the extreme weather events more often (IPCC, 2007). Burkina Faso is no different in that aspect. Also, inhabitants with a low income are more vulnerable to the effects of environmental shocks (Ahmed, Diffenbaugh, & Hertel, 2009; Leichenko & O'Brien, 2008). This group is more likely a part of climate-sensitive sectors such as agriculture or low-income informal or temporary jobs with minimum or no protection for climate-related employment disturbance (Cunguara, Langyintuo, & Darnhofer, 2011; Jones, LaFleur, & Purvis, 2009). In our example, the main sector is agriculture with 90% of the population working (FAPDA, 2014). This group is also more likely to not have a back-up asset or insurance to cover for the expenses caused by the extreme weather conditions. They are more likely to live in the areas that are more vulnerable to climate change and extreme weather events(Carter, Little, Mogues, & Negatu, 2007; Skoufias, Rabassa, & Olivieri, 2012). General agreement is that differential ability to tackle extreme weather conditions aggravate existing inequalities and power disparities within community (IPCC, 2014).

The income inequality and the incidence of poverty are negatively influenced by agro climatic shocks, due to their impact on sectoral sources of income. Although this influence is dependent on the self or social insurances against climatic risks, poor households are less likely to have such insurance in Burkina Faso. The observable relationship between income inequality and poverty revolve around income diversification in the income distribution. In the Sahelian Zone with the poorest agroclimatic and the most spread out incomes, inequality decreases but poverty increases following a drought. Here households that have less income are more influenced by agro climatic shocks because they do not have the choice to gain off-farm incomes (Reardon and Taylor, 1996).

In rural areas, the income strategies rely upon the purchasing power created by non-cropping occupations. These strategies don't have to aim to create crop output or supply input to cropping in the area. They are a method to protect food consumption of locals. Sahelian region's farmers prospered multi sectoral strategies to overcome food dangers caused by irregular weather situations (Reardon, Matlon & Delgado, 1988).

There are several types of organisations that are currently supporting the agriculture in the region. Village organizations and traditional organisations are the most common examples. The village organisations are mainly held by members willing to improve their livelihoods through collective action. The main difference between them and the traditional organisations is that they also intercede the relations between the villagers and economic, institutional and political actors outside the community whereas traditional organisations just regulate relations within the community (Mercoiret & Berthomé, 1997). The traditional organisations may differ from producer cooperative to broad multipurpose organisations depending on the country.

Village organisations has become important players in the scene by partnering up with development agencies who lean on them to apply their programs. Presence of village organisations has been recognised in many studies in their progress with social capital growth, poverty reduction and resource management (Uphoff & Wijayaratna, 2000). Since the agricultural growth is mainly upholded by small farms village organisations, they have a high importance in West Africa. They first appeared in the 1960s by government promotion. By 1980s economic and political liberalization, more autonomous organisations blossomed contrary to government-controlled cooperatives. They increased very quickly. Currently, village organisations exist largely in West African villages, binding the relationship between village community, the market and the gouvernement. For Burkina Faso however, the quantitative evidence on village organisations terms of prevalence, performance and participation benefits are insufficient so far (Bernard, Collion, Janvry, Rondot & Sadoulet, 2008).

Since mid-1980s, there has been some important significant economic reforms in Burkina Faso. Despite the increase in growth rate, rural poverty rates remained high (Collion & Rondot, 1998). Although there was a great institutional progress, the material gain was missing. For example, there were village organisations in most of the villages and the most of the rural households were a part of village organisations. One explanation for not having a material gain might be lack of access to resources or low managerial capacity village organisations could not showed efficiency (Bernard, Collion, Janvry, Rondot & Sadoulet, 2008).

In the west part of Burkina Faso we have more market oriented organisations (MO) whereas in the Centre North for example we have more community oriented organisations (CO). The most fertile part of the country is the West; the rainfall levels are appropriate for cultivating demanding crops such as maize and rice. These demanding crops are sold on both domestic and international levels. Since this region receives migration, the ethnic and religious diversity is high, thus the region forms an inclusive social context for appearance of market oriented organisations. This market oriented organisations are potent to embellish this social differentiation as opposed to social homogeneity that give birth to conservatism (Bernard et al., 2008).

In the Center North however, population is condensed. This region has a smoother terrain, with a more dry soil and rainfall that is lower and less predictable than west. Most of the production is for household's themselves. In a social perspective the diversity is also lower in this area. The majority of the population is Mossi. This ethnicity is shaped by a hierarchical social structure and they are administered by traditional leaders. Here we observe the occurrence of community organisations. Having unpredictable environment induced more need for solidarity, which in a sense guarantee individuals not to face risks alone(Bernard, Collion, Janvry, Rondot & Sadoulet, 2008).

We can conclude by saying the distribution of community organisations and market oriented organizations differs relying on the social homogeneity and environmental risks that might be encountered by the inhabitants. Finally, we observe external support whilst our quest to explain distribution of this two types of organisations (Bernard et al., 2008).

4 Prototype description

0. Name

LEZA, originally the name for the african rain god: a system for propagating rainfall, sun, wind speed, clouds and temperature. The emphasis is on unusual weather situations in order to alert habitants. To illustrate the call flow, appendix 1 show a diagram accordingly to our made feature choices.

1. Summary of key ideas

LEZA, originally the name for the african rain god, is a system for propagating rainfall, sun, wind speed, clouds and temperature. The emphasis is on unusual weather situations in order to alert habitants. This way habitants will be aware of incoming extreme weather conditions so that they can make preparations. The aim is to reduce the loss caused by extreme weather conditions.

Also, the habitants of Burkina Faso depend highly on agriculture, the sector is dominated by small-scale farms and employs 90% of the workforce (FAPDA, 2014). Thus, it is important to ensure a successful harvest. The final version of the application will enable habitants to call and request weather information for the desired region. In the short period of time we will not be able to provide an application for Africa, therefore we focus on Burkina Faso as it is one of the countries that is being influenced most from the climate change and it has a range of distinct agro-ecological zones representing Sahel-Sudan (Ingram, Roncoli & Kirshen, 2002).

2. Actors and goals

Table 1. Actors and goals of LEZA

Actors	Goals
Inhabitants who are dependent on weather information	Receive accurate weather forecasts in order to adjust agriculture methods and prepare for extreme weather conditions.
System provider for LEZA	Provide a working system that is accessible and user-friendly.
Multiple weather forecast provider	Provide accurate weather information of Burkina Faso

3. Context and scope

The context of Leza exists in this first prototype of small villages in Burkina Faso. Especially farmers in rural areas rely on the farming to nourish themselves. Most farmers in rural areas in Ghana are illiterate and are not familiar with the graphical representation of numbers. The goal of LEZA is to help habitants of Burkina Faso to adjust their actions and environment according to the weather. The scope of LEZA is exclusively to provide the weather forecast, as in providing the amount of rainfall, the temperature, the wind speed and the angle of the wind speed. We do not provide warnings that are

passively received by the user. For instance the user does not get a call or a text message because of an upcoming weather alert. This function does not lay in the scope LEZA.
LEZA’s main target group are farmers, however it can and will also have an impact on the farmer’s families and non farming users, as they rely on the impact of the weather on housing.
One performance measure are the farmers themselves, how they use LEZA and how they adjust their actions, for instance harvesting, according to the given weather forecast. Furthermore, the consequences of the actions chosen according to the weather forecast are an additional performance measure. The use of our application will be the first important short term
performance measurement. The scope of LEZA is narrowed down to the choice options mentioned in section 5 “Interaction and communication”. In future development weather parameters can be included to increase the information gain of the users.

4. Use case scenario script
To illustrate the use case a fictional scenario is described in the following paragraph.

Yacouba is a farmer living in one of the villages of the community of Guiaro, in Centre-Sud in Burkina Faso. He grows vegetables and some fruits. The main goal of agriculture for Yacouba is to nourish his wife and his four children. Even though he has a lot of experience in farming, the weather can be a reason for a bad harvest. There are some ‘natural’ signs to predict bigger weather changes but Yacouba always wished for a way to get reliable weather forecasts with his phone whenever he wants, without being dependent on other devices, people or the radio. He now has the possibility to call LEZA to query information. He usually calls every morning to check the weather for the next day.

1. *Yacouba calls the number of the service from his phone.*
2. *The application offers a choice of languages.*
3. *Yacouba chooses French.*
4. *The application asks the user to select whether alerts or the weather forecast should be given.*
5. *Yacouba chooses the weather forecast.*
6. *The application offers a selection of 13 regions to choose from.*
7. *Yacouba selects the region, namely Centre-Sud.*
8. *The application offers a range of 5 days in the chosen regions for the forecasts.*
9. *Yacouba selects tomorrow.*
10. *The application gives a verbal weather forecast for the tomorrow.*

5. Interaction and communication
LEZA consists of a voice service that allows farmers to call and receive a weather report for a particular region of their choice. Appendix 1 illustrates the call flow. The aimed functions include the following parts:

5.1 Choose the language
The user is able to choose between English and French at the moment. We chose to add English next to the french option of LEZA, which is a a world wide known language.

5.2 Select a region
After choosing a language, LEZA asks the user to choose first between North, East, South and West and then between 13 subregions of Burkina Faso.

5.3 Retrieve weather alerts
As we are aiming to prevent farmers and inhabitants from getting affected by extreme weather situations, LEZA gives the option to receive information about current weather alerts. This option can be accepted by pressing the digit 1 or it can be diverted to forecasts if the user presses the digit 2.

5.4 Select a day
LEZA connects to an API that provides the user with weather data. It is possible to retrieve a weather forecast up to five days in the future. The user can choose one day at the time.

5.5 Select a time of the day
The options to choose from are 6 am, 12 am and 6 pm. In the application they are called *morning/le matin, noon/midi* and *evening/la soirée.*

5.6 Retrieve weather information
LEZA connects to an external resource to retrieve weather forecast. The information available for users is divided into alerts and general weather forecast.

5.7 additional functionalities
There is an option to select the prefered weather setting to get the weather forecast directly without making all the beforehand choices again.

6. Information concepts and Technology infrastructure
A call is made, the voice server requests the VXML. All information about options of languages and available regions and up-to-date weather information are retrieved from XML (see appendix 2 and 3) which accesses the API to retrieve information about the weather. All the weather information is retrieved by a background process which periodically polls data from OpenWeather API via an Internet connection.

7. Cost considerations
Burkina Faso being a low-income, landlocked and limited resource country gives us the direction of making LEZA as low-cost as possible. The goal is to minimize the costs of the application and maximize the utility for the habitants.

The increase in mobile phone usage in Burkina Faso is higher than in Western countries, just like in many other African countries. This fact implies particular appreciation of these devices. Also from W4RA report we conclude that the farmers have access to mobile phones and radios. Both play a major role in communication in the targeted area. Most of the people use prepaid accounts. The country has three active mobile phone operators, Onatel is currently the biggest operator. The cost of getting a prepaid sim card is 0.76 euros with Onatel. The cost for calls and SMS varies depending on the receivers operator. However the maintenance of the phone still remains a challenge. The need for electricity to charge had led to creative solutions by villagers from solar panels to different charge points. The main costs of the application LEZA is caused by maintenance which can be distributed to a few volunteers on the spot and maybe some students form VU who volunteer to help.

8. Feasibility and sustainability

Creating a weather forecast application is surely not an innovation. It is certain that creating such an application is feasible. However there are risks, for instance the insecurity of a stable internet network and the access to electricity to charge the phones. We are aware of those risks but cannot interfere in the current situation on the spot. Making an artificial scenario without having interviewed locals in Burkina Faso recently makes it difficult to estimate if the application is still needed, how the old system can be improved and how the review is so far. Even though the last updates are from a visit in 2016, the situation there as well as the technical requirements change rapidly.

Furthermore there is no guarantee for the accuracy of the weather forecast derived from the OpenWeather Data API. We do not know how long this source will be accessible. Although we are using an additional source to cross validate the data for the weather forecast, it is not proven that the sources are reliable. Through the cross-validation we are trying to create a forecast which is as accurate as possible. The APIs we are currently using are limited in the number of possible queries. Therefore, another long term solution should be found.

9. Key requirements

MoSCoW list of requirements

- Must have: The application must have an up to date forecast as well as a choice of languages, so as many habitants of Burkina Faso can use it. English and French are chosen to be a must have. Furthermore a phone-access for end-users to dial into is a must have.
- Should have: LEZA should have an option to hear about alerts. Furthermore it will support Moore, a language that is widely spread in Burkina Faso. Also, report tool to analyze the usage of the system.
- Could have: The application could have subscription option which calls users at regularly to update them on weather forecasts. LEZA could support more languages, such as Bambara.
- Won’t have: LEZA will not have an option where habitants receive an weather alert after subscribing.

5 Solution design

By researching intensively on the topic ICT4D in general first and then more detailed on the topic weather forecast applications in Africa, we could find out what habitants, especially farmers, need while using an application that provides the weather forecast. Thus, prior developed applications, such as InfoMétéo, gave us already a direction for requirements. Through intensive research, we knew from the beginning our key requirements, for instance different languages, using APIs to get weather information and so on. Therefore, our idea was very clear from the beginning. Through some feedback iterations with the teacher from the course ICT4D we refined LEZA. In the following section the key functionalities of LEZA will be illustrated. The following figure shows interaction model for LEZA.

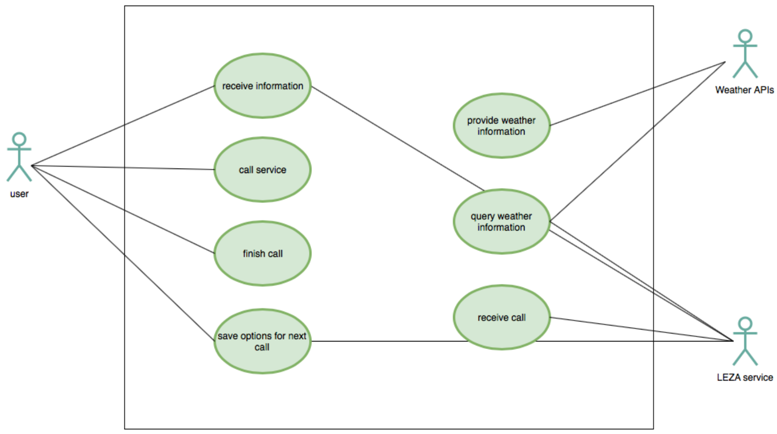

Figure 1. UML diagramm LEZA

5.1 Choose the language

During research we found out that Burkina Faso is multilingual country. The user is able to choose between English and French at the moment. French was introduced in Burkina Faso in 1919 during French colonial rule. Furthermore, french is the primary language taught in schools and country's judicial, administrative, and political institutions, as well as the press are done in french. However only 15% of the population speaks French by the day (Nag, 2017). Additional to those English and French we aimed to implement at least one of the indigenous and minority languages of Burkina Faso. This seems to be a bigger challenge than expected since no reliable translators have been found on the internet.

5.2 Select a region

After choosing a language, LEZA asks the user to choose between 13 regions of Burkina Faso. The first version made it possible to choose between those 13 by using double digits which easily causes errors. After the feedback we got, we added a new function. As regions may not make sense for every habitant of Burkina Faso, we decided to subdivide the country first in four regions, north, east, south and west. When a user chooses one of those regions, a subregion of the compass direction needs to be chosen. The menu composition can be seen in table 2.

Table 2. Regions divided in subregions according to compass direction with according digits.

	North (= 1)	East (= 2)	South (= 3)	West (= 4)
Digit 1	Centre	Est	Centre-Ouest	Boucle du Mouhoun
Digit 2	Nord	Centre-Est	Plateau-Central	Cascades
Digit 3	Centre-Nord		Centre-Sud	Hauts-Bassins
Digit 4	Sahel			Sud-Ouest

5.3 Retrieve weather alerts

Over time we realized through research how dependent habitants of Burkina Faso are on a proper weather forecast which alerts them in case of extreme weather situations. The option to receive information about current weather alerts is given in the beginning (see appendix 1).

5.4 Select a day

Giving forecasts for the same day is not enough. Living highly dependent on the weather habitants of Burkina Faso require a forecast for the next few days. Therefore, we implemented the option of choosing a day from the same day up until five days.

5.5 Select a time of the day

To get an even more precise weather forecast we implemented the option to choose between three time points of the day. For instance, the differences in temperature vary a lot during the night and during the day. The options are morning and afternoon. By looking at feedback by farmers in Mali (AOPP, May 2016) on the Kasadaka Weather system, our choice of two timepoints a day got confirmed.

5.5 Retrieve weather information

LEZA connects to an external resource to retrieve weather forecast. Additionally to the used API in prototype 1, multiple sources are taken into account now to make the weather forecast more accurate. The APIs are able to give weather predictions for up to 5 days. The information is given to the user based on the query made . By providing this information, users will be able to get prepared and plan ahead properly concerning farming and equipping houses and plantages and so on. Dangers that might be caused by the weather can thus be prevented, agricultural productivity can be increased and the loss can be reduced.

By having multiple API calls from different weather sources, data was processed before weather data from other sources returned. Therefore, we had to group them into a single promise events.

5.6 more functionalities

To make LEZA more user-friendly, we are planning on giving the option to safe prior choices to be able to hear weather forecast faster without going through the whole menu again.

To summarize the process of creating LEZA, it can be said that we implemented the given feedback, for instance further dividing the regions and the feedback of adding a language. Through connections our application got even tested in the field. We received feedback from Burkina Faso which was very positive and only gave suggestions for improvement for the quality recordings and an additional language. Both of those suggestions could not have been implemented because of lack of resources. However, those suggestions should be put into practice in future work.

6 Implementation and usage scenario

The following steps are an instruction to successfully build and deploy LEZA.

0. Make sure to have the following installed.

    - python 3.6.

- python-pip installed (Python 3)

Download the source code from https://github.com/tomescumihail93/KasaDaka-VSDK.
Create a virtual environment.

> (pip install virtualenv)
> virtualenv -p python3 venv
> source venv/bin/activate

1. Login into Heroku by using the following login data:
   email: michel.cojo@gmail.com
   pass: abc123$%^
2. Open a terminal/cmd.exe and the directory where you want to deploy an app on HEROKU and apply the following

```
> cd KasaDaka-VSDK
> heroku create --region eu leza
> git push heroku master
> heroku run bash
> pip install -r requirements.txt
> python manage.py makemigrations
> python manage.py makemigrations service_development
> python manage.py makemigrations api
> python manage.py migrate
```

4. First time only: create a superuser to login to the admin interface, load initial data in the database

```
> python manage.py createsuperuser
        [username: "admin"]
        [email: Enter/Anything]
        [password: "easyadmin"]
```

Not mandatory to initialize test vxml app:

```
> python manage.py loaddata initial_data.json

[...
remote:        https://leza.herokuapp.com/ deployed to Heroku
...]
```

Set the SFTP credentials in Heroku cli or web interface:

```
> heroku config:set  SFTP_PASS=FY4AX7ucUGXGsBzhnmcx
> heroku config:set  SFTP_USER=group17
> heroku config:set  SFTP_HOST=django-static.vps.abaart.nl
> heroku config:set  SFTP_PORT=22018
> heroku config:set  HEROKU=True

[Optional] > heroku ps:scale web=1
[Optional] > heroku logs --tail
> [CONTROL+C]
[Optional] > heroku ps
[Optional] > heroku run python manage.py shell
```

5. Create a database backup by using the following commands

to EXPORT:

> heroku pg:backups:capture

> heroku pg:backups:download

> pg_restore --verbose --clean --no-acl --no-owner -h localhost -U myuser -d mydb latest.dump

to IMPORT:

PGPASSWORD=mypassword pg_dump -Fc --no-acl --no-owner -h localhost -U myuser mydb > mydb.dump

5. Test the application on Kasadaka infrastructure by calling the following website:
http://ict4d.kasadaka.com/
The following parameters are needed

credentials mali:bamako

Your Name: Group17

VoiceXML URL (do not use https!): http://leza.herokuapp.com/vxml/start/2

Lock password: 1234

A live demonstration of the application can be heard by using the following web address. To hear the demonstration in English of LEZA use:
https://soundcloud.com/michel-cojocaru/sets/ict4d_final_demo

7 Scope and fidelity of the prototype implementation

In the following section we will clarify which functions of the proposed application are actually implemented and how future features can be added.

Comparing the original plan we made and the current version of LEZA it is visible that most of the features we wanted to implement have been accomplished.
Choosing a language, selecting a region, selecting a day, selecting a day, selecting a time of the day as well as retrieving weather information are all features that have been successfully implemented into the service. Furthermore, we improved some features during the development of the service. For instance, choosing regions was designed differently in the beginning compared to the current implementation where first a choice between four regions needs to be made, followed by choosing a subregion (see paragraph 5.2 in “Solution design”).

However, some functions are somewhat limited. These are:

- retrieving weather alerts is hardcoded so far. Thus, the next step would be to find a reliable API which allows the service to query alerts for the future.
- all audio-files that are uploaded to the system need to be in the correct format
- saving the prior choices in order to able to immediately gather information is not realized yet. This functionality belongs to future work.
- error endings are not fully developed. This part of the system would also need to be improved in future work.
- feedback options to constantly ensure optimal service.

8 Implementation, deployment and sustainability plan

As we learned in one of the classes in the extent of the course Information and Communication Technologies for development, sustainability is one of the main challenges when making a project. Being sustainable also creates a challenge for LEZA. The goal is to propose a business model which allows it to stand economically on its own. A prerequisite for a sustainable application is accurate data.

Upcoming costs that need to be taken into consideration are the phone call itself, the cost for an appropriate device which is able to make a phone call to LEZA, the cost of the service, internet connection and maintenance, the price of a weather update might be lowered in the future.

This might be needed if the service cannot connect to the internet for a few days. This would mean that the data is outdated and thus no longer useful. This would seriously damage our client base and therefore we have a few clients who can update the report. These clients are motivated to do so by allowing them to use the service for free.

LEZA will be rolled out in Burkina Faso first, since it is customized for this country only at the moment. The first thing to do is find a strategically well chosen location that can host the Kasadaka. For instance, a place where people have access to maintain the Kasadaka has to be chosen.
The next step would be the marketing of the system. One source could be for instance the radio, where the number of the service is given and the usage is explained. After the system has been rolled out over Burkina Faso and the feedback and acceptance is positive, it may be considered to adjust LEZA for other countries. In order for the system to be expanded in other countries than Burkina Faso, the following steps need to be undertaken:

- Determine the target group in order to determine the language
- Determine the number of regions and subregions (up to up to nine) and create these in the system using the web based management tool
- Create and upload the audio files in the prior chosen languages, using the web based management tool
- Find a suitable location for the system
- Ensure the maintenance of the system on side
- Test the system extensively, for each language and each place
- Generate and publish the phone number for accessing the system
- Provide a phone number for gathering feedback with regards to the system

Cost considerations

To offer a well working service, it is necessary to have estimation of the predicted costs which are needed for maintaining the system. We identified maintenance, infrastructure and development costs.

- Maintenance and development costs: So far there are no development and maintenance costs since this we created LEZA in context of the ICT4D course at the Vrije Universiteit. In case of realizing this system in the field, it would be necessary to find a person which is able to maintain the system. A possibility would be Non-governmental organization on side which agrees to do so without any payment.
- Infrastructure costs: The hardware used for this prototype consist of a Kasadaka, a low- cost, credit card-sized computer which runs on Linux. Moreover, a safe and accessible storage

place for the Kasadaka is needed. The next requirement which causes costs is a GSM network. It is delivered through a GSM dongle combined with a SIM- card. Furthermore, a working and reliable internet connection is required to be able to query weather information from the chosen APIs.

- User costs: Our main target group are local farmers which query information about the upcoming weather. So far there are no additional costs to the cost of a phone call to reach LEZA.

9 Additional evaluation

In order to asses the application, we made our fellow classmates try the application. The overall view was that the application is on point. They acknowledged the need for audition in our context and stated that they did not get frustrated like most of the voice based applications. Furthermore, the impression was that the application is well tailored to the circumstances in Burkina Faso. Attention should be paid on the fact that all assumptions are made based on literature. Therefore, we do not know how people from Burkina Faso would accept LEZA. Moreover, the test user thought that the built-in alarm is very useful and important. They also appreciated that there are multiple languages. To sum this evaluation up, we gave each of the 10 participants a questionnaire based on the System Usability Scale (SUS) (Brooke, 1994), see appendix 4, to measure the usability. The overall impression is, that LEZA is user friendly. However, improvement is possible and for instance for the recordings even needed.

At the presentation day, classmates and teachers mainly questioned where we retrieve the data from and they were satisfied with Open Weather APIs. Especially the fact that we are not using just one API was perceived positively. Furthermore, they asked if it wouldn’t cost too much for a phone call since the duration of speech was long. They were satisfied with the saving the choices we developed to shorten the duration of calls. Overall we experienced positive perception and feedback.

Moreover, we received feedback that was provided by the end users in Burkina Faso was positive. The main focus of the feedback was the quality of the recordings for the application. We are very aware of the fact that the recordings need improvement. Thus, we are satisfied that this is the only critics next to the additional language LEZA should have. This leads us to believe that the application was well accepted. Also, they marked that the accent used was not African French but rather a french accent. This is an improvement we cannot make at the moment but it is certainly considered for the future.

10 Discussion

The application LEZA is not completely finished and it will need continuous maintenance and improvement. Throughout the course, the importance of involving the local impressions and requirements collected on sight have been emphasized. We tried our best to follow a user-centric approach. However, our process was rather distant, as we could only gain information through research.

The section ”Scope and Fidelity” mentions the current limitations. To not name the prior explained limitations, we will focus in this section on the not yet mentioned limitations and findings. As the weather APIs enable only a certain amount of calls, they should reconsidered as a source for the application. Another solution to retrieve weather information could be local weather station which would provide LEZA with information on sight. Regarding to the feedback from Burkina Faso we did not implement a version of a rural language because that seemed impossible without a translator. We did ask in several online communities for help but there was no consistent answers were given. Therefore we decided to postpone the implementation for future work.

Furthermore, we assume that just by using LEZA, the habitants and farmers of Burkina Faso will improve their behaviour according to predicted weather forecasts. Moreover, our work depends on the assumption that habitants and farmers will certainly use our application. All those assumptions require usability tests, further research and insights on sight.

11 Conclusions and Future work

To summarize, we successfully implemented a weather forecast application for Burkina Faso in two languages. It has all functionalities that we aimed for at the beginning of the development process. Moreover, it includes functionalities, for instance the saving of choices, that were not planned from the beginning. For us as a group it was a positive experience to go through the whole process of developing an application with the additional requirements caused by the target country. Exploring the context of the dependence on the weather in Burkina Faso, it can be seen that there are several factors which need to be tackled in order to successfully offer LEZA in Burkina Faso.

The next step would be to prepare the application and improve it so far that we can test in the field under real circumstances. Improvement is needed, for instance the languages and the API, as mentioned in the “Scope and Fidelity” and “Discussion” section.

As mentioned in the “Solution design” section, both the quality of recordings and the addition of a local language, such as Mossi, should be implemented in future versions of LEZA. More attention should be paid in the future on cost reduction in order to make the application as low cost as possible and as sustainable as possible.

For the future, a marketing concept should be made to publish and advertise LEZA on sight. This would be thus one of the last steps in the process of creating a weather forecast application.

We are sure that this paper builds a base to develop the prototype further, test the underlying assumptions and hope that it encourages exploration of further ways in which the technical artefact can be embedded in the social context of Burkina Faso.

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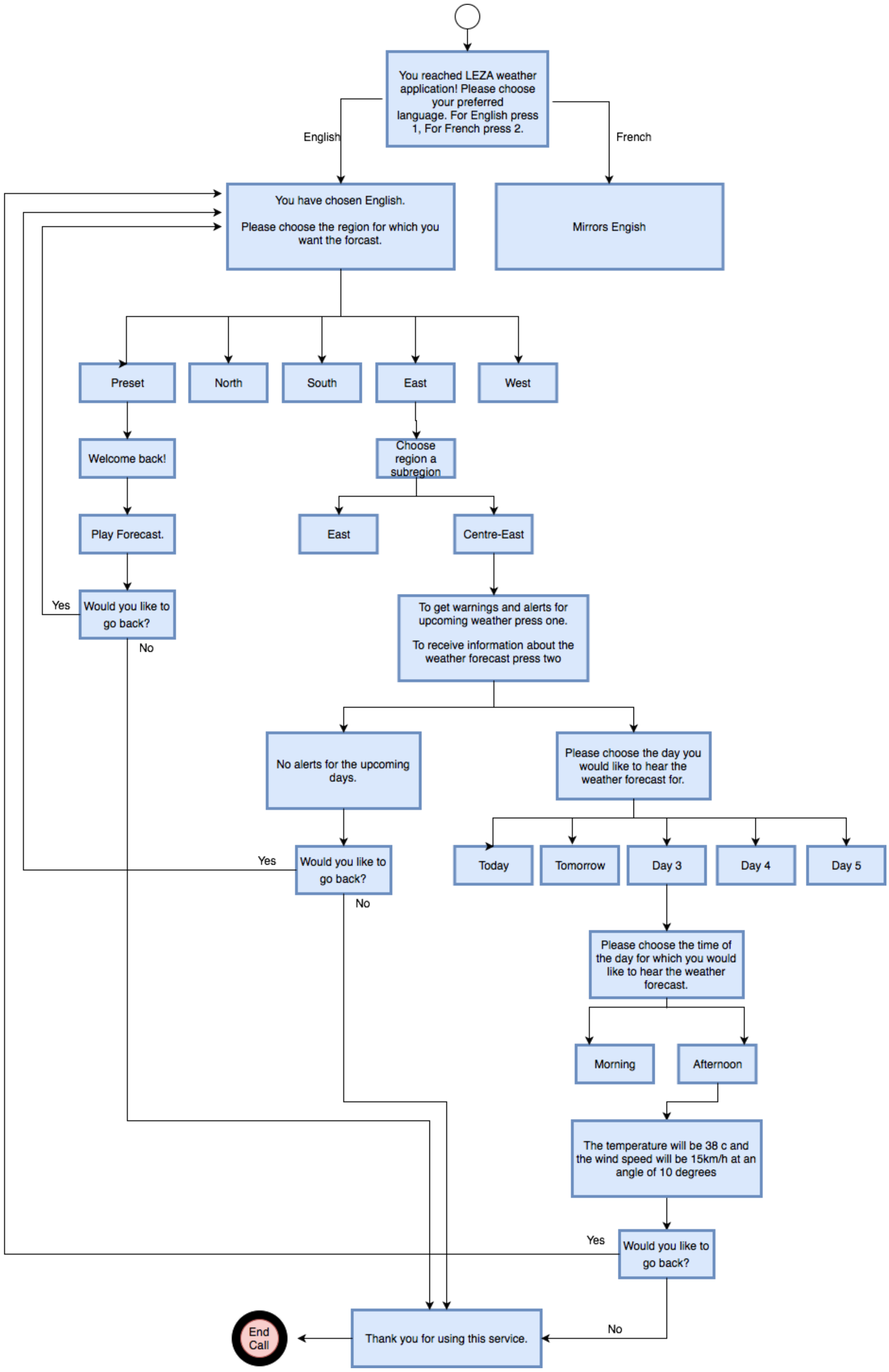
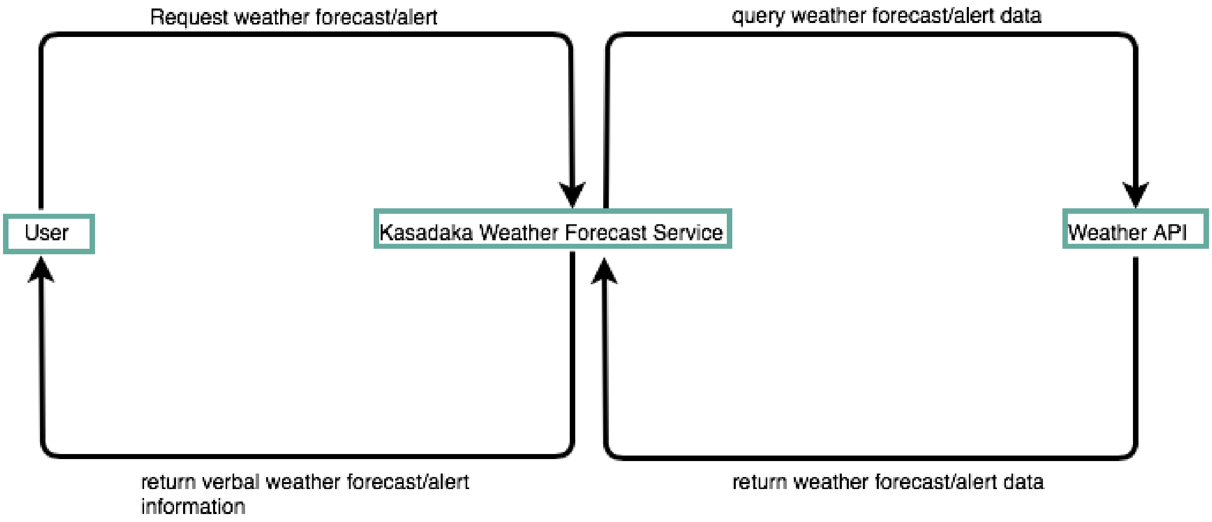
Appendices

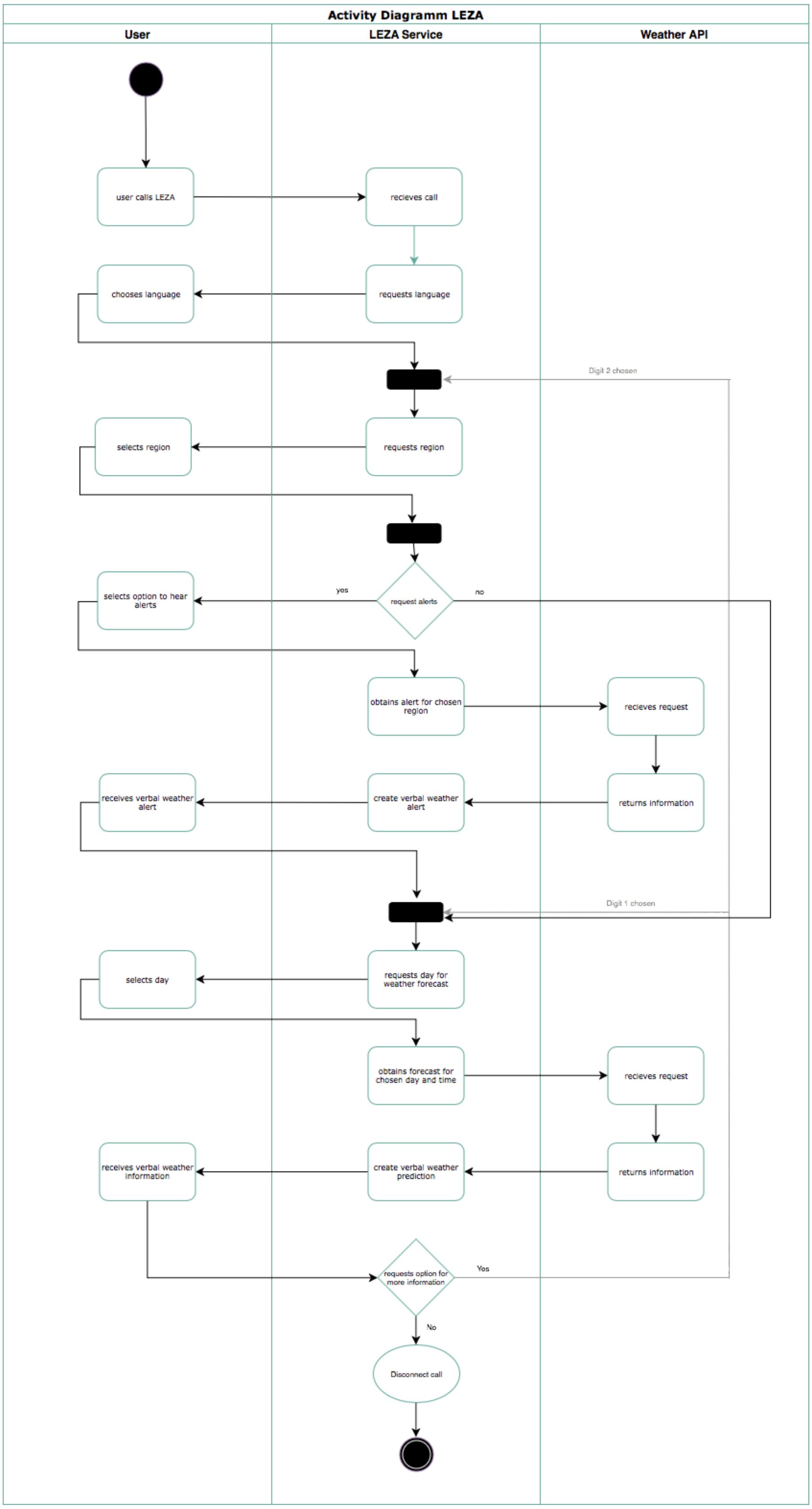
Appendix 1
Call flow LEZA



Appendix 2
Network configuration of LEZA



Appendix 3
prior activity diagramm LEZA



Appendix 4
Usability Questionnaire

The System Usability Scale

Dear participant, please fill in this questionnaire after you used LEZA for the first time. You can evaluate the following 10 items with one of five responses that range from Strongly Agree to Strongly disagree. Please write your response next to the question (1= strongly disagree, 5= strongly agree). Please remember, there is no right or wrong in this questionnaire, do answer according to your experience. Thank you for helping us improve LEZA.

1. I think that I would like to use LEZA frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

To calculate the SUS score, we summed up the score contributions from each item. Each item's score contribution ranges from 0 to 4. For items 1,3,5,7,and 9 the score contribution is the scale position minus 1. For items 2,4,6,8 and 10, the contribution is 5 minus the scale position. By multiplying the sum of the scores by 2.5 to obtain the overall value of SU.
SUS scores have a range of 0 to 100.