ANIMAL DISEASES IN RURAL GHANA

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Introduction

Livestock keeping in rural Ghana supports many households by providing direct income and serving as a social safety net. Yet, animal diseases severely constrain livestock production in central Africa, causing economic losses for farmers and livestock owners (Awa & Achukwi, 2010). Hence, as Mockshell et al. (2014) stated, "providing quality and sustainable animal health services to livestock dependent communities is a key to reducing economic losses and human health risks associated with animal diseases". In this document we explore the challenges associated with animal diseases in rural Ghana and propose a prototype of a voice-based system, that can play a role in the prevention of animal diseases and stimulation of knowledge sharing between the involved actors.

The document is organized as follows: the first section defines the contextual issues and makes the problem statement explicit. Next, a theoretical background is presented which further guides our research and the developed prototype. The following chapters describe the design and implementation of the prototype in more detail. The deployment and sustainability chapter provides more insight in relevant aspects that go beyond the technical artefacts and embeds our work in the broader societal context. Finally, in the discussion we reflect on the creation process of the prototype.

Contextual issues: animal health services in rural Ghana

Livestock-keeping households depend on animal health service providers to cure animal diseases. Yet, poor livestock owners often lack access to affordable and high quality animal health service delivery (Awa & Achukwi, 2010). Governments in developing countries have promoted private practices for animal health service delivery, in order to move to more sustainable services. This privatization policy resulted in a decrease of government employed para-vets (GPVs), leaving more ground for private para-vets (PPVs) to be covered. However, private practice mostly focuses on urban areas, making it difficult for livestock dependent rural communities to get affordable animal health services. To fill this gap governments have promoted community animal health workers (CAHWs) to deliver animal health services for the poor (Awa & Achukwi, 2010). According to Mockshell et al. (2014), this development has consequences for the quality of the service delivery. Although community animal health workers have been trained by the Veterinary Services Department (VSD) to be the front-line of disease prevention and surveillance in their communities (Turkson, 2003), they are the least preferred service providers because of high transaction costs and low performance resulting from limited training (Mockshell et al., 2014). The same study shows that the government para-vets are the most preferred, as they are perceived as the best performing animal health service providers relative to the other service providers. Another popular method is self-treatment of livestock, especially when animal health service providers cannot be reached or are too expensive. We would argue that this method will always retain its popularity, as it is a low cost solution.

According to Turkson (2003) and Turkson & Naandam (2003), other constraints to veterinary work in rural contexts are: (1) lack of transport, (2) farmers' poor attitude to animal care, resulting in cases being reported late, (3) farmers' unwillingness to pay, (4) lack of drugs and equipment, (5) lack of education of farmers/adherence to taboos, (6) staff not well distributed, creating shortfalls in some places, (7) high overhead costs for home visits and (8) absence of legislation to control drug sales and veterinary practice. Relating to the latter, respondents in this study have indicated that enforcement of the veterinary legislation is necessary to weed out the practice of veterinary medicine by unqualified persons. Furthermore, Mockshell et al. (2014) observed that when livestock keepers anticipate losing their livestock because of diseases and there is no animal health service available or it is too expensive, they will sell their livestock, creating an informal market for sick animals. Evidently, consuming this meat may have undesirable health implications for the public health.

In the described context, several interwoven problems contribute to poor animal health care. Drawing on the insights of the empirical studies we suggest that this problem should be approached at three different levels: (a) informing livestock keepers, community animal health workers, private para-vets and radio hosts about disease prevention measures, in order to act in advance, (b) facilitating knowledge transfer from government para-vets to the community animal health workers and private para-vets, in order to improve the quality of service (c) enabling farmers and livestock keepers to diagnose sick animals, perform self-treatment and understand when self-treatment is not recommended, in order to reduce mistreatment.

Designing a solution for this multi-leveled problem also requires consideration of constraints applicable in developing regions as Ho et al. (2009) identified. According to the author, the following constraints form key challenges in the implementation of possible solutions: poor electricity, little exposure to computing technologies, low literacy or linguistic knowledge restricted to local languages, and differences in sociocultural practices responsible for differences in mental models between Western and non-Western users.

Theoretical background

The animal diseases issue in rural areas carries various risks that have undesirable consequences. Losing livestock has financial consequences for livestock owners and farmers. To decrease the financial consequences, livestock owners and farmers might sell meat which is consumed by humans, causing new risks spreading to human health. It also seems that distress livestock sale is associated with increased poverty (Mockshell et al., 2014).

Prevention of such unwanted events is considered to be better than protection against the consequences of such events. It however goes without saying that prevention of all possible events is impossible to establish. According to Hollnagel (2006) risk and safety are linked together. Risk is the likelihood that something unwanted might happen. Safety is the absence of unwanted events. A higher level of safety is a lower level of risk and a higher level of risk is a lower level of safety. Prevention and protection go hand in hand when exoloring the animal diseases in the rural Ghana case. Prevention focuses on reducing the likelihood of unwanted events and protection on reducing the consequences (Hollnagel, 2007). In this particular case prevention is a way to reduce the likelihood of livestock becoming ill. Protection on the other hand is to provide the right treatment of ill livestock to reduce illness consequences (e.g. fatality, financial loss, increased poverty).

Various stakeholders (e.g. GPV's, CAHWs, livestock owners, farmers, etc.) with different stakes (preventing livestock illness, providing effective diseases treatment, etc.) are involved in the animal diseases context. Examining the involvement of and relation between the stakeholders we have to turn to relevant themes, specifically two contrary themes representing each its own mindset. We are referring to the goods-dominant (G-D) logic and service-dominant (S-D) logic (Lusch & Nambisan, 2015). The G-D logic is the traditional mindset that forms approaches of producing tangible goods. The production process is separated from the customer to gain efficiency in producing standardized goods. These goods are inventoried and transported to a place and time demanded by the customer. Lusch and Nambisan argue that the G-D logic's separation and control of actors restricts service and product innovation. Here is where the S-D logic comes in, making the distinction between the two types of innovation irrelevant and offering a broader and transcended view in contrast to the G-D logic. This S-D logic is an emerging mindset which is centered around both tangible and intangible market offerings, which makes it more relevant since the digital era forces us to move away from G-D logic. S-D logic views the stakeholders in a 'service' network as actors, following the actor-to-actor (A2A) network structure. In this A2A-network service innovation is a collaborative process where value is co-created by all involved actors, meaning the service offerers (e.g. GPVs, CAHWs) as well the beneficiaries (e.g. farmers, livestock owners). The S-D logic is a mindset where specialized knowledge and skills of one actor are applied to benefit another actor (Lusch & Nambisan, 2015). In the animal diseases case the CAHWs who are closest to the farmers and livestock owners are not able to provide in the needs due the lack of knowledge of skills. This knowledge and skills are possessed by the GPVs who are too far from the rural areas. Solving this multi-leveled problem demands a way to "transport" this knowledge and skills to the CAHWs, PPVs, livestock owners and farmers. This can be achieved by establishing a service platform wherein a collaborative process is incorporated enabling value co-creation. CAHWs will gain knowledge and skills to provide more effective treatment eventually generating more income. Livestock owners and farmers will be able to prevent illness of their livestock or otherwise protect their livestock against illness consequences. The government eventually achieves a more sustainable services environment.

In sum, the risk management and S-D logic perspective combined, inform our solution by a) emphasizing that both prevention and protection should be considered and b) offering a broader and transcended view, which puts emphasis on the collaborative process in which value is co-created by all involved actors.

Solution design

When designing a system or prototype which focuses on the aspects discussed in the previous chapters, some considerations need to be taken into account. Firstly, as many different actors are involved in the system, an environment should be created that allows for interpretive viability by encouraging users to develop their own agendas and by putting their ideas forward (Birkinshaw et al., 2008). Secondly, the solution should avoid technological determinism and should focus on the "constructive process that involves the negotiation of meaning among different stakeholders with different views and interests and results in the emergence of a dominant meaning that can be seen as a particular discourse" (Grant et al., 2006). The designed system may support the process, however, solving the problem will require active participation and collaboration of all involved actors. Furthermore, as suggested by Mockshell et al. (2014), the government may act as a catalyst by setting minimum standards for training, certification and supervision of community animal health workers or private para-vets by governmental veterinary experts.

In other words, this initiative should be supported by a program which is much broader than the system itself. The design of the system is depicted in the following use case diagram. This diagram shows the actors and the actions they can perform within the system. A short description for each actor and use case is included in table 1.

Figure 1 - Use case diagram

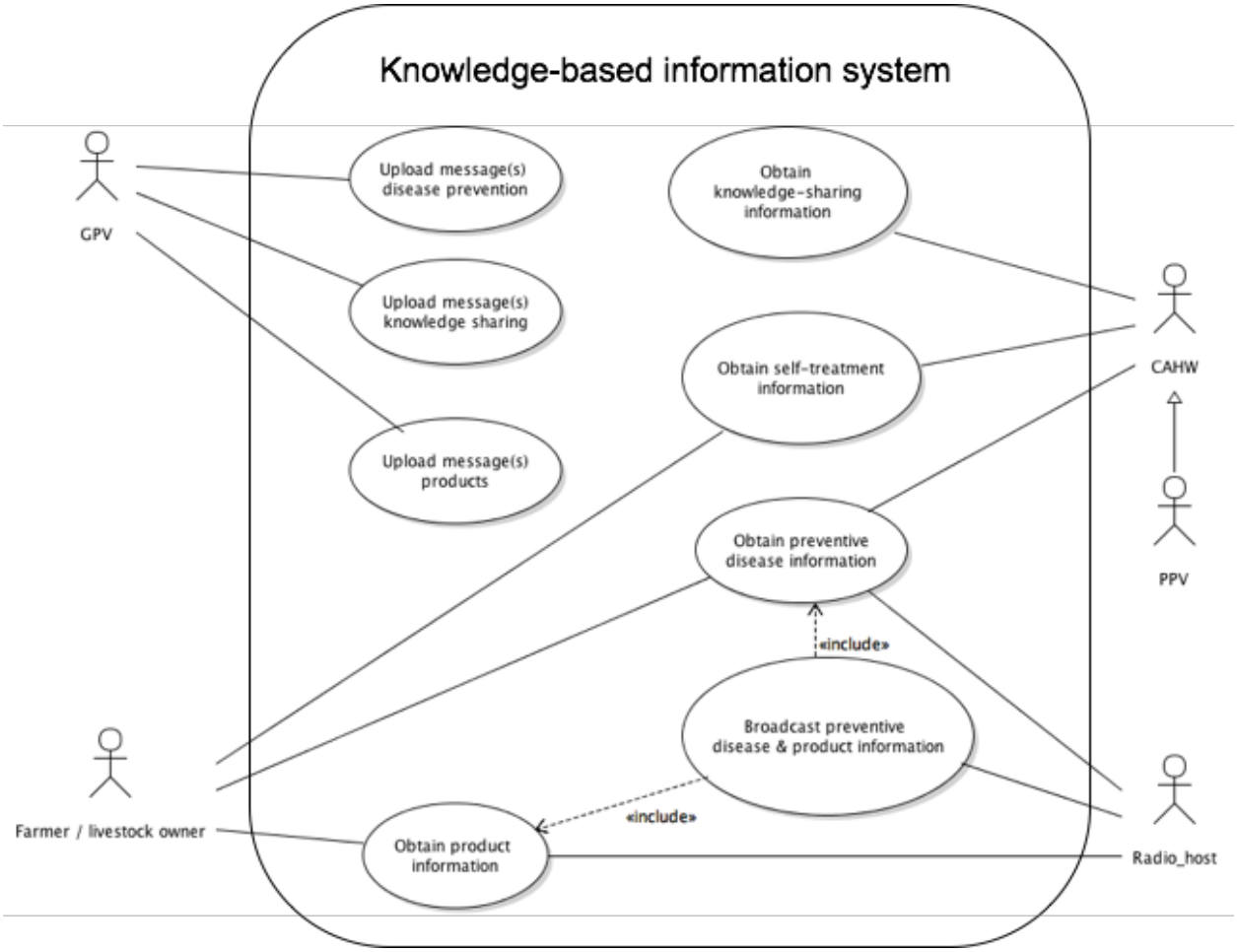


Table 1 - Actors description

Actor	Description
Government para-vets (GPV)	Governmental veterinarians with a university degree in animal health providing animal health services.
Private para-vets (PPV)	Private veterinarians with a diploma or certificate in animal health providing animal health services. Usually running a retail business in drugs.
Community animal health worker (CAHW)	Health workers with limited training in animal health providing animal health services.
Farmer	Individuals working in the agricultural sector (e.g. rearing animals).
Livestock owner	Citizens that own livestock (usually safety net purposes).
Radio host	Providing radio programs.

Use case descriptions:

1. Upload message(s) disease prevention: a GPV records messages (outside of the system) regarding disease prevention. These messages can be uploaded to the system through a web interface. This information can be retrieved by farmers, livestock owners, radio hosts and CAHWs.
2. Upload message(s) knowledge sharing: a GPV records messages (outside of the system) for knowledge sharing purposes. These messages can be uploaded to the system through a web interface. This knowledge can be obtained by CAHWs and PPVs.
3. Upload message(s) products: a GPV records messages (outside of the system) regarding products like medicine, with purchase advice. These messages can be uploaded to the system through a web interface. This information can be retrieved by farmers, livestock owners, radio hosts and CAHWs.
4. Obtain knowledge-shared information: A CAHW or PPV consults the information system to obtain educational information for assistive purposes to diagnose an animal's disease.
5. Obtain self-treatment information: a farmer or livestock owner consults the information system to obtain advice for certain symptoms. This advice could be medication or a visitation to the vet. (extension of DigiVet). This information is intended for farmers and livestock owners, but also available for animal health service providers.
6. Obtain preventive disease information: a farmer or livestock owner consults the information system to obtain general information related to common diseases (e.g. seasonal/regional), eventually enabling disease prevention.
7. Obtain and broadcast preventive disease & product information: a radio host obtains and broadcasts the recorded preventive disease and product purchase advice information (to reach the passive farmers and livestock owners).
8. Obtain product information: a farmer or livestock owner consults the information system to obtain purchase advice information on products like medicine.

Initially we developed a prototype with some basic core functionalities. During the ICT4D course we expanded this prototype with more functionalities to cover more use cases. For the expansion we used the feedback from the lecturers of this course and eventually the feedback received from the Mali trip. In the next paragraph we describe how we processed the feedback from Mali. More on the prototype and its

fidelity is included in the prototype paragraph. In the last paragraphs of this chapter we elaborate more on the service, its functionalities and infrastructure.

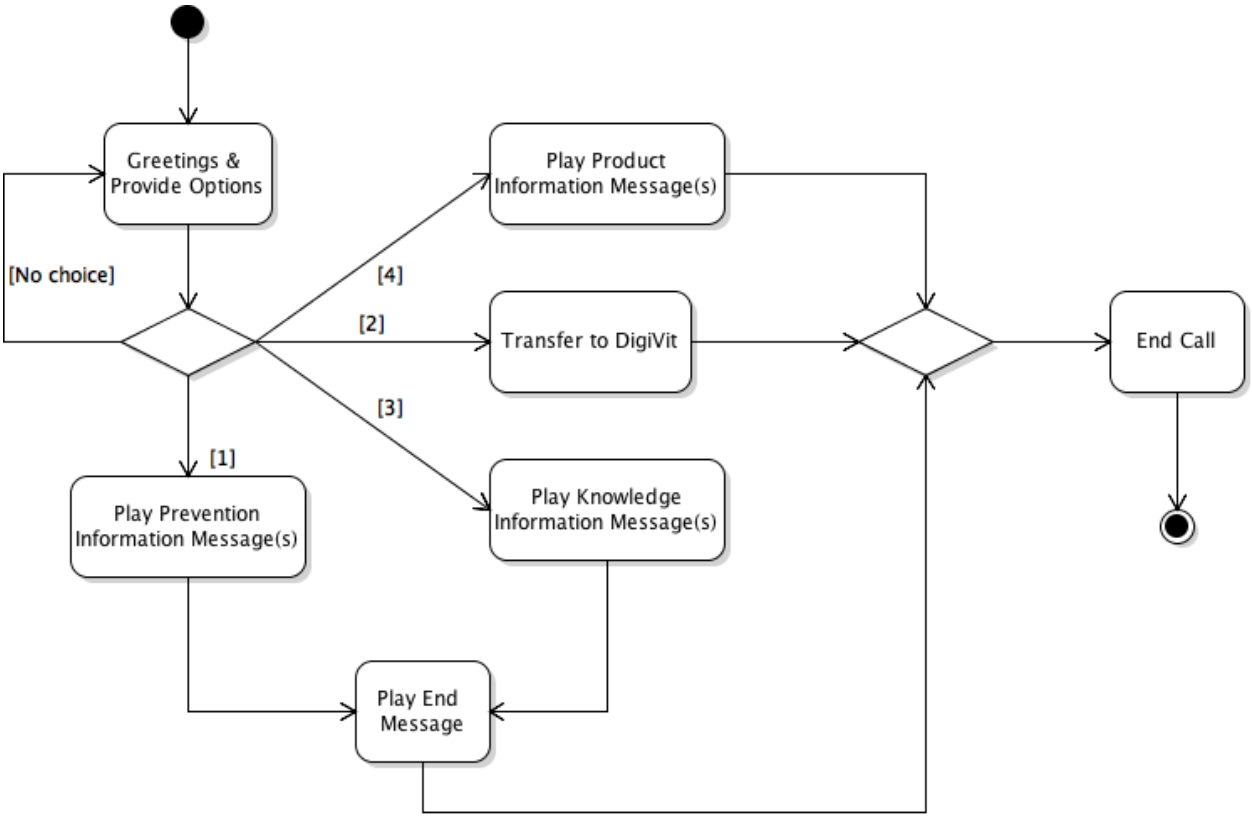
Feedback from Mali

Ho et al. (2009) suggest that methods should be employed which address the local contexts, as opposed to deploying technologies developed for industrialized countries. This can be done by performing a user-centered design, in which a technological artefact is designed, evaluated and modified based on input from the user. In our approach we aim at including the voices of the intended beneficiaries (Ferguson & Taminiau, 2014), allowing for the users to participate in the development phase. Firstly, the prototype has been based on a use case description provided by farmers in Ghana. Our starting point is the concrete need in the rural areas for dealing with animal diseases. Secondly, the feedback provided by the lecturers has been incorporated in the demonstration version of the prototype. Concretely we have added DTMF and support for both English and French. Especially the French language was important for the demonstration purposes, so that local farmers can understand the nature of the messages which will be made available through the system. Thirdly, we have incorporated feedback from the farmers as provided during the demonstrations in Mali. The farmers have indicated that they would like to also get information about products (e.g. medicine) of vets and where to find them. This information could also contain warnings not to buy certain medicine from specific individuals or distribution channels, as they may be fake. Based on this feedback we have added an extra category to our prototype, which will hold information regarding veterinary products. This will allow the GPV to share a list of those allowed to sell veterinary medication and warn for frauds. Next to the additional functionality, we also account for the underlying problem of medication provision, by addressing who should be able to sell veterinary products. This is described further in the sustainability chapter. This chapter also deals with the feedback we received from the farmers in Mali, stating that the success of the service will heavily depend on the capabilities of the GPV. Implying that it may not work in places where the quality of the content provided by the GPV is insufficient. Adequately dealing with this goes beyond the system and requires a critical review of the role of the government in the context of animal health in rural areas. The sustainability chapter elaborates further on this.

Description of the service

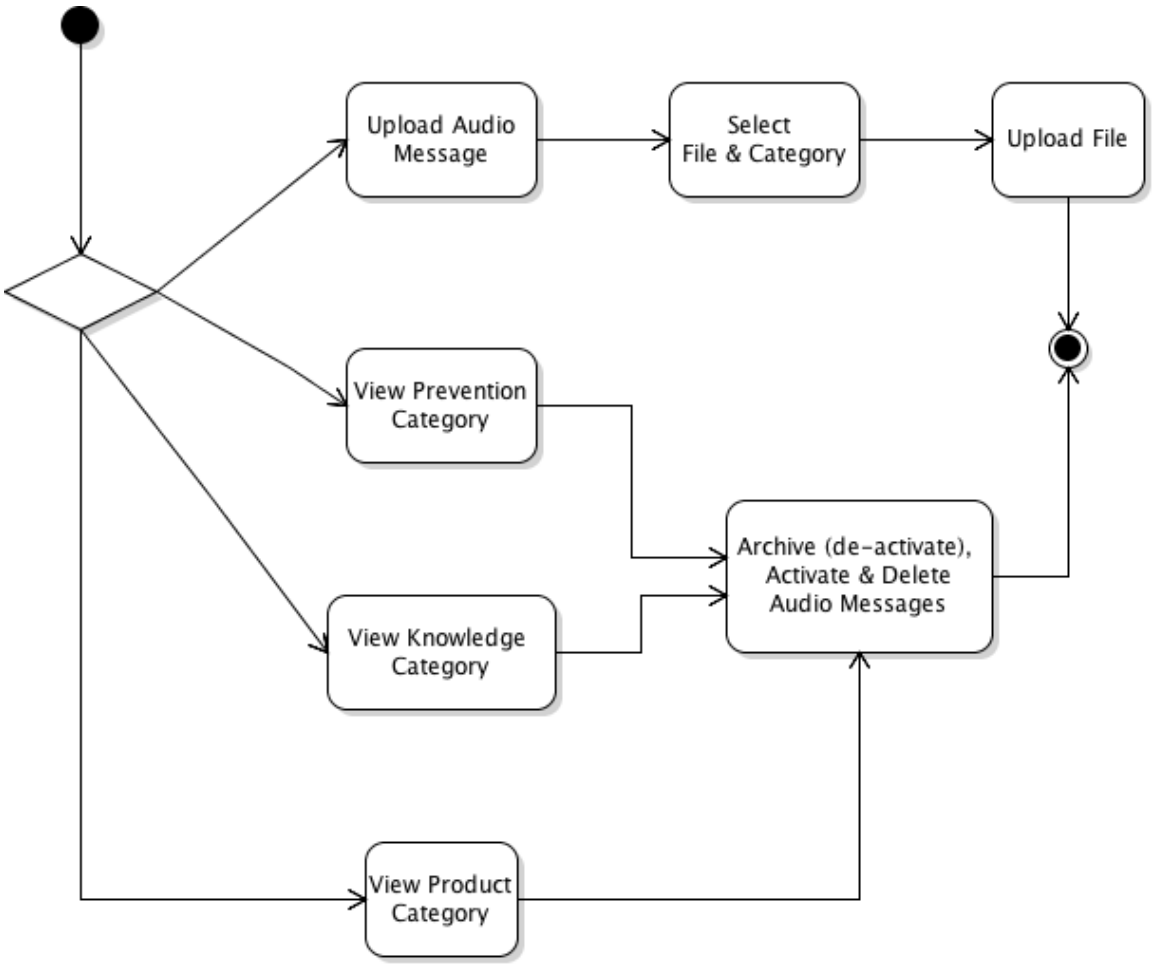
In the previous paragraph we have identified six use cases. For our prototype we have selected two use cases to give an impression of the system's functionality. This concerns use case “obtain preventive disease information”, use case “obtain knowledge-shared information” and use case “obtain product information”. The functionality of the use cases is displayed in the call-flow diagram (figure 2).

Figure 2 - Call-flow diagram



The aim of this service is to: (a) share prevention and product purchase information with farmers and livestock owners (b) make knowledge intensive information available for the CAHWs. The radio hosts can also access the prevention and product purchase information, in order to broadcast it to the local region. The system and its information is also accessible for private para-vets. However, private para-vets are not the primary target group, as we target the local community primarily. This prototype has been extended with: (a) relevant audio content in the prevention category, (b) relevant audio content in the knowledge sharing category and (c) support for both the English and French language. The messages are recorded outside of the system by the government para-veterinarians and eventually uploaded through a web interface. This is depicted in the next activity diagram followed by a description.

Figure 3 - Web interface flow diagram



The government para-veterinarians have access to a web interface where the audio messages are maintained. This web interface enables them to upload, activate, de-activate and delete audio messages on the file server. A user is presented with four options: upload an audio message, view prevention category, view knowledge category and view product category. By choosing to upload an audio message the user can choose a file and one of the categories to upload the files to (prevention, knowledge and product category). These messages will become available for other stakeholders to consult through the service. In all other options the users can manage the audio messages of each category. They are able to archive the messages, which means de-activating the messages without deleting them. Archived messages can also be activated again, which means they will be available to consult through the service. Lastly, the users can also delete message, which will not be available anymore on the file server. For representational purposes the use case scenario's in the appendix can be referred to.

Data model

The prototype uses a database to keep track of all audio messages and their properties. This database contains one table (named: 'files'). The structure of this table and the usage of the different properties is described below in table 2.

Table 2 - Database table description

Field name	Field type	Description
id	Integer	This is the auto-increment primary key.
Filename	Varchar	This field contains the name of the uploaded file. Upon upload each file name will get a timestamp as prefix, in order to make the files unique on the file system. File names will also be modified, so that they are url friendly, meaning that characters which can cause problems in url's are removed.
Category	Varchar	This field holds the category to which the audio file belongs. This can be one of the following values: {prevention, knowledge, product}.
Status	Varchar	This field holds the status of the audio message. This can be one of the following values: {LIVE, ARCHIVED}. ● LIVE: represents that the message is available, meaning that messages will be played through the voice interface. ● ARCHIVED: represents that the message is put aside, meaning that it will not be played through the voice interface.

The content of this table is mutated by the web interface as the user upload new audio messages and archives or deletes existing ones. The voice interface uses the content of this table to determine which audio message should be played in which category.

As the need for data management in this prototype is quite minimal, we a have selected a lightweight database (sqlite3). We have considered using Linked Data, however we have not found a matching requirement justifying its use in the context of the prototype. The goal of our prototype is to be local to the rural areas. In other words, the information shared through the service should be tailored so that it is relevant for the specific rural community. This means that messages are content wise specific and in certain cases may also be in a local tongue. Hence, disclosing this information through an open standard does not make sense as it loses its meaning outside the context for which it is intended. The Kasadaka platform does support Linked Data, hence if future requirements do justify the use of Linked Data it can be implemented using already existing tools on the Kasadaka platform.

Scope and fidelity of the prototype

We are aiming to provide farmers and livestock owners with disease prevention information to reduce financial loss risks which pushes them further into poverty. We also wish to prevent other undesirable consequences like meat consumption of sick animals, spreading the problem to human health. This covers the prevention aspect of risk management. As we indicated preventing all unwanted events is not a conceivable task since all possible scenarios are impossible to come up with beforehand. Therefore, we developed the protection aspect as well in the prototype. In table 3 we have included the use cases with all their particularities, relevant remarks and fidelity (whether the use case is developed or not).

Table 3 - use case particularities and fidelity

Use case	Particularities and remarks	Fidelity
1. Upload message(s) disease prevention	GPV's prepare audio message(s) to upload to the service. These messages can be referred to by other actors to prevent animal diseases (use case 6). This belongs to the prevention aspect of risk management.	Developed
2. Upload message(s) knowledge-sharing	GPV's share their knowledge by recording specific message(s) for CAHWs and PPVs. The messages are consulted in use case 4. This messages are focused on treatment of illnesses, which means it mainly focusses on the protection aspect of risk management.	Developed
3. Upload message(s) products	GPV's upload message(s) regarding advice on purchase locations. This use case was developed after receiving feedback from Mali. Our focus group indicated such a functionality would be beneficial. This part mainly focuses on protection. The message(s) are consulted in use case 8.	Developed
4. Obtain knowledge-sharing information	Recorded messages uploaded in use case 2 are obtained here by the CAHWs and PPVs.	Developed
5. Obtain self-treatment information	Actors are forwarded to the DigiVet application. This takes place outside of our service.	Not applicable
6. Obtain preventive disease information	Recorded messages uploaded in use case 1 are obtained here by the mainly farmers and livestock owners, but other actors can access this as well. Radio hosts access this information to share it on a radio broadcast.	Developed
7. Broadcast preventive disease & product information	Radio hosts access messages of use case 1 and 3 for broadcasting purposes. This is to reach passive farmers and livestock owners as well. This use case focuses on prevention and protection.	Developed
8. Obtain product information	Message(s) uploaded in use case 3 are obtained here by the actors.	Developed

This system is designed to reach pro-active as well passive farmers and livestock owners. The passive farmers and livestock owners are reached by radio broadcasts, use case 7. We have recorded the messages of the prototype with some common diseases for demonstration purposes. An additional functionality is use case 5, where the farmers and livestock owners are forwarded to the DigiVet application. That application currently facilitates animal disease diagnoses where an advice is provided on whether to visit

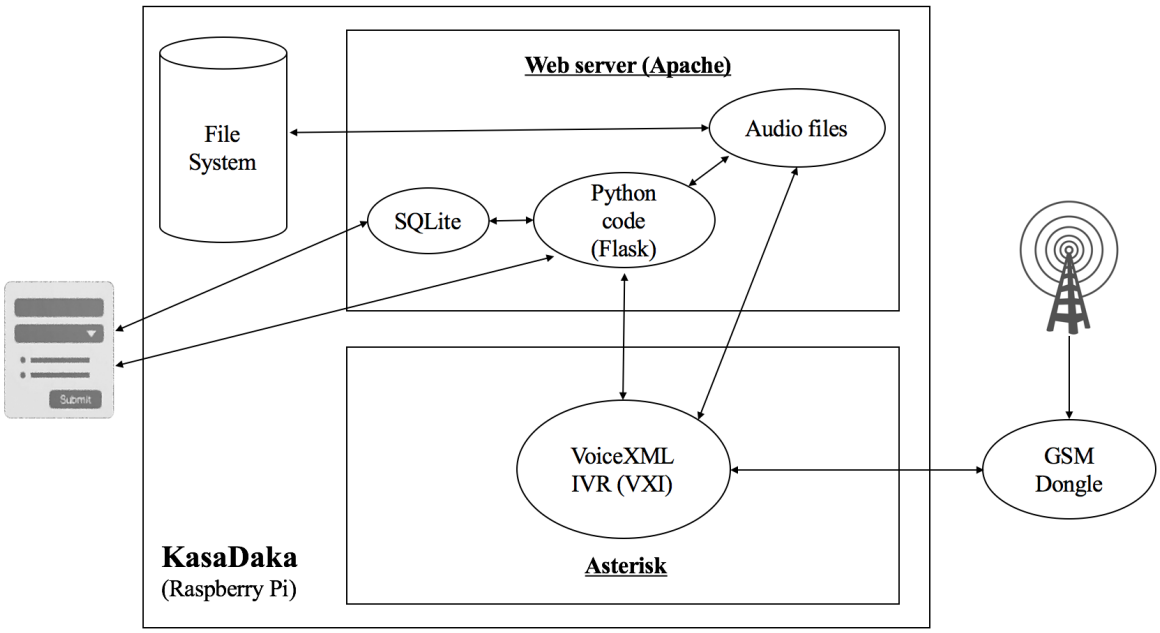
or not visit a vet. This application is outside of the developed animal diseases service. An extension in this DigiVet application could be medication advice, covering the self-treatment (STS) aspect more. Since farmers and livestock owners will have the urge to self-treat their animals we advise to provide them with information enabling them to do this more responsibly.

Our prototype requires collaboration between different actors which have their own unique contribution using their knowledge and skills, stimulating co-creation of value. In our prototype we covered all designed use cases. The actual recording and converting of messages in the supported format is placed out of scope for the prototype. We assume that audio content is uploaded through the web interface in the right format. Recording audio through the voice service turned out to be troublesome to implement. Furthermore, merely recording a message through the voice interface would not suffice from a functional point of view, as additional functionality is required to support placing the audio message in the proper category, taking it offline and deleting it. This justified developing the web interface, which provides sufficient functionality for demonstration purposes, as it allows for both uploading and managing of uploaded audio content. Finally, it is important to note that this prototype lacks functionality or capabilities which are typically found in real-world applications. For instance, the ability to login, log out, manage users, handle errors and many other usability enhancements. The prototype focuses on the concept itself, therefore all functionalities and enhancement which do not directly contribute towards proving the concept are left for further development.

Implementation

During the last phase of the project, some expansions and improvements are made to the application. In terms of presentation, the application contains a front-end web interface, enabling users to perform management of audio messages. Additionally, the infrastructure layer is extended with SQLite for local file storage, Flask as a web framework and Python as intermediate. These three components are connected with each other and are providing services such as displaying, sorting and/or referring to the appropriate (audio) files on the file system and the web interface. For example, through the Python code, the specific .VXML files on the file system are being invoked. The .VXML enables referring to the proper .wav files. Furthermore, by incorporating Flask, it is made possible to route the actions from the web interface between the file system, and SQLite. The Python code is able to perform database queries as deleting, archiving or bringing an audio message to the “live” status. Finally, openVXI makes it possible to interpret .VXML files and to play the audio files through the IVR protocol. The infrastructure and implementation of the application is presented through a revised infrastructure model (see figure 4). The code-part - and its detailed implementation - can be found in the repository “KasaDaka” on GitHub (see Appendix).

Figure 4 - Infrastructure model



The application can be tested in the Kasadaka environment. The description how to test the application is visualized through an usage scenario. For readability reasons, the usage scenario and the installation instructions are attached to the appendix of the project report. Firstly, - and as part of the scenario - the installation instructions and important notes are described. The installation is required in order to be able to test the application. Secondly, the usage scenario provides in global terms how to access the web interface, followed up by an instruction on how to use the functionalities.

Deployment and sustainability

Sustainable development

Resource scarcity and crises are an important issue in debates about sustainability (Holling, 2001). In context of social and ecological systems, the author denotes the concept of "sustainable development". In this case, the definition of sustainability is related to the capacity to create, test and maintain *adaptive capability*. Additionally, development is the process of creating, testing and maintaining *opportunity*. Hence, when we combine the two concepts into "sustainable development", this will lead to the objective to encourage adaptive capabilities and to create opportunities. In this section, we will try to explore how sustainable development can be applied in the context of animal health service delivery in rural Ghana.

Nawi et al. (2013) emphasize that in the current literature, social aspects of sustainable development are underlit, mostly broad defined and difficult to apply. This means that there is minor attention to the fact how IT projects impact the local context. According to the authors, the concept of sustainability should balance between economic, environmental and social dimensions. In this case, the social dimension should empower people in the community in becoming more active in seeking ways to keep a project running. With this in mind, we can put the following questions: *do the local actors recognize and accept the added value of a technology? Are they willing to support this technology also in the future?* Hence, besides economic and environmental aspects, the social dimension in the context of sustainable development should also be taken into consideration. More explicit and related to the design and

implementation of IT, sustainable IT is "a technology that is capable of being maintained over a long span of time and independent of shifts in both hardware and software".

In sum, social aspects related to sustainable development deserve more attention. Furthermore, sustainability is about adaptive capability, but also the process of creating opportunities. For instance, resource scarcity in respect of services and products requires a more sustainable basis of the actors involved, meanwhile empowering the same actors in taking preventive measures in case of animal health diseases. In the next section, we will focus how prevention of animal diseases in combination with knowledge sharing can fit into the local context in a more sustainable way.

Decentralization of veterinary services

In 2001, the Food and Agriculture Organization (FAO) of the United Nations has proposed a policy framework on the reform and decentralization of agricultural services (Smith, 2001). As part of the framework, governance and decentralization of veterinary services is examined, aiming at deciding what forms of and approaches to decentralization may be appropriate to reconsider. Against the backdrop of decentralization and improved service delivery, the author mentions that “decentralization aims at an economic and political system that responds more closely to people’s preferences and requirements and with a closer link with the people in the local areas”. To decrease the gap between suppliers and users of products and services, decentralization measures are expected to achieve three objectives: (a) improved efficiency in service provision, (b) more transparency of service providers and (c) better accountability to service users. In the context of the three objectives and according the decentralization paradigm, the hypothesis is that transparency and accountability will potentially lead to better service provision. By providing better services to the people in local areas, this may lead to more willingness to pay for veterinary services. Because of better and more reliable services, more costs will be covered from sources other than the central government. Costs covered from other resources may eventually lead to a decrease of the government’s role in the long term.

Commissioned by the United Nations, the study of FAO is conducted in Kenya and New Zealand. By examining veterinary services, the author emphasizes that returns on effective treatment are recognizable and that poor livestock owners are well aware of the advantages. However, the costs of providing veterinary services to poor livestock owners are often high, mostly because of the transport costs and time required to reach their locations. Given this fact, it is reasonable to give priority to the para-veterinary technicians in the communities provide primary services in rural areas. Primary services can be described in terms of training, certification of their competence and legal access to the market of veterinary products. As stated by the author, far-away areas in both countries are served by low level technicians. Hence, to improve efficiency in service provision, empowerment of the low level technicians in the local communities is required. In this case, to support the transition process of decentralization, a more pro-active government role may be justified on a temporary basis.

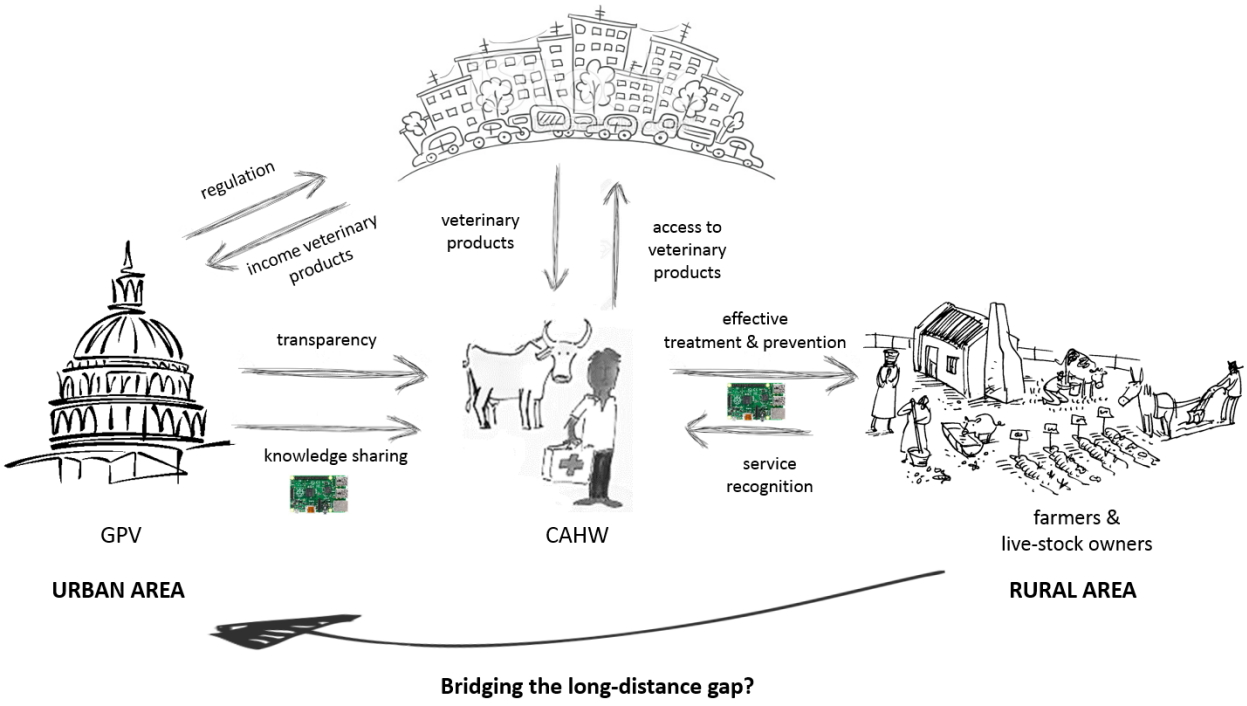
The result of the study underlines a part of the problem, which is described in section XX and specific in the case of Ghana. From the policy framework that is proposed, we see parallels with the challenges that the CAHWs in Ghana are facing, but also opportunities to overcome obstacles on the ground. From the perspective of the CAHW, the assumption is that legal market access both to veterinary products and knowledge from the GPVs may empower the low level CAHWs in their community. By supporting the CAHWs through knowledge and tools, local provision of veterinary services could be improved in rural areas. Furthermore, improved veterinary services may result in more willingness to pay for veterinary services and more importantly, better prevention of animal diseases. In addition, the role of government is

justified in two ways. Firstly, a pro-active government on temporary basis can support the process of transition and decentralization of veterinary services. Secondly, the role of the government should be connected to the main public interests. In this case, the government will remain active in control of epidemic diseases and inspection of meat and other livestock products to prevent outbreaks of animal diseases. However, we can argue that the government's position and the level of its involvement in each of these services may differ between countries and regions, and highly be dependent on the quality of service of the private sector.

Benefits

Based on the conducted review and against the backdrop of the contextual issues, in figure 5 a business model scenario is proposed. In this case, the business model scenario puts the emphasis on development of benefits rather than financial returns.

Figure 5 - business model scenario to decentralized veterinary services



The GPV, as part of the government, will provide knowledge information regarding animal health diseases in order to empower the CAHW. Meanwhile, the CAHW will gain access to the market of legal veterinary products, e.g. medicine and tools, which enables him to provide veterinary services. The assumption is that the combination of knowledge information and access to veterinary products will lead to more effective treatment and prevention of animal health diseases. Effective treatment and prevention as part of improved service delivery may lead towards better service quality in the communities, and more important, recognition of the CAHW amongst the farmers and live-stock owners. In addition, the local farmers and live-stock owners will have access to preventive information, giving them the opportunities to gain information from two channels, namely 1) from the CAHW and 2) from the Kasadaka service. Finally, by empowering the CAHW in the local community, the travel distance will also be reduced. The

local farmers and live-stock owners will not be forced to travel long distances to get veterinary services in case of animal diseases, or vice versa.

As stated earlier, in this case a proactive role of the government is justified. In this respect, the government may influence the veterinary products on the markets to prevent abuse in terms of illegal products. Furthermore, the GPV can contribute to more transparency, for example by demanding certification or license from the CAHWs in order to be able to provide veterinary services in rural areas.

Discussion and future work

In this report we suggest that the challenges faced by livestock dependent rural communities are apparent, yet they have root causes lying deeply under the surface. Many different factors contribute to the problem. In solving such an interwoven problem, there is no 'one size fits all' method. Instead, an open approach involving all stakeholders may yield better results.

This is in line with the essence of the ICT4D course. Throughout the course, the importance of involving the local beneficiaries has been emphasized. In our project we aim to follow a user-centric approach. Yet, the development itself was rather distant, as we gathered most insights from reviewing literature and information from secondary sources. The case description was based on a concrete local need, however the further development was done with no input from local stakeholders, except for the feedback gathered in Mali (note that the case description and the performed research were based on Ghana). Therefore, on a self-critical note, we can postulate the question to what extent the voices of the intended beneficiaries were truly included? We recognize this as a limitation of the developed prototype. Future work has the opportunity to use the contributions from our research and ground them in the local context through involvement of the beneficiaries our research has identified.

Furthermore, we recognize that our work depends on the assumption that the combination of knowledge information and access to veterinary products will lead to more effective treatment and prevention of animal health diseases. Future research needs to specifically address this assumption as it is central to the proposed solution. In empowering the community animal health workers and improving the performance, to be the front-line of disease prevention and surveillance in their communities, we emphasize the subtleties of the local contexts. For instance, the community animal health workers may have different capabilities and needs, therefore awareness of and focus on the local context is crucial.

Finally, we would argue that overcoming the above challenges and succeeding in empowering the CAHW to provide better animal health services, may not completely resolve the problem of the livestock dependent rural communities. Our literature review has shown that private veterinarians can be found where profits can be made. Therefore, we propose that livestock dependent rural communities may remain facing challenges as skilled people leave to urban areas in their pursuit of a better life. Rural communities cope with their specific problems, which may unfortunately be inherent to rural areas.

Conclusion

Exploring the context of animal health service delivery, it can be seen that many interwoven problems contribute to the overall problem. Yet, drawing on the insights provided by prior research, we propose a direction in which all stakeholders can collaborate, co-create value and together better the situation. We argue that empowering the community animal health worker through a combination of knowledge

information and access to veterinary products is central to overcoming obstacles such as better service provision, trust and the long-distance issues. We also make a practical contribution with the developed prototype, which can play a role in resolving the animal diseases problem in rural Ghana. We hope that this paper encourages future work to develop the prototype further, tests its underlying assumptions and further explore ways in which the technological artefact can be embedded in the societal context.

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Appendix

A - Usage Scenario

a). Installation instructions

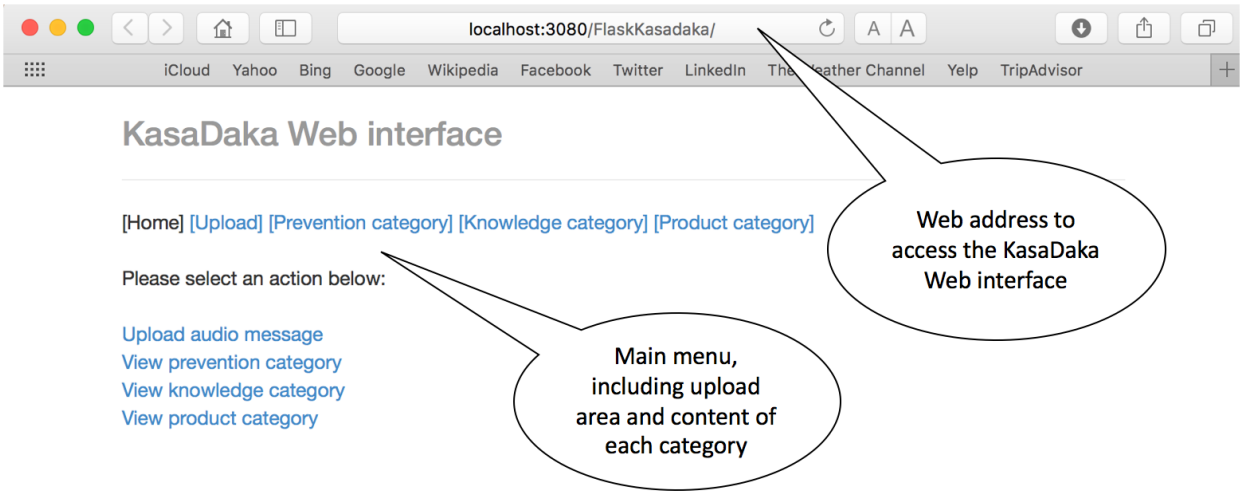
Installation instructions:

1. Import the KasaDaka appliance in Virtual Box and start the virtual
2. In the home directory, remove the entire KasaDaka folder
3. Install sqlite3 by running the following command: sudo apt-get install sqlite3
4. From the terminal, run the command: git clone http://github.com/alentoric/KasaDaka.git
5. From the terminal, run the command: sudo chmod -R 777 /home/kasadaka/KasaDaka/html/audio
6. You can now start the web application from your laptop by visiting the url http://localhost:3080/FlaskKasadaka/ or form the virtual by visiting the url http://localhost/FlaskKasadaka/
7. You can call the voice service by using Linphone and connecting to animalhealth@127.0.0.1

Important notes:

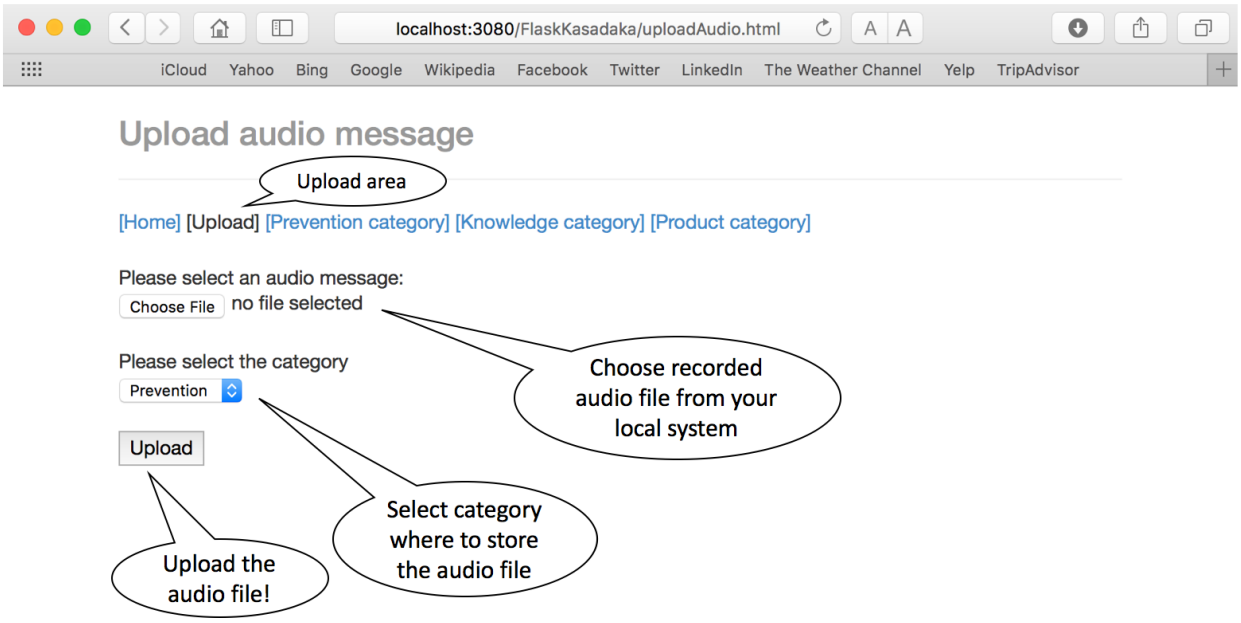
1. Make sure to check whether your home folder is named 'kasadaka'. If your home folder has a different name, please adjust the urls in the instruction above and in /home/{YOUR_HOME}/KasaDaka/FlaskKasadaka/FlaskKasadaka/config.py accordingly.
2. You can download test messages from http://passionforlearning.net/kasadaka/test-messages.zip

b). Kasadaka - web interface



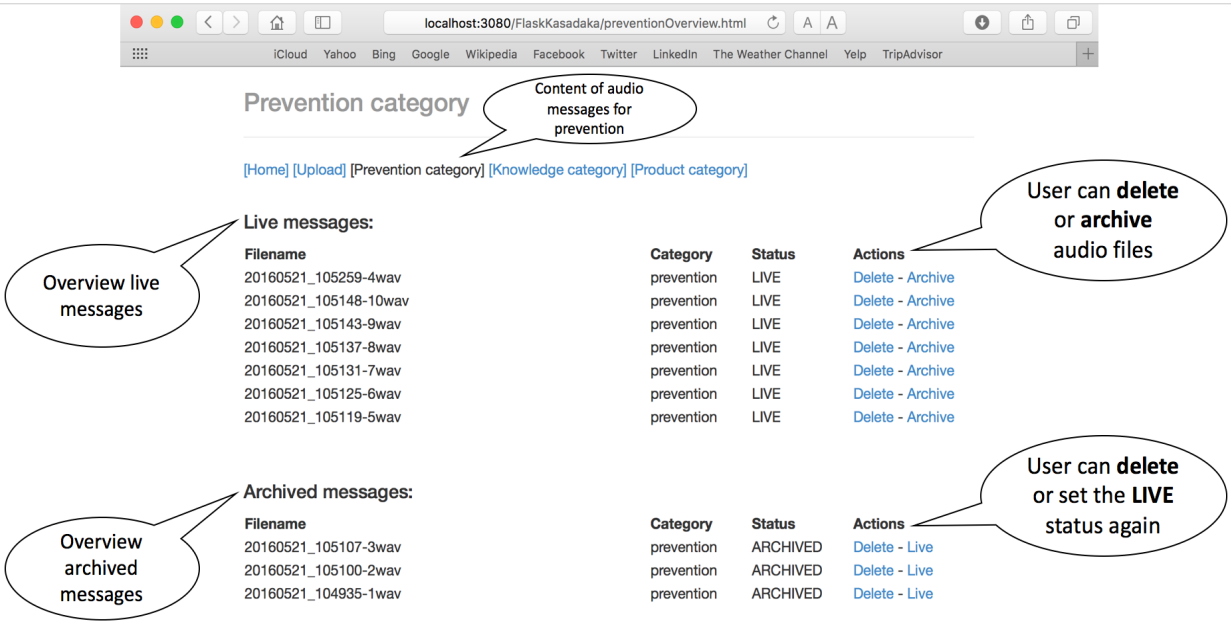
After the installation, the KasaDaka web interface can be visited by using the following link: http://localhost:3080/FlaskKasadaka. When the content is displayed correctly, the main menu will be presented. In the upper part of the web interface, an overview of the main menu is shown, including the upload area and content of the three main categories. Below, the user is able to choose to upload an audio file, or to view the content of a category.

c). Upload Audio Message



In the upload area, it is possible to upload an audio file from the local system and for a particular category. The user can choose between the categories prevention, knowledge or product.

d). Content of a Category



In each category, an overview of the uploaded audio files will be displayed. In the example above, we can find the overview for the prevention category. From the “Live messages” section, the user is able to archive or to delete audio messages. On the other hand, the user can decide to set a audio message to the “live” status in the section “Archived messages” or to delete the message. By calling the animal diseases health service, all the messages in the “Live messages” category will be played. For test purposes, you can call the voice service by using Linphone and connecting to animalhealth@127.0.0.1.