VRIJE
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ICT for Development

Assignment 3: Implementation prototype

Group 6

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1. PoultryVet

1.1 Introduction

Backyard Poultry production is widespread among rural households in Ghana and provides an opportunity for small scale enterprise development to contribute to poverty alleviation. However, diseases remain a major challenge to the poultry industry in Ghana. According to the Veterinary Service Department the total poultry population is estimated to be over 20 million with 80% of this being rural scavenging chicken. Disease is a major cause of poultry loss, about eighty percent (80%) of that is lost annually, can be attributed to sicknesses as the Newcastle disease [2]. According to Turkson 1998, the distribution of veterinary staff within the field is not uniform; the majority of veterinarians tend to be in regional and district offices, with a number of districts having no veterinarians in the field [3]. In addition, the technological and educational restrictions, such as lack of internet access and illiteracy, are some of the factors that increase the digital divide between these rural communities and citizens. Thus, farmers living in rural areas do not have access to poultry health information, or veterinarians. PoultryVet is a voice-based veterinary service that aims to diagnose poultry diseases, gives poultry farmers the option to contact a veterinarian, and get advice about the diseases.

1.2 Scope

The application is a voice-based service optimized for the 2G networks (GSM). 2G networks do not need the expensive high-tech and sophisticated mobile devices. Cheap basic low-tech mobile devices capable of making and receiving calls and SMS can easily connect to 2G networks. These low-tech mobile devices are widely dispersed and available in all of Ghana.

The application provides accurate diagnosis for the top four most common diseases for the four most kept types of poultry (chicken, guinea fowl, duck, and turkey). The following is the list of poultry diseases on which the application focuses [6]:

1. NewCastle's Disease
2. Fowl Pox
3. Infectious Bursal Disease
4. Marek's disease

PoultryVet must be able to get user inputs and store it in the database which can be used in the future. Finally, PoultryVet is designed to support English language which is the official language in Ghana.

1.3 Motivation

This section describes the reasoning behind the decision to develop the PoultryVet.

1.3.1 Lack of resources

Farmers living in remote rural areas in Ghana generally have low incomes. The small flock of poultry they have are mainly used for either families consumption, or to sell at the local markets (they act as a sort of savings). Often they are also kept for cultural purposes to be given as gifts, as payment of bride price and for religious rituals. Thus, rural poultry plays very important nutritional and socio-economic roles in the rural life in Ghana [6]. Ghanaian poultry farmers are unable to produce competitively because of the low prices of imported meat [5]. Thus, the focus will be to make veterinary information more accessible to all farmers living in remote areas, and to give them options to call a veterinarian based on price per consultant.

1.3.2 Illiteracy

According to WorldReader adult literacy rate for Ghana was 76.6%. Adult literacy rate of Ghana increased from 57.9% in 2000 to 76.6 % in 2015 growing at an average annual rate of 15.30% [7]. But literacy attainment in Ghana is varied across regions, from the more literate, urban south of the country to the less-literate, rural north. More than 250 languages and dialects are spoken in Ghana. English is the country's official language and it is also the standard language used for educational instruction [8]. Supporting English and only a couple of local language might interpreted offensive by speakers of other local languages not supported. Also, it is too complex to include all the indigenous languages. To stay out this quagmire of cultural sensitivities PoultryVet will only support English.

1.3.3 Lack of proper technical infrastructure

In Ghana, as in many other African countries, there is a gap between the rate of Internet adoption in rural and urban areas. While Internet adoption is growing steadily in Accra and other major cities, there is virtually no connection in most parts of rural Ghana. Hence, people use the mobile phone as a mean to communicate due to it’s low cost and it is easy to use. Coverage is available across most of the country and according to the 2010 Ghana Census, 29.6 percent of rural Ghanaians own a mobile phone [14].Thus, the focus would be on using the technical infrastructure that is currently available in rural communities which is the mobile phone.

1.4 Problem Statement

Poultry forms an integral part of the farming system of rural household in Ghana’s remote districts, and the health of poultry is very critical to support the system. The overall poultry health can be improved by veterinarians. However, most rural households do not have access to veterinary assistance. Thus, the problem that arises in these rural areas is that the expertise is often not

locally available and poor technical infrastructures prevent information and knowledge from being accessible. In addition, the cost of accessing a veterinarian is high which is another issue for the farmers who mostly cannot afford to pay for that cost.

1.5 Issues

1.5.1. Contextual Issues

When developing an ICT system for developing countries, there are many contextual issues that have to be taken into account. As mentioned above, in many rural communities, apart from the absence of reliable electricity supply and a poor road network, there is also the problem of poor telecommunication network coverage, which could be a problem for farmers who intend to make use of the PoultryVet call service. Furthermore, the users are mostly illiterate and do not have knowledge about animal husbandry, the birds are poorly kept, and depended mainly on scavenging. Poultry farmers rely on their own knowledge when dealing with sick poultry [4]. Majority of them resorted to the use of various forms of herbal mixtures in the drinking water of their birds when disease symptoms were noticed.

1.5.2. Technical Issues

Unlike developed countries, applying new technologies and applications in undeveloped countries is subject to many technical issues. These issues can be viewed from different perspectives.

1.5.2.1. Technical Infrastructure

Lack of proper technical infrastructure in undeveloped countries can restrict applying new technologies. In case of PoultryVet, the application is limited to 2G networks, as the mobile network operators in Ghana do not support 3G, or 4G. In addition, lack of internet access is another issue which can further restrict the application. Not all areas have access to the Internet, and the Internet speed is also very low. Finally, the available mobile devices mostly support the basic functionalities, such as making and receiving calls and SMS. This can also considered a limitation, because it is not possible to develop common mobile applications (such as Android or IOS apps) which can provide many functionalities.

1.5.2.2. Technical Knowledge and Skills

The end users of PoultryVet are the farmers which are mostly illiterate. This can restrict the application. It means that the application cannot have very sophisticated and high-tech features, because the farmers will not be able to use them. Therefore, the application must be as easy as possible to be used by illiterate people.

1.6. Theoretical Background

1.6.1. Digital Veterinarian

In today's world, almost everything is going toward digitalization, whether it is a bank transaction, or it is a e-health app which counts the number of steps one walks. This can be generalized to everything in everyday activities. Digitalization has many advantages. One of the most important advantages of digitalization is the cost-efficiency. By removing the paper works, printed documents, and the space required to keep those documents, there will be a significant decrease in the costs. In addition, by removing the need for the employees who are responsible to perform the tasks, the cost will be decreased as well. The other positive point about digitalization is the accessibility. The data can be accessed from different places and there might be different mediums and ways for data accessibility. However, there are some disadvantages associated with digitalization. The first and most important disadvantage can be the need for a medium (device) to access the data. Data access and interaction is almost impossible without having a medium. In addition, some specific skills might be necessary to be able to work with those mediums.

Digital veterinarian is based on digitalization theory. Therefore, it has its own advantages and disadvantages. The farmers who are going to interact with a digital veterinarian will have far less costs than contacting a traditional veterinarian. Furthermore, they are able to access the digital veterinarian services from remote places, as long as there is network service available. However, the need for a mobile device and the skills to work with its basic functionalities must be taken into consideration. Without and mobile device and necessary skills, it will be impossible to access the service.

Although digital veterinarian has disadvantages, but it can make the life easier for the farmers who cannot afford to transfer their livestock to a veterinarian and pay for the associated costs.

2. Related Literature

Our project is based on the Digivet, a voice-based telephonic extension by Gossa Lo & Romy Blankendaal. The previous DigiVet also aimed to make veterinary information more accessible to farmers living in remote areas. This voice-based version of the Digivet elaborated on the already developed visual version by adding a second one that enables local farmers to call to the Kasadaka [9].

Farmerline Ltd is a mobile service founded by Alloysius Attah and provides personalized voice alerts that communicate critical information related to price, weather and farming techniques. Furthermore services are offered via SMS, and Android as well as voice-based messaging service to help reach farmers with low literacy levels [10].

Another project is Vet africa, an app created by a Scotland based tech company in partnership with Microsoft created The app which is popular in East Africa is used to diagnose livestock

disease and suggest suitable medications for farm animals. The app also helps farmers monitor and record animal data [11].

3. Solution Design

3.1. Feedback

The assignment 1 feedback was that price of phone calls should be cross-checked because prices mentioned in the report are too high. Regarding the voice service, some of the voice fragments were to long. The feedback received after assignment 2 was that the application was missing a database to store the input and that the current system was to limited for this. All issues mentioned in the feedback has been addressed in the iterations leading to the final prototype.

3.2. Data Models and System Architecture

3.2.1. Data Model

3.2.1.1. Data Input

A data model is the organization of data and the standardization of how this data relates to each other and to properties of real world entities.The setup of the data model is to gather a minimum quantity of data and to utilize that to the maximum. The information that is manually put in by the user are the phone number of the PoultryVet service and the answers on the asked questions, all other data is captured as byproduct of the technology used. When an user calls PoultryVet the following data will be captured: 1) phone number of the caller, 2) phone number called, 3) time of connection, 4) time of disconnection, 5) DTMF inputs, and 6) time DTMF inputs.
The user calls PoutlryVet with his mobile phone. The phone number of the phone used to call is the number of the caller and will be stored as “caller id”. The phone number the user called (the PoultryVet phone number) is converted to the service name and saved as “service id” (in this case PoultryVet). The time of when the first connection with the application is established is stored as “start”, and the time when the line is disconnected is saved as “end”. When PoultryVet asks a question the user can give an answer using the numpad of his phone, this is called DTMF input and has a range between 0 and 9. Each DTMF input is captured and linked to the asked question and stored in the database as “visited element”. The time of every DTMF input is saved as the visited element timestamp under the name “time”.

3.2.1.2. Inferred Data

The information retrieved from a call session is used to aid the veterinarian. From the visited elements (question answers) the following information can be inferred: 1) animal type, 2) disease, 3) available medicines, 4) available vaccines, and 5) the contacted veterinarian. The animal type, disease and veterinarian can be derived directly from the answers to the questions. Information

about medicines and vaccines will be added from another table based on the diagnosed disease. The medicine and vaccine data is added manually by the Admin in the menu “disease information”. In figure 1 the PoultryVet data model is visualized.

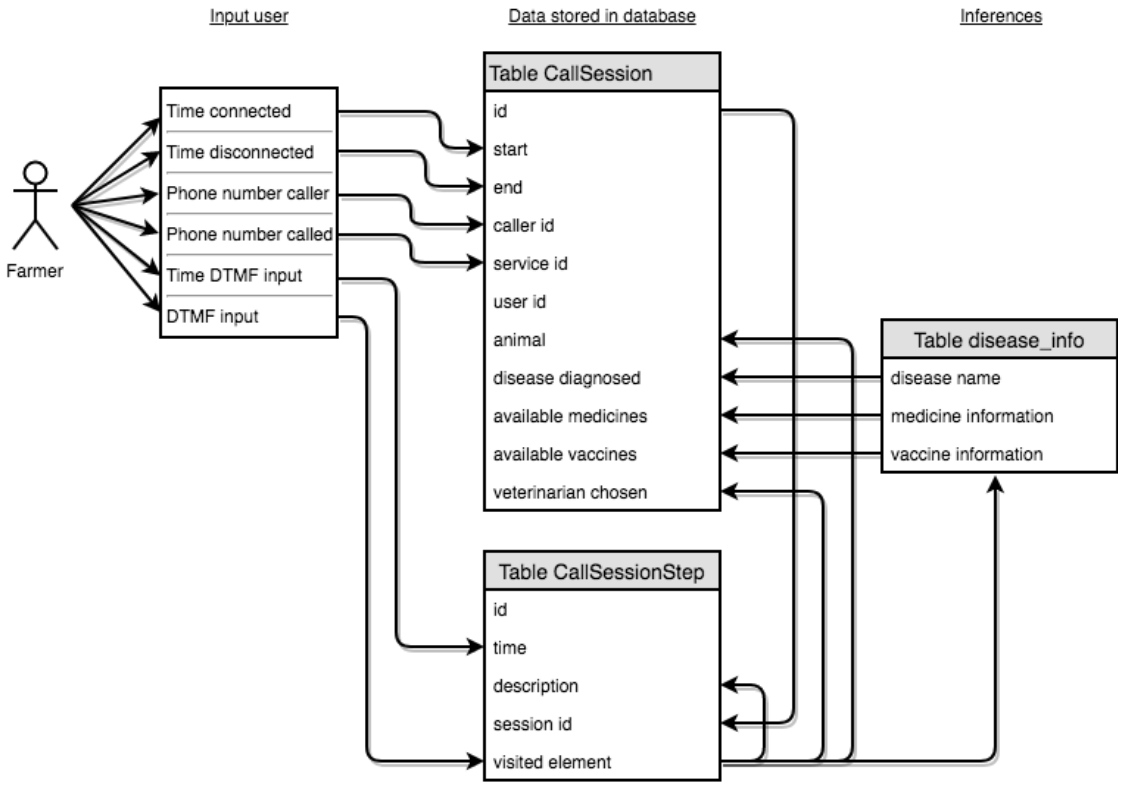

Figure 1: PoultryVet data model

3.2.1.3. Possible Extensions

In this subsection an example is provided for how the captured data can be further utilized when linked to another data source. As mentioned previously the phone number of the caller and the time of the first connection are stored. If access to the phone company call records can be realized, the data can be enriched with geospatial information. This can be done by matching phone number and connection time and then retrieving which telecom antenna the caller went through. The accessed antenna provides an approximate location of the caller. This geospatial data can in turn be used to generate maps where which disease is occurring and with which frequency. Information about disease patterns and an early warning for epidemic can be derived from this.

3.2.3. System Architecture

The PoultyVet system consist of the following elements: 1) mobile phone, 2) mobile telephone network, 3) KasaDaka, 4) internet network, and 5) a laptop or desktop computer. The farmer needs a mobile phone and access to the mobile network to call the PoultryVet voice service. The user call is received by the KasaDaka via the mobile network, which then will play the voice

service and save the user data inputs. If the farmer wants to speak to a veterinarian, the KasaDaka refers the call via the mobile network to the (mobile) phone of the veterinarian. The user inputs are saved by the KasaDaka in the client database. Via the internet with a laptop or desktop computer the veterinarian can access the client database. The system architecture is pictured in figure 2.

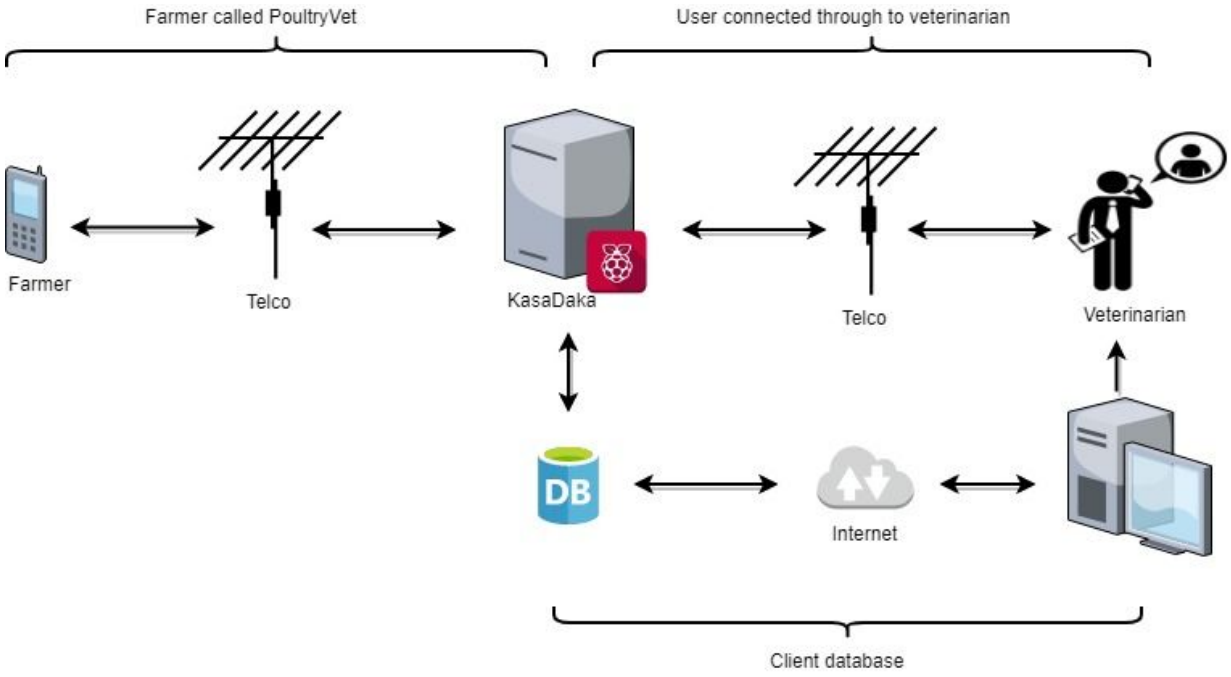

Figure 2: System Architecture

3.3. Application Implementation

There are a few requirements to implement PoultryVet:

1. **Application server:** The application hosting server is used to host the application files and codes. For the case of PoultryVet, Heroku is used. Heroku is a cloud platform that lets companies build, deliver, monitor and scale apps.
2. **Hosting server for sound files:** The hosting server is used to host the sound files associated with the application. Therefore, all the sound files (.wav) are located on this server, separated from the application files.
3. **Raspberry Pi:** The Raspberry Pi is connected to a 2G or 3G GSM-dongle that contains a SIM-card. This is a device necessary to be connected to the service. A virtual Raspberry Pi is already deployed and can be accessed via http://ict4d.kasadaka.com.

3.3.1. Installation Guide

PoultryVet is already deployed to https://poultryvet.herokuapp.com/ and ready to use by calling 020-3697664 from inside the Netherlands. For the people who live outside the Netherlands, the country code should be added (+31203697664). However, to make everybody able to use this

app, a description of the installation and demonstration in details is provided. It should be mentioned that the procedure for installation is only required for setting up a new server.

3.3.2. Get PoultryVet

The latest version of PoultryVet is available in a github repository. This repository is located in the following link:
https://github.com/Jaspera1980/KasaDaka-VSDK

The first step is to fork this repository and clone it on your local machine. Open git bash and type the following command:

```
$ git clone https://github.com/Jaspera1980/KasaDaka-VSDK.git
```

3.3.3. Deploying PoultryVet

To host PoultryVet, it should be deployed to Heroku. To deploy the app to Heroku, you need to create an account. Go to www.heroku.com, signup for a new account, create a new app, and make sure to select python as development language. Also, install the Heroku toolkit using the following link:

https://devcenter.heroku.com/articles/heroku-cli

Then open a cmd.exe in the directory where you've cloned your forked repository, and enter the following commands:

```
> heroku login
```

Enter your heroku credentials

```
Email: [email you used to create account]
Password: [password chosen to create account]
Logged in as [ email you used to create account]
```

Then type " heroku create --region eu"

```
$ ~\KasaDaka-VSDK>heroku create --region eu
```

The static files (such as audio files) are located on a server, and can be accessed using Secure File Transfer Protocol (SFTP). Set up the environment variable 'HEROKU by entering the following commands:

```
> heroku config:set  SFTP_PASS=YyE6vzc4vSwVv9sZVxxU
> heroku config:set  SFTP_USER=group6
```

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

Then, push the files using the following command:

```
> git push heroku master
```

After the files are deployed, enter the following commands:

```
> heroku run bash
> python manage.py makemigrations service_development
> python manage.py migrate
> python manage.py loaddata db_backup2.json
```

After these commands are successfully done, the app is ready to be tested.

Source code: https://github.com/Jaspera1980/KasaDaka-VSDK

3.4. Usage Scenario

To connect to PoultryVet, a mobile phone with basic functionalities, and 2G network is required. The following is a step-by-step usage scenario which can be used for testing purposes. Furthermore, Figure 3 shows the call flow diagram which contains all the steps and explains all the steps the call should go through.

1. Call 020-3697664.
2. After the mobile phone is connected to PoultryVet, a welcome message is played.
3. PoultryVet asks the user to select the type of bird by pressing 1 for chickens, 2 for fowls, 3 for ducks, and 4 for turkeys.
4. PoultryVet informs the user that a series of questions will be asked to diagnose the disease of the animal. To make it as easy as possible, all the questions are designed to be Yes/No questions. For yes, the user presses 1, and for no, the user presses 2.
5. Based on the answers provided, two conditions may occur. PoultryVet diagnoses the disease, or no diagnosis could be done.
    a. If a disease is diagnosed, PoultryVet announces the type of disease and provides the user with three options: 1) To listen to the info about the disease; 2) To contact a veterinarian; or 3) to end the call.
    b. If no diagnosis occurred, PoultryVet provides the user with two options: 1) To contact a veterinarian; or 2) To end the call.
6. In both of the above cases:

a. If the user selects to contact a veterinarian, PoultryVet provides information about three veterinarians and asks the user to select one of them. Based on the selection, the user will be connected to the selected veterinarian.
b. If the user selects not to contact a veterinarian, the call will end.

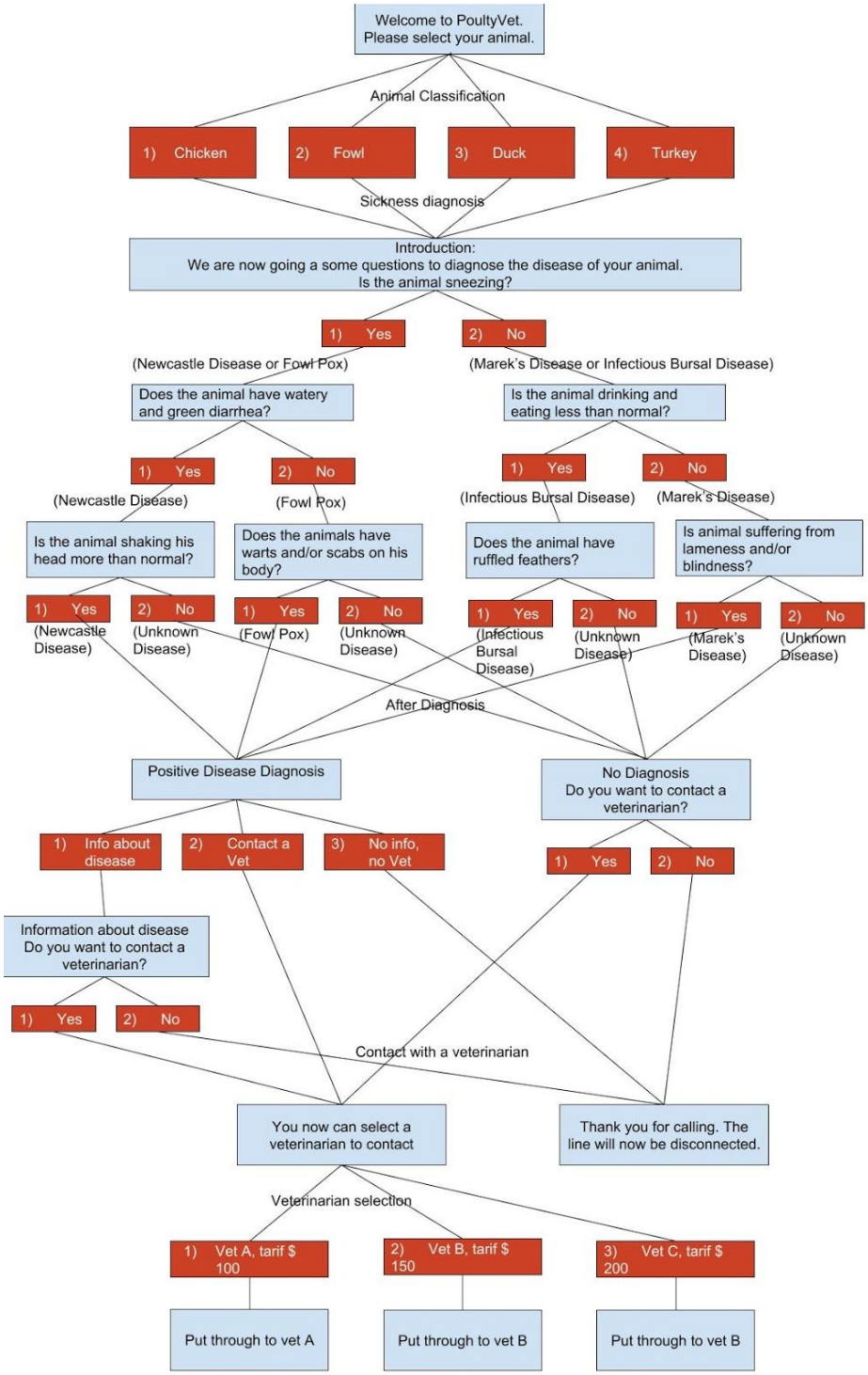

Figure 3 - Call Flow Diagram

3.5. Prototype Scope and Fidelity

Section 1.2. Scope, talked about the scope of PoultryVet implementation. This section explains to what extent the scope defined for the project is achieved. Table 1 shows the scope defined for PoultryVet and the implementation fidelity.

No	Scope	Status	Description
1	Operate on 2G (GSM) network	Implemented	The application is able to operate using 2G network.
2	Mobile phones with basic functionalities can connect to the service.	Implemented	Any kind of mobile phones with the most basic functionalities can connect to the service and interact with it.
3	Support four types of birds, e.g. ducks, fowls, chickens, and turkeys.	Implemented	PoultryVet supports the mentioned four types of birds.
4	Diagnose top-four birds' diseases, e.g. Fowl Pox, Marek's disease, Newcastle, and Infectious Bursal.	Implemented	PoultryVet is able to diagnose the mentioned four types of diseases.
5	Get user inputs and store in the database.	Implemented	PoultryVet is able to get user inputs and store in the database.
6	Support English language	Implemented	PoultryVet supports English language.

Table 1 - Scope and Fidelity

4. Deployment & Sustainability

4.1. Deployment Plan

ICT4D projects deployed in several developing countries run into many technical, cultural, and environmental challenges. Brewer, Demmer, Ho, Honicky, Pal et al. (2006) identifies the following challenges: poor electricity, little exposure to computing technologies and low literacy. Therefore, in this subsection a deployment plan for the PoultryVet is discussed [12].

4.1.1. Target Audience and first deployment

PoultryVet will target poor rural farmers living in Northern Ghana. At first, the service will be deployed as a pilot in a limited number of rural villages. Feedback from the pilot will be used to

improve the application prior to wider deployment. In the next sections, the practical implications of setting up the service will be elaborated.

4.1.2. Power Source

As explained in the previous assignment, rural communities in Ghana are a deprived community which lacks proper telecommunication infrastructure, electricity, and sometimes appropriate buildings. The PoultryVet runs on the Kasadaka which is built on a Raspberry Pi computer. This piece of hardware needs a power source to function properly. Estimated strictly in terms of a household's connection to the national grid, rural households are reported to have limited access to electricity [13]. To meet this particular need, the use of generators or solar panel is an option.

4.1.3. Climate

Another important factor is the weather. Ghana has a tropical climate. It can get rainy or hot depending on the season. Most households in the rural communities use earth/mud bricks, which are relatively cheaper, but have a shorter life span or durability [14]. Looking for a proper building to house the system must be planned from before deployment.The space in which the system is held should be kept as dry as possible and should not contain leaks.

4.1.4. IT Knowledge

Overall, developing countries have severe shortages of IT personnel [13]. Taking this into consideration, training a person to troubleshoot is important, so that when the system encounters a problem, IT personnel can at least try to solve the problem themselves and also assist the farmers. To mitigate this problem, a detailed training manual about the system could be developed and organized in form of a workshop where farmers can receive information and training about the system.

4.2. Sustainability Plan

Sustainability in regard to the PoultryVet project is the viability after the ending of the pilot phase. In other words, can the project survive without any outside financing or expertise? And is the product of the project likely to be adopted by the targeted users? Sustainability can be split into socio-technical and economic sustainability.

4.2.1. Social-technical sustainability

In this project social-technical sustainability is enduring interaction between users and technology in a low-resource area in a development country. This is partly covered in the use case description which describes the social context in which the idea for the application was conceived. Furthermore, the social-technical sustainability is embedded in the project research approach, which is an iterative process based on continuous user feedback.

4.2.2. Economic sustainability

The PoultryVet application is designed for the agricultural sector. For the future survival, the objective is that the application must be able to sustain itself by private funding. Private funding in this case is that the costs of the application are shared by the rural farmers and the veterinarians. How much a party is willing to pay for a service depends on a right balance between its benefits and affordability.
The service will only be used by rural farmers when there is a clear economic benefit. The PoultryVet service aims to save the farmers money by a more efficient process to decide if the services of a veterinarian are required and by reducing the death of poultry by providing basic information. The more efficient the process of the disease diagnosis service, the less a veterinarian has to be on site for the preliminary disease diagnosis. If the bird is not sick or the disease is not curable, no unnecessary costs are made. The service also offers the possibility to listen to information about the transmission of the diagnosed disease, prevention and treatment. The farmer can prevent the spread of the disease and judge if the help of a veterinarian is required (some diseases are incurable and the only option is to kill and burn the birds). The benefit for veterinarians is that they get customers referred by the system plus a possible disease diagnosis with supplementary information.

Summarization of benefits for the farmer:

1. Preliminary disease diagnosis
2. Provides information about disease transmission, treatment and prevention
3. Helps with contacting a veterinarian

Summarization of benefits for the veterinarian:

1. Provides customers
2. Client and disease database

4.3. Business Plan

4.3.1. Business Model

Both farmer and veterinarian gain from the service. For modeling the PoultryVet economics, the e³value methodology was used [1]. The economic model for the service is that both farmer and veterinarian carry the costs. This model was chosen because if the service would be free for the farmer, they might call only for the disease information and forgo contacting the veterinarian. In that case the veterinarian carries the cost for hosting the service but misses a part of the benefits. However, if the farmer has to pay the full expenses of a charged phone call, the service would be too expensive for the farmer, and the veterinarian would get customers for free. The economic model is visualized in figure 4.

The farmers would be charged a small fee for calling the service, and the veterinarian has to pay a commission for every customer referred to him. It must be noted that this is the initial economic model and that it might change when practice shows that it is unviable or when the use of the service gives rise to other business models.

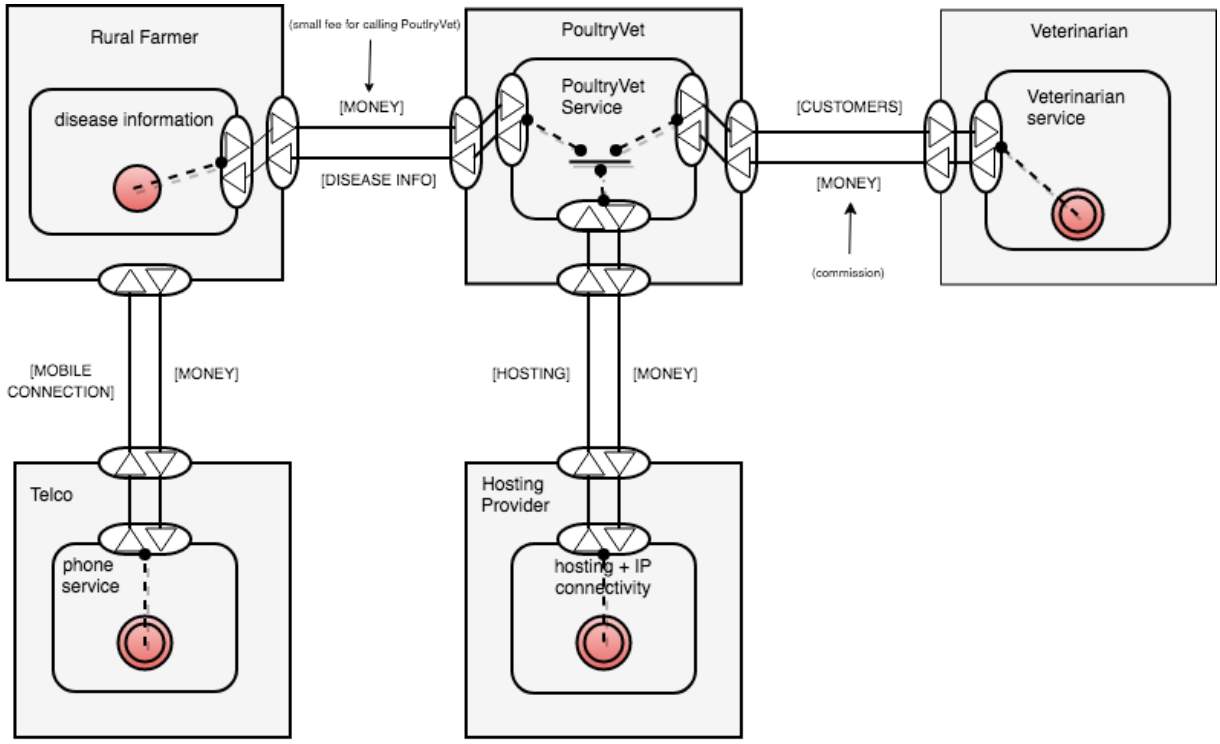

Figure 4: Economic model of PoultryVet

4.3.2. Alternative Business Models

Another business model can be for example that veterinarian owns the KasaDaka and hosts the service on is own behave, using PoultryVet as a business front channel. In that case, the veterinarian will be the sole beneficiary and cost carrier of the service. Thus the business model on which the sustainability of the service is based is dynamic and subject to change if the situation demands that.

5. Evaluation

It is very interesting that after all the efforts done to design and deploy the application, we can see it is running and works as expected. We can connect to PoultryVet using a basic mobile phone or a smartphone. The application can get the inputs, evaluate the inputs, and make decision based on those inputs. It can diagnose the animal disease, based on the answers we provide. The voice quality is good. In general, we can say that the application works well.

6. Discussion

6.1. Challenges

The outcome of this project highlights several challenges of disease diagnosis, and particularly mobile-phone based poultry disease diagnosis in Ghana.These challenges should be taken into account in the development of animal disease diagnostic systems based on mobile technology in the developing world.

6.1.1. Diagnosis Accuracy

An increasing number of applications has been developed over the years and marketed to assist livestock farmers with diagnosing animal disease, yet little attention has been paid to their diagnosis accuracy claims and potential risks. Our system makes diagnosis based on the answers given by the poultry farmers on the questions. In the current setup of the application, there is no examination in order to determine the prototype's accuracy. The main concern is that the diagnosis could be wrong and that this could affect the trust the farmers have on the system. For example the farmers could administer the wrong vaccine if they decide to treat sick birds themselves.

6.1.2. Low Economic Value

Poultry production is mainly practiced in rural communities and in most cases serves as major source of income, but it continues to be crippled by competition from imported poultry meat. Because of this, most of the rural poultry farmers engaged in trading and other off-farm employment to secure multiple sources of income and food security. Taken the low economic value of poultry, the farmer might not be willing to make expenses to save his birds and might not even think of getting veterinarian, or at very least not think of calling a poultry diagnosis hotline.

6.1.3. Lack of Proper Data

There has been some limitations while the PoultryVet was being developed. One of the biggest limitations was lack of proper data resources about animal diseases in Ghana. The Ministry of Food and Agriculture acknowledges that there is inadequate data on virtually every sub-sector, especially livestock and it is a major constraint to policy planning and must be tackled with seriousness [15]. Moreover in EMPRES Global Animal Disease Information System (EMPRES-i) which is a global reference database for animal diseases, there is no data about the occurrence of the four relevant poultry diseases; only scarce data about the avian influenza. According to Sumberg et al (2013) policy analysts, advocates, and programme and project developers rely on national data series available through government statistics offices and the Statistics Division of the United Nations Food and Agriculture Organization (FAOSTAT) because it is the best data available and or more often because it is the only data available [16].

6.2. Application Issues

Working with Heroku (which overwrites the old data with each iteration) some volatility was experienced in deploying the application. During the last iteration of our application a bug while loading the database data was encountered. The application still works fine offline, but whilst uploading the last iteration to Heroku an error was returned while executing the loaddata command. This error could not be solved before the report deadline. The authors deeply regret this. To give an idea of the functionality and prove that the application actually works a video has been made. To watch to video please follow this link: https://youtu.be/UjfrUJCu5cs
The previous version of PoultryVet (working version) is available at the following link: https://poultryvet2.herokuapp.com/.

7. Conclusion and Future Work

7.1. Conclusion

Designing, developing, and deploying PoultryVet showed that how hard it can be to apply technologies in undeveloped countries, because there are too many factors that must be taken into consideration to provide the end-users with an operable system. These factors (lack of facilities, such as Internet availability, lack of electricity, and lack of literacy) can put many limitations on the way of applying those technologies. Despite all these difficulties and limitations, there is still many opportunities which can be used to provide the people with useful services. Even a small service such as PoultryVet can make the life of the people easier.

7.2. Future work

During the presentation the feedback was given that in Mali the poultry industry is larger. The most spoken and official language of Mali is french. Adding french as supported language makes it possible to expand the application to Mali. Adding an extra language is relatively easy to carry out. The database hosts information concerning medicines and vaccines. This information is currently manually entered in the database. This information can also be collected from open sources (if available). By linking the database the external sources more accurate and update information about medicines and vaccines can be offered to the veterinarians.
Another future extension could be to add geospatial data to the database. Capturing geospatial data can be done in numerous ways; the farmer can be asked to indicate his village, the application can be deployed every locally, it could be inferred from phone company call logs, etc etc. The location data can be used to discover disease patterns or first signs of epidemics.
As mentioned in the discussion section, diagnosing disease is challenging. In the voice service only questions about symptoms are asked that are distinct for a particular disease. It can therefore be argued that with a reasonable probability the right diagnosis is made. To know how accurate

the disease diagnosis is the results needs to be validated. The only way to be sure which disease an animal carried is to do section on a dead specimen. Operating in a low-resource environment that would likely be a too costly endeavor. An alternative can be to let the veterinarian do the validation. An extra field in the client database can be added where the veterinarian can enter his disease diagnosis. In this way there will be a mechanism in place for the validation of diagnosis. When large disparities between the PoultryVet diagnosis and those of the veterinarians occur, this could a starting point for further investigation.

8. Bibliography

[1] See http://e3value.few.vu.nl

[2] VETERINARY SERVICES DEPARTMENT, Controlling Newcastle disease in village chicken, Accra, Ghana (1998) 12 pp

[3] Turkson, P.K., 1998. Systems analysis of privatization of animal health delivery services in Ghana and Jamaica, Ph.D. Thesis. North Carolina State University, NC.

[4] Blackie, S. (2014). Village Chicken production system in the Greater Accra region, Ghana. *Journal of Biology Agriculture and Health Care*, Vol. 4. No. 9. pp 89- 94

[5] Bruce, M. S. (2011, August 22). Ghana's poultry farmers battling for survival as country imports $200m frozen chicken. Ghana Business News. Retrieved from https://www.ghanabusinessnews.com/2011/08/22/ghanas-poultry-farmers-battlingfor-survival-as-country-imports-200m-frozen-chicken/

[6] FAO. 2014. Poultry Sector Ghana. FAO Animal Production and Health Livestock Country Reviews. No. 6. Rome

[7] Ghana Adult literacy rate, 1970-2017 - knoema.com. Retrieved from https://knoema.com/atlas/Ghana/topics/Education/Literacy/Adult-literacy-rate

[8] Taluah R.A. (2016). The Teaching and Learning of the English Language in Ghana: Problems and Implications. *Imperial Journal of Interdisciplinary Research (IJIR)*,Vol-2, Issue-5, 2016

[9] Lo, G., & Blankendaal, R. (2016). Digivet: a knowledge based veterinary system for rural farmers in north ghana.

[10] Fao.org, (2016). Developing the Knowledge, Skills and Talent of Youth to Further Food Security and Nutrition CASE STUDY : [online] Available at: http://www.fao.org/fileadmin/templates/cfs/Docs1415/Events/youth/casestudies/CFS42_Youth_Africa_Farmerline.pdf

[11] Tariku Jibat Beyene. (2018). A Smartphone-Based Application Improves the Accuracy, Completeness, and Timeliness of Cattle Disease Reporting and Surveillance in Ethiopia. *Frontiers in Veterinary Science*, Vol-5.

[12] Brewer E. (2006). The Challenges of Technology Research for Developing Regions. *IEEE Pervasive Computing*,Vol 5, No 2, pp 15-23.

[13] Mensah Emmanuel Joseph. (2014). Infrastructure Access and Household Welfare in Rural Ghana. *African Development Review*, Vol 26, No 13, pp 508-519

[14] Ghana, Ghana Statistical Service, (2012), 2010 Population and Housing Census, Summary Report of Final Results. 10. Ibid

[15] Ministry of Food and Agriculture (2010) Medium Term Agriculture Sector Investment Plan (METASIP): 2011–2015. Accra: Republic of Ghana.
[16] Sumberg, J.; Awo, M.; Fiankor, D.-D.D.; Kwadzo, G.T.-M. and Thompson, J. (2013) Ghana's Poultry Sector: Limited data, conflicting narratives, competing visions. STEPS Working Paper 56. Brighton: STEPS Centre

8. Appendix

Link to PoultryVet VXML source code:
https://drive.google.com/file/d/1fRTs2augLr5EuLamuADmpPTDPa-dSO3G/view?usp=sharing

Link to PoultryVet Github:
https://github.com/Jaspera1980/KasaDaka-VSDK

Feedback assignment 1

Final Grade:	**9.0**	
Element	Score (E, G, S, I)	Remarks
Is the problem description clear	Anna: E Francis: E	Anna: Did research on chicken disease very good!
Context well described	Anna E Francis: E	Summary of Key Idea reads "*The service will be voice-based and is available in English*."; Consider first describing entire system as it would work in the field Cross-check price of calls in Ghana; 12 to 172GHC (2,20 to 31,50 euros) sounds too high Note - Kasadaka can be setup in an urban area instead
Does the design 'solve' the problem	Anna: G/E Francis: E	
Design clarity, implementability	Anna E Francis: G	Anna: Very wel structuresdocument
HCI design considerations followed	Anna: G/E Francis: E	
correctness	Anna: E Francis: E	
completeness	Anna: G Francis: G	
HCI implementation	Anna: G Francis: E	Could not test looks good Nice addition of recorded audio. Clear and simple interface; however some voice fragments are a bit too long
code and documentation	Anna G Francis: G	

Feedback assignment 2

Final grade: **7.5**	**General Remarks:** Migration OK, extension of functionality still limited (no database). Can be improved in cycle 3.	
Criterium	**Score (E,G,S,I)**	**Remarks**
Tech impl:	G G	Ported to Kasadaka and Heroku. Works well Please include VXML URL in documentation
Scope & exp:	S	Still waiting for a database to store the input. Current system is therefore limited.
Doc & Quest's:	G (Anna/Victor)	Nice documentation, demo scenario. Feedback questions are relevant
Document:	G	Doc well structured, clearly shows what has been done and what is still missing.